Discard old editions of this publication. Each year the appropriate sub-committee of the Ontario Pest Management Research and Services Committee reviews the pesticides listed in this publication.

To the best knowledge of the committee, at the time of printing, the pesticide products listed in this publication were:

- federally registered
- classified by the Ministry of the Environment and Climate Change (MOECC)

The information in this publication is general information only. The Ontario Ministry of Agriculture, Food and Rural Affairs does not offer any warranty or guarantee, nor does it assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

This publication lists a number of brand names of pesticides. It is neither an endorsement of the product nor a suggestion that similar products are ineffective.

The Pesticide Label

Consult each product label before you use a pesticide. The label provides specific information on how to use the product safely, hazards, restrictions on use, compatibility with other products, the effect of environmental conditions, etc.

The pesticide product label is a legal document. Follow all label directions.

Registration of Pesticide Products

The Pest Management Regulatory Agency (PMRA) of Health Canada registers pesticide products for use in Canada following an evaluation of scientific data to ensure that the product has merit and value, and the human health and environmental risks associated with its proposed use are acceptable.

1. Full Registration

Pesticide registrations are normally granted for a period of 5 years, subject to renewal.

2. Conditional Registration

Conditional registration may be granted for a specified, limited time period, where the registrant agrees to produce additional scientific or technical information.

3. Emergency Registration

An emergency registration is a temporary, time-limited registration of no more than 1 year, approved to deal with serious pest outbreaks that have limited control options.

Maximum Residue Limits

The PMRA has established maximum residue limits (MRLs) for pesticides. Processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market to determine if more restrictive limitations apply. Keep accurate and up-to-date records on pesticide use in each crop.

Supplemental Labels

You MUST obtain a supplemental label and follow all the label directions when PMRA approves new uses for a registered pesticide that do not appear on the current label.

Examples of when you must use a supplemental label include:

- Emergency Use Registration
- Minor Use Label Expansion

You can obtain a copy of a supplemental label from the pesticide manufacturer or pesticide vendor, the grower association that sponsored the emergency registration or minor use, from OMAFRA or PMRA’s Pest Management Information Service.

For more information on the federal registration status, search Pest Management Regulatory Agency at www.canada.ca or call 1-800-267-6315.

Regulation of Pesticides in Ontario

The MOECC is responsible for regulating pesticide sale, use, transportation, storage and disposal in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the Pesticides Act and Regulation 63/09.

All pesticides must be used in accordance with requirements under the Pesticides Act and Regulation 63/09, which are available on the e-laws website at ontario.ca/e-laws or by calling the ServiceOntario Publications Toll-Free number: 1-800-668-9938 or 416-326-5300.

Classification of Pesticides

The Ontario Pesticides Advisory Committee (OPAC) is responsible for reviewing and recommending to the MOECC, the classification of pesticide products before they can be sold or used in Ontario. Once approved by the MOECC, classified products are posted on the MOECC website: ontario.ca/pesticides.

Certification and Licensing

Growers and Their Assistants

For information about certification for growers and training for assistants, check the Ontario Pesticide Education Program website: www.opep.ca or call 1-800-652-8573.

Commercial Applicators (Exterminators) and Their Assisting Technicians

For more information about exterminator licensing and technician training, visit:

- the Ontario Pesticide Training and Certification website at www.ontariopesticide.com/index.cfm/home-page or call 1-888-620-9999 or 519-674-1575
- the Pesticide Industry Council’s Pesticide Technician Program website at www.hort-trades.com or call 1-800-265-5656 or e-mail pic@hort-trades.com
- the Pesticide Industry Regulatory Council (PIRC) at www.oipma.ca.
Acknowledgements
The information contained in this publication is printed following review by the Vegetable Sub-Committee under the Ontario Pest Management Services Committee.

If you need technical or business information
contact the Agricultural Information Contact Centre at
1-877-424-1300
ag.info.omafra@ontario.ca

Looking for vegetable production information on the Internet?
Check the OMAFRA website at
ontario.ca/crops

This publication contains pest control products that have been registered as of January 31, 2017 on field vegetable crops in Ontario. Any supplements to this publication will be posted on the OMAFRA website at ontario.ca/crops.

This publication is a companion to OMAFRA Publication 839, Ontario Field Vegetable Guide (expected release date: 2019). This publication will contain more comprehensive information on disease and insect pest biology and management strategies, and other information related to the production of field vegetables in Ontario.

Cover images
Front cover photo: (left to right) cabbage looper (credit: Jim Chaput, Ontario Ministry of Agriculture, Food and Rural Affairs) banana pepper, cutworms (credit: Elaine Roddy, Ontario Ministry of Agriculture, Food and Rural Affairs), tomatoes (credit: Shutterstock), pumpkins, sweet corn (credit: Shutterstock), potato flowers (credit: Shutterstock)

Back cover small photos: top left: spinach (credit: Shutterstock), bottom left: gourds, top right: tomatoes (credit: Shutterstock), bottom right: bean leaves
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  broccoli, Brussels sprouts, cabbage, cauliflower, kale,
  kohlrabi and specialty vegetables, including headed
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  cucumber, melons (including cantaloupe, muskmelon,
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  basil, cilantro, chive, dill, lavender, lemon balm,
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Introduction

Products Listed in This Book
Products listed in this book are registered for use on field vegetable crops and have been reviewed by the registrants and the Vegetable Sub-Committee under the Ontario Pest Management Services Committee.

Products are organized by pest for each vegetable crop. Consult each product label before you use a pest control product. Labels for registered pest control products are available at the Pest Management Regulatory Agency (PMRA) website at www.canada.ca (search “Pest Management Regulatory Agency”).

Crop Group Information
A crop group is a grouping of plant species based on botany and taxonomy (e.g., plant families), as well as on how the crops are produced. Crop groups are often further divided into smaller and more closely related subgroups. A pest control product may be registered on a subgroup, rather than the entire crop group. Crop groupings are used primarily to set maximum residue limits and establish a common pre-harvest interval (PHI) for a similar set of crops. It is important to remember that not all products have a crop group registration, and products registered on one crop are not necessarily registered on all members of its crop group. There are some crops that do not belong in a crop group. A complete list of all crops included in both original and revised crop groups can be found by searching “Residue Chemistry Crop Groups” on the Government of Canada’s website: www.canada.ca.

Levels of Control for Fungicides and Insecticides
The Efficacy Guidelines for Plant Protection Products in the Pest Management Regulatory Agency Directive 2003–04 define levels of control as follows:

**Fungicides**

**Control:** The product, when applied in accordance with the label directions, consistently reduces disease incidence and severity to a commercially acceptable level.

**Suppression:** Consistent control at a level that is not optimal, but still of commercial benefit. Suppression is not used for products that show highly variable performance.

**Insecticides**

**Control:** The product, when applied in accordance with the label directions, consistently reduces pest numbers or pest damage to a commercially acceptable level.

**Suppression:** The product, when applied in accordance with the label directions, does not consistently reduce pest numbers or pest damage to a commercially acceptable level. Under such situations, the level of performance offered by the product must still have value in a pest management program.

**Note:** These guidelines are currently suggestions and are under review by the Pest Management Regulatory Agency. Currently, approved Canadian labels may also include a statement “reduction in damage from” the target pest. This is an undefined level of control less than suppression, and this statement is still under review with the Pest Management Regulatory Agency.
1. Pest Management

Integrated pest management (IPM) is an approach to managing pests that uses all available strategies to reduce pest populations below an economic injury level. IPM does not advocate a continuous pesticide spray program to eradicate pests. Instead, it promotes the integration of cultural, mechanical, biological and chemical control strategies. Using these pest control strategies can minimize the adverse effects of pesticides on the environment and maintain economic returns.

An IPM program makes management decisions based on:

- pest identification, biology and behaviour
- resistance management strategies
- beneficial organisms
- monitoring techniques
- use and timing of appropriate management tools
- stage of crop growth
- recordkeeping

More detailed information on IPM for field vegetables can be found in OMAFRA publications such as:

- Publication 839, Ontario Field Vegetable Guide (expected release: 2019)
- Ontario CropIPM, onontario.ca/cropIPM
- Publication 700, Integrated Pest Management for Onions, Carrots and Lettuce in Ontario: A handbook for growers, scouts and consultants
- Publication 12, Sweet Corn Production Manual

Current information is also available on the OMAFRA website at onontario.ca/crops. Additional information is supplied via newsletters, meetings, field monitoring, demonstrations and pest management workshops.

For more information on available IPM programs, contact OMAFRA’s Agricultural Contact Centre at 1-877-424-1300, or the nearest OMAFRA Resource Centre.

For a list of available crop consultants providing monitoring services, contact OMAFRA’s Agricultural Information Contact Centre at 1-877-424-1300, or the nearest OMAFRA Resource Centre.

Pest Control Measures

Cultural and Mechanical

Integrated pest management incorporates cultural and mechanical practices to prevent or delay the development of pest outbreaks. Management tools include, but are not limited to:

- site selection
- crop rotation
- resistant/tolerant cultivars
- clean, certified seed
- sanitation
- elimination of alternative hosts
- inter-cropping
- water management (i.e., drainage, irrigation management)
- optimized plant and soil health
- barriers (i.e., row covers)
- encouraging natural enemies of crop pests

See Pest Management for Organic Vegetable Growers, on page 3, for more information on cultural, mechanical and biological controls.
Crop Rotation for Control of Diseases
Crop rotation can be an important practice for preventing some diseases caused by fungi, bacteria and nematodes. Rotation with non-susceptible crops for 3 years usually allows enough time for infected plant material in the soil to completely decompose. In the absence of susceptible plant material, these soil-borne pathogen organisms die off. For some soil-borne pathogens, such as phytophthora in peppers and cucurbit crops, a rotation longer than 3 years may be required.

Rotation only works when successive crops are not susceptible hosts. It is important to remember that plants in the same family (i.e., potatoes, tomatoes, peppers and eggplant) may all be susceptible to the same disease organisms. Do not rotate with plants in the same family.

Some diseases that are spread by wind or by insects may not be controlled by crop rotation. For example, some leaf blight organisms and powdery mildew fungi can blow into fields from neighbouring weeds and infested fields. However, crop rotation will reduce the level of many disease-causing organisms that remain in the soil or on crop residue left in a field.

Chemical Controls
Chemical controls include synthetic, inorganic and biological pesticides. They kill/inhibit development of target pests and thus limit subsequent pest populations. Plant defence activators (e.g., Regalia Maxx) induce natural plant defences against crop pests, but do not directly impact the plant pathogen itself. Applications of plant defence activators to crops may “activate” the defence response of the plant, thus inhibiting infection.

Chemical controls are important tools for crop protection when used as part of an IPM program. Understand the pest's life cycle and apply chemicals at the stage when the pest is most vulnerable. Select the appropriate product for the target pests.

To control insects, monitor fields closely. Spray according to action thresholds or at critical stages of crop development.

To control disease, apply fungicides prior to disease infection and development. Use factors such as weather conditions, crop stage and (where available) disease prediction models to assist in fungicide spray timing.

Insect Control in Vegetable Crops During Bloom
Healthy pollinator populations are an essential element to many vegetable operations. Honeybees and native pollinators provide pollination services or may enter other fields looking for an alternate source of pollen or water. Some pest control products are toxic to bees and other pollinators through direct contact. Systemic insecticide products may also pose a high risk to bees and other insect pollinators. Bees can be exposed to product residues in or on flowers, leaves, pollen, nectar and/or surface water. Do not apply insecticide or allow it to drift onto blooming crops or off-site habitat if bees are foraging in or adjacent to the treatment area.

Many insecticide and miticide labels and some fungicide labels have specific precautions about applications during bloom. Some insecticide labels may include several precautionary statements. Label statements may include, but are not limited to:

- do not use on flowering crops or weeds
- do not apply to flowering crops or weeds if bees are visiting the treated area
- avoid spraying when bees are foraging (see Precautions for Applying Insecticides, page 3)

Please note that the information in this publication is general information only. Read each pest control product label for information on bee toxicity. See Bee Poisoning, on page 19, for information on preventing bee poisoning. Also, search “Protecting Pollinators during Pesticide Spraying”, at www.canada.ca for more information.
### Precautions for Applying Insecticides

This is general information only. Read each pest control product label for specific precautions regarding bees and/or other pollinators.

**Dust generated during planting of treated seed may be harmful to bees and other pollinators:**
- Alias 240SC
- Cruiser 5FS
- Gaucho 480 FL
- Poncho 600FS

**Bees can be exposed to product residues on flowers, leaves, pollen and/or nectar resulting from seed treatment applications:**
- Actara 240SC
- Cruiser 5FS
- Fortenza
- Poncho 600FS
- Supresto 75WS
- Titan ST

**Do not use during crop or weed flowering period:**
- Approve
- Cygon 480
- Fulfill 50WG
- Lagon 480 E
- Lorsban 15G
- Lorsban 50W
- Lorsban 4E/Lorsban NT
- Movento 240SC
- Nufos 4E
- Piranex 480EC
- Warhawk 480 EC

**Do not apply to flowering crops or weeds if bees are visiting the treated area:**
- Actara 240SC²
- Actara 25WG²
- Admire 240F³
- Agri-Mek 1.9%-EC
- Agri-Mek SC
- Alias 240SC
- Assail 70WP
- Clutch 50WDG
- Concept
- Delegate WG
- Diazinon 500E
- Diazinon 50WSP
- Entrust 80
- Entrust
- Exirel
- Grapple²
- Imidan 70-WP
- Lannate TNG
- Malathion 25W
- Malathion 85E
- Matador 120EC
- Oberon Flowable¹
- Orthene 75% SP
- Radiant SC
- Rimon 10 EC
- Silencer 120 EC
- Success
- Thionex 50W WSP
- Thionex EC
- Voliam Xpress
- Vydate L

**Avoid spraying when bees are foraging:**
- Ambush 500EC
- Decis 5 EC
- Dibrom
- Perm-UP
- Pounce 384EC
- Mako
- Sivanto Prime
- Sevin XLR
- TwinGuard
- UP-Cyde 2.5 EC

¹ Bee brood may be exposed to residues in or on pollen and nectar brought back to the hive by bees foraging on flowering crops and weeds.
² Bees may be exposed directly, through spray drift, or to residues on/in leaves, pollen and nectar in flowering crops and weeds.

---

### Natural Enemies (Beneficials)

Natural enemies are beneficial organisms, including predatory insects, parasites, pathogens and nematodes, which help suppress crop pest populations. Many beneficials occur naturally in the environment; others may be introduced to field or greenhouse production. To learn more about natural enemies in field vegetable crops, see the Great Lakes Vegetable Working Group website at [http://www.ncipmc.org/glvwg/](http://www.ncipmc.org/glvwg/).

Beneficials will not completely eliminate damage by pests. However, once they are established, they can maintain pest populations at lower levels. They are also effective at controlling indirect pests such as aphids, leafhoppers and mites. Beneficials are less effective at keeping populations of direct pests (those attacking the harvested product) at levels acceptable for commercial production. One of the advantages of beneficial insects is that their activities can prevent or delay the development of pesticide resistance.

Where possible, select chemical control products that will not harm the beneficials. Toxicity information regarding beneficial insects is available on some pest control product labels.

---

### Pest Management for Organic Vegetable Growers

Several organic certification bodies serve Ontario farms and processors. Contact these organizations to get information on how to be certified. For more information on certification, as well as addresses and links to details of the organic regulations and standards, see the Infosheet *Organic Food and Farming Certification* at [ontario.ca/organic](http://ontario.ca/organic).
Pest management in organic production involves the use of numerous control strategies aimed at preventing pest problems before they appear. In organic production, pest control products should be used as a last resort, only when other management practices have not been sufficient to prevent the pest from causing economic damage to the crop.

**Organic and Biopesticide Pest Control Products**

Organic pest control products are pesticides that are approved for use in organic production. For organic products, both the active ingredient and all additional ingredients must be derived from natural sources (typically biological or botanical).

All organic pest control products must be registered by the PMRA on the pest and crop on which they are used, and meet the requirements of the Canadian Organic Standards and any additional requirements of the local organic certification body.

Biopesticides are products derived from natural materials such as plant extracts, bacteria and minerals. It is important to note that the definition of a biopesticide varies between organizations and countries. In Canada, biopesticides are divided into two major classes, microbial and biochemical pesticides.

Microbial pesticides contain a beneficial microorganism, such as a bacterium, fungus, virus or protozoan, as the active ingredient. They are relatively specific to their target pest. Microbial pesticides registered for use in vegetables include *Bacillus subtilis* (e.g., Serenade SOIL) and the various subspecies and strains of *Bacillus thuringiensis* (e.g., Bioprotec).

Biochemical pesticides are naturally occurring substances and/or their synthetic analogues. A synthetic analogue is a manufactured molecule that resembles a naturally occurring substance. They generally control pests by different mechanisms than conventional pesticides or by making crops unsuitable for feeding. While many biopesticides are less toxic and pose a lower risk than conventional pesticides, some can be quite toxic.

While many biopesticides are used in organic production, it is important to be aware that not all biopesticides are organically acceptable and that not all organic products are biopesticides. In some cases, the active ingredient may be organic, but it may be formulated with other ingredients that are not acceptable for organic production (e.g., some formulations of the bacteria *Bacillus thuringiensis*). Similarly, there are organic pest control products that do not meet the definition of a biopesticide (e.g., copper is a mineral and not considered a biopesticide).

**Organic Products in Conventional Production**

While organic and biopesticide products are used most widely by organic producers, they can be a useful tool for conventional growers as well. Possible advantages for conventional producers include:

- lower potential for pest resistance
- providing a rotational option to help manage resistance development in other conventional products
- shorter re-entry intervals
- shorter pre-harvest intervals
- potentially lower toxicity to non-target organisms

While organic products and biopesticides can be helpful additions to IPM programs, they may not provide the same high level of control as conventional pesticides. Biopesticides are often labelled for suppression or partial suppression of pests. To improve control, combine their use with the other pest control tactics mentioned in the previous section.

**Using Organic and Biopesticide Products**

Although many organic and biopesticide products are formulated, packaged and applied in a very similar fashion to conventional pesticides, the active ingredients are different. They have unique, specialized modes of action that make them more susceptible to numerous biological and environmental factors.
Some of the possible challenges associated with using these products are:

- more frequent applications needed to control pests
- slower acting than conventional pesticides
- may provide suppression but not control of the pest
- more expensive than conventional pesticides
- fewer pests controlled

**Resistance Management**

Resistance is the ability of a pest to survive exposure to a pesticide at a rate or concentration that previously controlled it. Resistance to a pesticide develops after repeated exposure to a specific chemical or chemical family. A few naturally occurring resistant individuals survive after each application, while the susceptible portion of the population is killed. These resistant survivors multiply and gradually replace the susceptible ones. Eventually the resistant population dominates, and the pesticide loses efficacy.

There are many potential causes for pest control failures. Before assuming a population is resistant to a product, consider the following factors, which may affect the effectiveness of pest control products:

- **Product selection** — Select the appropriate product that has activity and is labelled for the specific pest(s)/crop combination. Certain pest control products may work only under specific circumstances (i.e., pests to be controlled, weather and soil conditions, timing, etc.).
- **Water volume** — See Water Volumes, on page 9.
- **Rate** — Ensure that pest control products are applied at the rate(s) indicated on the label.
- **Calibration and coverage** — See Coverage, on page 9.
- **Timing** — Some pest control products may work on specific life stages of a pest.
- **Water pH** — Some pest control products have water pH requirements.
- **Time required for knockdown of pest** — Some pest control products have delayed effects.
- **Weather conditions** — See Air Temperature and Relative Humidity, Rainfall, and Wind Speed, Temperature Inversions and Drift, on page 10.

Resistance to pesticides can develop very quickly. Do not use the same chemical repeatedly unless it is used in rotation with a different chemical or used in combination with other chemicals having a different mode of action.

Many chemicals with the same active ingredients are marketed under different brand names. For example, the insecticide chlorpyrifos is marketed under the brand names Lorsban, Pyrifos, Nufos, Pyrinex and Warhawk.

Different chemicals may also have the same mode of action. For example, both Assail and Admire, although different active ingredients, have the same mode of action. Using Assail after Admire is equivalent to using Assail after Assail, since resistance to both chemicals develops at the same time, even though only one may have been used repeatedly.

Certain pests are more prone to develop resistance to pesticides than others. Pests with a short life cycle and many generations per growing season are more likely to develop resistance. Pests are more likely to develop resistance to pesticides that have a single mode or site of action than to those with multiple modes of action.

See Table 1–1. Insecticide Groups Based on Sites of Action, on page 6, and Table 1–2. Fungicide Groups Based on Mode of Action, on page 7, for a list of chemical families and their modes of action.

The pest control tables in Chapter 3, Crop Protection, starting on page 25, list the chemical group (Group Name (Group #)) for each pest control product. Over the course of the season, rotate between products from different chemical groups.
### Table 1–1. Insecticide Groups Based on Sites of Action

The classification scheme listed below is adapted from the Insecticide Action Committee Mode of Action Classification (IRAC) 8.1 (April 2016).

<table>
<thead>
<tr>
<th>Group #1</th>
<th>Primary Site of Action</th>
<th>Group Name1</th>
<th>Product name(s)2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>acetylcholinesterase inhibitors</td>
<td>carbamates</td>
<td>Lannate TNG, Sevin XLR, Vydate L</td>
</tr>
<tr>
<td>1B</td>
<td>organophosphates</td>
<td></td>
<td>Cygon 480, Diazinon 500 E, Dibrom, Imidan 70 WP, Lagon 480 E, Lorsban 15G, Lorsban 4E, Lorsban 50W, Lorsban NT, Malathion 85E, Nufos 4E, Orthene 75 SP, Pyrifos 15G, Pyrínex 480 EC, Thimet 20-G, Warhawk 480 EC</td>
</tr>
<tr>
<td>3A</td>
<td>sodium channel modulators</td>
<td>pyrethroids</td>
<td>Ambush 500EC, Capture 240EC, Concept, Decis 5 EC, Force 3.0G, Mako, Matador 120EC, Perm-UP Pounce 384EC, Silencer 120 EC, UP-Cyde 2.5 EC, Voliam Xpress</td>
</tr>
<tr>
<td>4A</td>
<td>nicotinic acetylcholine receptor competitive modulators</td>
<td>neonicotinoids</td>
<td>Admire 240 F, Admire 240 SPT, Assail 70 WP, Actara 240 SC, Actara 25WG, Alias 240 SC, Clutch 50 WDG, Concept, Cruiser 5FS, Gaugh 480 FL, Grapple 2, Poncho 600 FS, Sepresto 75 WS, Titan</td>
</tr>
<tr>
<td>4C</td>
<td>sulfoximines</td>
<td></td>
<td>Closer, TwinGuard</td>
</tr>
<tr>
<td>4D</td>
<td>butenolides</td>
<td></td>
<td>Sivanto Prime</td>
</tr>
<tr>
<td>5</td>
<td>nicotinic acetylcholine receptor allosteric modulators</td>
<td>spinosyns</td>
<td>Delegate WG, Entrust, Entrust 80, Success, TwinGuard</td>
</tr>
<tr>
<td>6</td>
<td>Glutamate-gated chloride channel allosteric modulators</td>
<td>avermectins</td>
<td>Agri-Mek 1.9% EC, Agri-Mek SC</td>
</tr>
<tr>
<td>8B</td>
<td>non-specific inhibitors</td>
<td>chloropicrin</td>
<td>Chloropicrin 100, Pic Plus</td>
</tr>
<tr>
<td>8F</td>
<td>methyl isothiocyanate generators</td>
<td></td>
<td>Basamid GR, Busan 1020, Busan 1180, Busan 1236, Enfuse M 510, Vapam HL</td>
</tr>
<tr>
<td>9B</td>
<td>selective homopteran feeding blockers</td>
<td>pymetrozine</td>
<td>Fulfill 50WG</td>
</tr>
<tr>
<td>11A</td>
<td>microbial disruptors of insect midgut membranes</td>
<td>Bacillus thuringiensis</td>
<td>Bioprotec 3P, Bioprotec CAF, Dipel 2X DF, Thuricide HPC</td>
</tr>
<tr>
<td>15</td>
<td>inhibitors of chitin biosynthesis, type 0</td>
<td>benzoyleurases</td>
<td>Rimon 10 EC</td>
</tr>
<tr>
<td>17</td>
<td>moultng disruptor, Dipteran</td>
<td>cyromazine</td>
<td>Citation 75WP, Governor 75WP</td>
</tr>
<tr>
<td>18</td>
<td>ecdysone receptor agonists</td>
<td>diacylhydrazines</td>
<td>Intrepid</td>
</tr>
<tr>
<td>20B</td>
<td>mitochondrial complex III electron transport inhibitors</td>
<td>acequinocyl</td>
<td>Kanemite 15 SC</td>
</tr>
<tr>
<td>20D</td>
<td>bifenzate</td>
<td></td>
<td>Acramic 50WS</td>
</tr>
<tr>
<td>23</td>
<td>inhibitors of acetyl CoA carboxylase</td>
<td>tetronic and tetramic acid derivatives</td>
<td>Movento 240 SC, Oberon Flowable</td>
</tr>
<tr>
<td>28</td>
<td>ryanodine receptor modulators</td>
<td>diamides</td>
<td>Coragen, Exirel, Fortenza, Verimark, Voliam Xpress</td>
</tr>
<tr>
<td>29</td>
<td>chordotonal organ modulators</td>
<td>fonicamid</td>
<td>Beleaf 50SG</td>
</tr>
<tr>
<td>NC</td>
<td>not classified</td>
<td>not classified</td>
<td>BotaniGard 22 WP, BotaniGard ES, Kopa Insecticidal Soap, Opal Insecticidal Soap, Safer's Trounce, Sluggo Professional, Superior 70 Oil, Surround WP</td>
</tr>
</tbody>
</table>

1 Although sharing the same primary target site, it is possible that not all members of a single major mode of action (MoA) class have been shown to be cross-resistant. However, for the purposes of this classification system, it should be assumed that cross-resistance exists between compounds in any one sub-group.

2 Some products are listed in more than one group because they contain more than one active ingredient from different groups.
### Table 1–2. Fungicide Groups Based on Mode of Action

This classification scheme is based on the Fungicide Resistance Action Committee (FRAC) List, February 2016.

<table>
<thead>
<tr>
<th>Group #</th>
<th>Mode of Action (Target Site)</th>
<th>Group Name</th>
<th>Product Name(s)</th>
<th>Risk of Developing Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>mitosis and cell division (ß-tubulin assembly)</td>
<td>MBC (Methyl-Benzimidazole Carbamates)</td>
<td>Senator 70 WP, Senator PSPT, Senator 50 SC</td>
<td>high</td>
</tr>
<tr>
<td>2</td>
<td>signal transduction (MAP/Histidine-kinase)</td>
<td>dicarboximides</td>
<td>Rovral</td>
<td>medium to high</td>
</tr>
<tr>
<td>3</td>
<td>sterol synthesis in membranes (C14-demethylase)</td>
<td>DMI (demethylation inhibitors)</td>
<td>Aprovia Top, Bumper 432 EC, Caramba, Dividend XL RTA, Ernesto Silver, Folicur 432F, Inspire, Maxim D, Mettle 125 ME, Nova, Proline 480 SC, Quadris Top, Quash, Quilt, Stadium, Stratego PRO, Tilt 250E</td>
<td>medium</td>
</tr>
<tr>
<td>4</td>
<td>nucleic acids synthesis (RNA polymerase I)</td>
<td>phenylamides</td>
<td>Allegiance FL, Apron Maxx RFC, Apron XL LS, Dividend XL RTA, Maxim XL, Ridomil Gold 1G, Ridomil Gold 480 SL, Ridomil Gold MZ 68 WG</td>
<td>high</td>
</tr>
<tr>
<td>7</td>
<td>respiration (complex II: succinate-dehydrogenase)</td>
<td>SDHI (succinate dehydrogenase inhibitors)</td>
<td>Aprovia, Aprovia Top, Cantus WDG, Ernesto Silver, Fontelis, Kenja 400 SC, Lance WDG, Luna Tranquility, Pristine WG, Pro-Gro, Sercadis, Vertisan, Vitaflo 280</td>
<td>medium to high</td>
</tr>
<tr>
<td>9</td>
<td>amino acids and protein synthesis (methionine biosynthesis)</td>
<td>AP (anilino-pyrimidines)</td>
<td>Luna Tranquility, Scala SC, Switch 62.5 WG</td>
<td>medium</td>
</tr>
<tr>
<td>11</td>
<td>respiration (complex III: cytochrome bc1)</td>
<td>Qol (quinone outside inhibitors)</td>
<td>Acapela, Cabrio EG, Cabrio Plus, Dynasty 100 FS, Flint, Headline EC, Pristine WG, Quadris Flowable, Quadris Top, Quilt, Reason 500 SC, Stadium, Stratego PRO, Tanos 50 DF</td>
<td>high</td>
</tr>
<tr>
<td>12</td>
<td>signal transduction (MAP/Histidine-kinase)</td>
<td>PP (phenylpyrroles)</td>
<td>Apron Maxx RFC, Maxim 480 FS, Maxim D, Maxim Liquid PSP, Maxim MZ PSP, Maxim PSP, Maxim XL, Scholar 230 SC, Stadium, Switch 62.5 WG</td>
<td>low to medium</td>
</tr>
<tr>
<td>13</td>
<td>signal transduction</td>
<td>aza-naphthalenes</td>
<td>Quintec</td>
<td>medium</td>
</tr>
<tr>
<td>17</td>
<td>sterol biosynthesis in membranes (3-keto reductase, C4-demethylation)</td>
<td>hydroxyanilides</td>
<td>Decree 50 WDG</td>
<td>low to medium</td>
</tr>
<tr>
<td>21</td>
<td>respiration (complex III: cytochrome bc1)</td>
<td>Qol (quinone inside inhibitors)</td>
<td>Ranman 400 SC, Torrent 400 SC</td>
<td>medium to high</td>
</tr>
<tr>
<td>22</td>
<td>mitosis and cell division (ß-tubulin assembly)</td>
<td>benzamides</td>
<td>Gavel 75 DF</td>
<td>low to high</td>
</tr>
<tr>
<td>24</td>
<td>amino acids and protein synthesis (protein synthesis)</td>
<td>hexopyranosyl antibiotic</td>
<td>Kasumin 2 L</td>
<td>medium</td>
</tr>
<tr>
<td>27</td>
<td>unknown</td>
<td>cyanoacetamide oxime</td>
<td>Curzate 60 DF, Tanos 50 DF</td>
<td>low to medium</td>
</tr>
<tr>
<td>29</td>
<td>respiration (uncoupler of oxidative phosphorylation)</td>
<td>2,6-dinitroanilines</td>
<td>Allegro 500 F</td>
<td>low</td>
</tr>
<tr>
<td>33</td>
<td>unknown</td>
<td>phosphonates</td>
<td>Aliette WDG, Confiene Extra, Phostrol, Rampart</td>
<td>low</td>
</tr>
<tr>
<td>40</td>
<td>cell wall synthesis (cellulose synthase)</td>
<td>carboxylic acid amides</td>
<td>Acrobat 50 WP, Forum, Orondis Ultra A, Revus, Zampro</td>
<td>low to medium</td>
</tr>
<tr>
<td>43</td>
<td>mitosis and cell division (delocalization of spectrin-like proteins)</td>
<td>benzamides</td>
<td>Presidio</td>
<td>resistance not known</td>
</tr>
<tr>
<td>44</td>
<td>lipid synthesis and membrane integrity (microbial disrupters of pathogen cell membranes)</td>
<td>microbial</td>
<td>Cease Biological, Serenade Opti, Serenade SOIL</td>
<td>resistance not known</td>
</tr>
</tbody>
</table>

1 Some products are listed in more than one group because they contain more than one active ingredient from different groups.
### Table 1–2. Fungicide Groups Based on Mode of Action

This classification scheme is based on the Fungicide Resistance Action Committee (FRAC) List, February 2016.

<table>
<thead>
<tr>
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<th>Mode of Action (Target Site)</th>
<th>Group Name</th>
<th>Product Name(s)</th>
<th>Risk of Developing Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>respiration (complex III: cytochrome bc1)</td>
<td>QoSI (Quinone outside Inhibitor)</td>
<td>Zampro</td>
<td>medium to high</td>
</tr>
<tr>
<td>46</td>
<td>cell membrane disruption (proposed)</td>
<td>plant extract</td>
<td>Timorex Gold</td>
<td>resistance not known</td>
</tr>
<tr>
<td>M1</td>
<td>multi-site contact</td>
<td>inorganic</td>
<td>Copper 53W, Copper Spray, Coppercide WP, Cueva, Kocide 2000, Parasol Flowable, Parasol WG, Coppercide WP</td>
<td>low</td>
</tr>
<tr>
<td>M2</td>
<td>multi-site contact</td>
<td>inorganic</td>
<td>Microthiol Disperss, Microscopic Sulphur</td>
<td>low</td>
</tr>
<tr>
<td>M3</td>
<td>multi-site contact</td>
<td>dithiocarbamates</td>
<td>Cabrio Plus, Dithane Rainshield, Dithane F-45, Ferbam 76 WDG, Gavel 75DF, Granuflo-T, Manzate Pro-Stick, Maxim MZ PSP, Penncozeb 75DF Raincoat, Polyram DF, Pro-Gro, PSPT 16%, Ridomil Gold MZ 68WG, Solan MZ, Thiram 75 WP, Tuberseal, Vitaflo 280</td>
<td>low</td>
</tr>
<tr>
<td>M4</td>
<td>multi-site contact</td>
<td>phthalimides</td>
<td>Folpan 80 WDG, Maestro 80DF, Supra Captan 80 WDG</td>
<td>low</td>
</tr>
<tr>
<td>M5</td>
<td>multi-site contact</td>
<td>chloronitiles</td>
<td>Bravo ZN, Echo 720, Echo 90DF</td>
<td>low</td>
</tr>
<tr>
<td>U8</td>
<td>actin disruption (proposed)</td>
<td>aryl-phenyl-ketone</td>
<td>Vivando SC</td>
<td>medium</td>
</tr>
<tr>
<td>U15</td>
<td>oxysterol binding protein (OSBP) inhibition (proposed)</td>
<td>piperidinyl-thiazole-isoxazolines</td>
<td>Orondis Ultra B</td>
<td>medium to high</td>
</tr>
<tr>
<td>P1</td>
<td>host plant defence induction (salicylic acid pathway)</td>
<td>benzo-thiadiazole</td>
<td>Actigard 50WG</td>
<td>resistance not known</td>
</tr>
<tr>
<td>P5</td>
<td>host plant defence induction</td>
<td>plant extract</td>
<td>Regalia Maxx</td>
<td>resistance not known</td>
</tr>
<tr>
<td>NC</td>
<td>not classified (unknown)</td>
<td>diverse</td>
<td>Actinovate SP, Bio-Save 10 LP, Contans WG, Fracture, MilStop, Mycostop, Prestop, PureSpray Green Spray Oil 13E, Rootshield Granules, Rootshield HC, Storox, Tivano</td>
<td>resistance not known</td>
</tr>
</tbody>
</table>

1 Some products are listed in more than one group because they contain more than one active ingredient from different groups.

---

**Steps to Delay the Development of Pesticide Resistance**

- Rotate between products from different chemical groups. Avoid the repeated use of any one pesticide or group of pesticides.
- Follow the pesticide label. Many products make specific recommendations about the maximum number of sequential applications and the maximum number of total applications permitted in one season.
- When applying a pesticide, use the appropriate rate, timing, water volume, nozzle selection and water pH.
- Ensure the sprayer is well maintained and properly calibrated.
- Follow an IPM program that makes use of a variety of different pest management strategies, including cultural, mechanical, biological and chemical options.
- Spray insecticides only when necessary. Use established thresholds where available.
- Apply pest control products preventively before disease occurs. Wherever possible, follow disease prediction models. Applying fungicides in an attempt to eradicate a disease after it has become established is rarely effective and can increase the risk of selecting for resistant populations of the pathogen.
• When tank-mixing pest control products, ensure that each component belongs to a different chemical group with a different mode of action. Also ensure that they are compatible as a tank mix. Compatibility issues may result in problems in the tank or in reduced control or crop damage due to chemical interactions.
• If you experience a control failure after using a registered product, do not reapply the same pesticide.
• Keep accurate records of the type of product used during each application throughout the season.

Resistance can be costly to the grower. The development and registration of new products is expensive and time consuming. Prudent use of pesticides will help reduce the development of resistant populations and conserve the effectiveness of existing products.

### Spraying Vegetable Crops

#### Water Volumes

When the pesticide label does not prescribe a carrier volume, the spray operator must decide the appropriate volume. Ideally, it will be enough to suspend the product in solution and distribute spray droplets evenly over the target surface(s) but not so much as to cause excess spray to run off the plants. Most insecticides/fungicides are applied in 135–450 L/ha of water. Herbicide applications range from 55–350 L/ha. There are always exceptions. The spray operator must consider a few factors when determining an appropriate volume:

The mode of action of the product being applied. For example, a contact product will require a higher droplet density than a locally systemic product, which has limited translocation in plant tissues.

The location of the target. For example, if the target is a mobile insect found predominately on the upper side of the leaf surface, it will be easier to spray and lower carrier volumes will be required. However, if the target is a disease that occurs deep in the plant canopy, more carrier volume will be required to penetrate and contact the pest.

The row spacing, size, density and stage of development of the crop. The more plant canopy to be protected per hectare, the more carrier volume will be required to adequately cover all surfaces.

#### Coverage

Coverage can be defined as the number of discrete spray droplets per target area, combined with the total area covered. For example, a single large droplet impinging on a leaf would not be as effective as 100 smaller droplets evenly distributed over the leaf surface, even though they deliver the same amount of product. Good coverage on the upper, and often lower, leaf surface is an essential component of the performance of many fungicides and insecticides.

To confirm sufficient coverage, the sprayer operator requires some form of feedback. Visually inspecting foliar “wetness” and spray residue, or waiting to see if the spray successfully controlled the pest is not sufficient. Water-and-oil sensitive paper is a tool that can be used to assess spray coverage in the field. Table 1–3. Water-and-Oil Sensitive Paper — Recommended Droplet Density, on this page, illustrates the paper manufacturer’s recommended droplet density per square centimeter for insecticide, herbicide and fungicide applications.

#### Table 1–3. Water-and-Oil Sensitive Paper — Recommended Droplet Density

<table>
<thead>
<tr>
<th>Number of droplets per cm²</th>
<th>Application Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–30</td>
<td>insecticides</td>
</tr>
<tr>
<td>20–30</td>
<td>herbicides (pre-emergence)</td>
</tr>
<tr>
<td>30–40</td>
<td>contact herbicides (post-emergence)</td>
</tr>
<tr>
<td>50–70</td>
<td>fungicides</td>
</tr>
</tbody>
</table>

#### Nozzle Selection

All agricultural spray nozzle manufacturers classify the output rate and range of droplet sizes produced by each of their nozzles. This information appears in their catalogues as tables linking droplet size classification to nozzle size (output rate typically in U.S. gal/min.) and spray pressures (typically in lb/in.²).

The American Society for Agricultural and Biological Engineers (ASABE) Standard S-572.1 droplet size classifications associate a colour and a code to flat fan nozzles to indicate their average droplet size (see Table 1–4. ASABE ISO Standard Tip Colours and Symbols Denoting Volume Median Diameter for Flat Fan Nozzles). Be aware that hollow cone nozzles are only just beginning to adopt these standards, and the manufacturer’s catalogue should be consulted to confirm droplet sizes and rates.
<table>
<thead>
<tr>
<th>Category</th>
<th>Symbol</th>
<th>Colour Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra fine</td>
<td>XF</td>
<td>purple</td>
</tr>
<tr>
<td>Very fine</td>
<td>VF</td>
<td>red</td>
</tr>
<tr>
<td>Fine</td>
<td>F</td>
<td>orange</td>
</tr>
<tr>
<td>Medium</td>
<td>M</td>
<td>yellow</td>
</tr>
<tr>
<td>Coarse</td>
<td>C</td>
<td>blue</td>
</tr>
<tr>
<td>Very coarse</td>
<td>VC</td>
<td>green</td>
</tr>
<tr>
<td>Extra coarse</td>
<td>XC</td>
<td>white</td>
</tr>
<tr>
<td>Ultra coarse</td>
<td>UC</td>
<td>black</td>
</tr>
</tbody>
</table>

Most fungicides and insecticides require medium or medium-to-fine spray droplets. Smaller droplets are easily carried away on the wind and/or evaporate before hitting the target, resulting in pesticide drift and poor spray coverage. Poor spray coverage is a common cause of control failures. Coarse (or larger) droplets will greatly reduce the possibility of herbicide spray drift but should be used with higher carrier volumes to increase the number of droplets required for sufficient coverage of plant surfaces for insecticides or fungicides. Be aware that coarse droplets are prone to run-off and do not cover under-leaf surfaces without air-assist.

Hollow-cone nozzles produce more droplets with a finer size than solid-cone nozzles. Hollow- and solid-cone nozzles are particularly suited to the application of wettable powders, flowables and suspensions, and may assist in penetrating dense crop canopies such as field tomato, particularly when combined with an air-assist curtain. However, excessive boom height and ambient wind will cause significant drift from these nozzles unless the sprayer is equipped with shrouds or an air-assist system to intercept drifting spray. Further, the pumps on many field sprayers may not produce sufficient pressure to properly operate cone nozzles, which typically run at 50 psi and greater.

Flat fan nozzles on approximately 50-cm centres provide uniform spray distribution across the whole boom. They are frequently used for herbicide applications but are becoming more common for fungicide and insecticide application as well. The newer, low-pressure air induction (aka Venturi) flat fan nozzles produce very coarse droplets that reduce drift significantly but, once again, may require higher carrier volumes to produce the critical droplet density required for coverage.

**Air Temperature and Relative Humidity**

Pesticides can cause phytotoxicity or burning of plant foliage or flowers if applied during very hot weather (temperatures above 25°C). In hot conditions, avoid midday applications, as plants will be more prone to injury. Spraying during hot conditions may also cause a large portion of the spray droplets to evaporate before they hit the target, reducing efficacy and increasing drift. For more information about weather conditions, see the OMAFRA Factsheet *How Weather Conditions Affect Spray Applications*.

During conditions of high relative humidity (greater than 80% relative humidity), the drying of the spray materials will be delayed. Slow and prolonged drying of pesticides can lead to phytotoxicity in some instances.

Synthetic pyrethroid insecticides (e.g., Mako, Decis, Pounce, Matador, etc.) break down quickly when air temperatures are above 25°C, reducing their effectiveness. If possible, apply these in the evening, when temperatures have dropped, or select a different product.

**Rainfall**

The decision to spray just prior to a rain or shortly after should be based on plant protection. This may be more critical when applying fungicides. Fungicides are most effective if the leaf is adequately covered prior to infection. Once they have dried, most fungicides can withstand about 2.5 cm of rainfall and still provide adequate protection.

Many pre-emergent herbicides are best applied before a rain. Moist soils allow for better distribution of the herbicide within the seed zone. Post-emergent applications are best applied after a rain or should be timed to allow adequate drying prior to rainfall.

**Wind Speed, Temperature Inversions and Drift**

When applying fungicides and insecticides, moderate air movement helps move the product in and around the crop. In addition, light winds will help in the drying process. Optimum air movement is 3–10 km/h.

Drift potential is affected by the interaction of boom height, droplet size and ambient wind speed. To avoid particle drift, do not spray when wind speeds are high or gusty. Spraying during periods of dead calm is not advised, because spray may remain suspended in the air until the wind changes and potentially be carried off-target.
Spraying fine droplets and/or a volatile agrichemical (e.g., 2,4-D, dicamba, etc.) when a period of weather stagnation or a strong temperature inversion is expected within 24 hours of completing the application can lead to vapour drift. This occurs when fine particles or volatilizing pesticide gets trapped and concentrated in the inversion layer, and move unpredictably over great distances within that layer.

For more information on preventing pesticide drift, see Manage Drift, on page 20, and the OMAFRA Factsheet Pesticide Drift From Ground Applications.

**Soil Fumigation**

Soil fumigants are used to control soil-borne pests of vegetables, including nematodes, weeds and plant pathogens. When using a fumigant, always follow the instructions on the label carefully regarding rates, soil/field conditions, application and sealing methods, plant back intervals and safety. Proper use of fumigants is important for safety and efficacy. Shank-injection of fumigants is preferable, as this application method reduces the volatilization of the fumigant gas, which greatly lessens the potential for the gas to drift off-target.

Prior to application, work the soil to a depth of 20–25 cm. The moisture content of the soil must be at a level that would permit good seed germination. Proper soil preparation is an important step for using fumigants, especially for metam potassium and metam sodium products.

Fumigation typically occurs either in the fall or in the spring — check product label for product-specific timings. With fall applications, work the soil several weeks before fumigation to ensure that the crop residue is well decomposed. Do not disturb the soil after sealing until the normal spring cultural operations are started. After spring fumigation, cultivate the soil thoroughly before planting to aerate and ensure that all traces of fumigant have dissipated. Ensure untreated soil is not mixed with treated soil during cultivation.

Note many fumigants require a 21-day plant-back interval or more to prevent damage to the crop. Soil temperatures affect the performance of fumigants and the length of time between application and planting. Consult each fumigant label for the appropriate soil temperature guidelines and how they impact plant-back intervals.

**DO NOT** apply when a temperature inversion is occurring, or is predicted to occur within 48 hours after application is complete, as fumigant vapours may drift.

**DO NOT** apply if light wind conditions (less than 3 km/h) are forecast to persist for more than 18 consecutive hours from the time the application starts until 48 hours after the application is complete.

Establish a buffer zone for fumigant applications. A buffer zone is an area established around the perimeter of each application block. See the label for the buffer zone area specific to each product. Before applying one of the fumigation products in Table 1–5. Pre-Plant Management of Vegetable Pests Through Fumigation, develop and implement a soil fumigation management plan. See product labels for details.

**Fumigation Management Plan**

A written Fumigation Management Plan must be developed prior to the start of any soil fumigant application. Entry into the application block by any person (other than fumigant handlers, emergency personnel, and local, provincial or federal officials performing inspection, sampling or other similar official duties) is PROHIBITED during the application block period. Any person involved in the use of fumigants is considered a fumigant handler. All fumigant handlers must hold an appropriate pesticide applicator certificate or license recognized by the provincial/territorial pesticide regulatory agency where the pesticide application is to occur. Only fumigant handlers with an appropriate pesticide applicator certificate or license may be in the application block from the start of the application until the Application Block Period expires, and in the buffer zone during the Buffer Zone Period.

The application block period begins at the start of application and expires at least 5 days after the application is complete, depending on criteria during the application (i.e., tarped or non-tarped, etc.). The applicator must verbally warn workers of the application. Fumigant Application signs must be posted on all entrances to the application block. Signs must be posted prior to the start of the application (but no sooner than 24 hours prior to application) and remain posted for the duration of the application block period. Signs must be removed within 3 days after the end of the application block period.
### Table 1–5. Pre-Plant Management of Vegetable Pests Through Fumigation

This information does not replace that included in product labels. The following is provided as general information only. Carefully follow the manufacturer’s directions for the use of soil fumigants. Avoid mixing untreated soil with treated soil.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Trade Name (PCP#)</th>
<th>Crops</th>
<th>Application</th>
<th>Rate</th>
<th>Pests Controlled/Application Notes</th>
</tr>
</thead>
</table>
| chloropicrin | Chloropicrin 100 (25863) | tomatoes, peppers | broadcast or banded² | 93 L/ha | Soil-borne pests (early-season control):  
  • nematodes  
  • root knot nematode  
  • root lesion nematode (on root vegetables (CG1) only for Pic Plus; on root vegetables (CG1), tomatoes, peppers and potatoes for Chloropicrin 100)  
  • diseases, certain species of  
  • Phytophthora spp.  
  • Thielaviopsis spp.  
  • Fusarium spp.  
  • Pythium spp.  
  • Verticillium spp. (Pic Plus only) |
|             |                   | potatoes | banded      | 55 L/ha |                                  |
|             |                   | root vegetables (Crop group 1) including: table beets, carrots, horseradish, parsnip, radish, rutabaga, sweet potatoes, sugar beets, turnips | broadcast or banded² | 93 L/ha |                                  |
| Pic Plus (28715) | tomatoes, peppers | broadcast or banded² | 108 L/ha |                                  |
|             |                   | potatoes | banded      | 64 L/ha |                                  |
|             |                   | root vegetables (Crop group 1) including: table beets, carrots, horseradish, parsnip, radish, rutabaga, sweet potatoes, sugar beets, turnips | broadcast or banded² | 108 L/ha |                                  |
| dazomet | Basamid Granular (15032) | eggplant, lettuce, pepper, tomato | seedbeds | 3.25–5 kg/100 m² | • nematodes (uncysted only — will not control cyst nematode)  
  • most germinating weed seeds  
  • soil fungi |

**Application Notes**

Prior to application, soil should be in condition for planting with sufficient moisture to support seed germination. Seal immediately after application by dragging a cultipacker immediately behind chisels, or wet down treated area to a depth of 2.5 cm. Leave soil undisturbed for 10–14 days. Aerate for at least 5 days after cultivation.

Fumigation may temporarily raise the level of ammonia nitrogen and soluble salts in the soil. This is most likely to occur when heavy rates of fertilizer and fumigant are applied to soils that are either cold, wet, acid or high in organic matter. To avoid injury to plant roots, fertilize as indicated by soil tests taken after fumigation. See label for details.

All areas broadcasted with a product containing chloropicrin must be covered with a plastic tarpaulin or Raven Vaporsafe 1 mil. film for a minimum of 5 days.

**Notes**

1 The product registration number (PCP#) has been placed in the guide for convenience, but the pesticide label in possession should always be used for the most accurate and current PCP#.

2 Use the following formula to calculate the rate for banded application: rate for banded application = (product rate (L/ha) x 30)/row spacing (cm).
Table 1–5. Pre-Plant Management of Vegetable Pests Through Fumigation

This information does not replace that included in product labels. The following is provided as general information only. Carefully follow the manufacturer’s directions for the use of soil fumigants. Avoid mixing untreated soil with treated soil.

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<thead>
<tr>
<th>Common Name</th>
<th>Trade Name (PCP#)¹</th>
<th>Crops</th>
<th>Application</th>
<th>Rate</th>
<th>Pests Controlled/Application Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>metam potassium</td>
<td>Busan 1180 (25124)</td>
<td>vegetables</td>
<td>seedbed (injection)</td>
<td>430–553 L/ha</td>
<td>Soil-borne pests:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>field (injection)</td>
<td>231–576 L/ha</td>
<td>• nematodes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• weeds and germinating weed seeds (see label for list of weeds)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• diseases</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Rhizoctonia spp.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>• Pythium spp.</td>
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<td></td>
<td></td>
<td>• Phytophthora spp.</td>
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<td></td>
<td></td>
<td></td>
<td>• Verticillium spp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Sclerotinia spp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• clubroot of crucifers</td>
</tr>
</tbody>
</table>

**Application Notes**

Inject into well-cultivated, moist soil only. Before applying, always cultivate area thoroughly, breaking up clods and loosening soil deeply and thoroughly. A week before treatment, moisten soil after cultivation to desired depth. Lightly cultivate immediately before application if soil has crusted. Seal immediately after incorporation. See the label for sprinkler recommendations and specifics on planting intervals.

Planting may take place 21 days after treatment if soil is well-drained, light-textured and relatively dry and warm. May need to wait at least 30 days to plant if soils are heavy, high in organic matter or are wet and/or cold. Wait at least 60 days after application of 576 L/ha. Make frequent shallow cultivations to aerate heavy clay or if cold and wet conditions persisted after application.

| metam sodium      | Enfuse M 510 (29142) | agricultural | broadcast | 0.78 L/30 m² | Soil-borne pests:                                                                                     |
|                   |                      |              |            |             | • nematodes                                                                                           |
|                   |                      |              |            |             | • weeds                                                                                                |
|                   |                      |              |            |             | • fungi                                                                                                |

**Application Notes**

Before applying, cultivate area thoroughly, breaking up clods and loosening soil deeply and thoroughly. Lightly cultivate immediately before application. Apply evenly over the moist, cultivated soil. Wait 7 days after application, then rake soil to a depth of 8 cm. Rake again 7 days later to a depth of 5 cm.

Planting may take place 21 days after treatment if soil is well-drained, light- to medium-textured and relatively dry and warm. May need to wait at least 30 days to plant if soils are wet and/or cold.

¹ The product registration number (PCP#) has been placed in the guide for convenience, but the pesticide label in possession should always be used for the most accurate and current PCP#.
**Table 1–5. Pre-Plant Management of Vegetable Pests Through Fumigation**

This information does not replace that included in product labels. The following is provided as general information only. Carefully follow the manufacturer’s directions for the use of soil fumigants. Avoid mixing untreated soil with treated soil.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Trade Name (PCP#)¹</th>
<th>Crops</th>
<th>Application</th>
<th>Rate</th>
<th>Pests Controlled/Application Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>metam sodium</td>
<td>Busan 1020</td>
<td>vegetables</td>
<td>seedbed</td>
<td>700–900 L/ha</td>
<td>Soil-borne pests:</td>
</tr>
<tr>
<td>(cont’d)</td>
<td>(19421)</td>
<td></td>
<td>(injection)</td>
<td></td>
<td>• nematodes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>field</td>
<td>375–935 L/ha</td>
<td>• germinating weed seeds (see label for list of weeds)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(injection)</td>
<td></td>
<td>• diseases:</td>
</tr>
<tr>
<td></td>
<td>Busan 1236</td>
<td>vegetables</td>
<td>seedbed</td>
<td>511–657 L/ha</td>
<td>• Rhizoctonia spp.</td>
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<tr>
<td>(25103)</td>
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<td>(injection)</td>
<td></td>
<td>• Pythium spp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>field</td>
<td>274–683 L/ha</td>
<td>• Fusarium spp. (Vapam HL only)</td>
</tr>
<tr>
<td></td>
<td>Vapam HL</td>
<td>vegetables</td>
<td>seedbed</td>
<td>410–670 L/ha</td>
<td>• Phytophthora spp.</td>
</tr>
<tr>
<td>(29128)</td>
<td></td>
<td></td>
<td>(injection)</td>
<td></td>
<td>• Verticillium spp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>field</td>
<td>279–696 L/ha</td>
<td>• Sclerotinia spp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(injection)</td>
<td></td>
<td>• clubroot of crucifers</td>
</tr>
</tbody>
</table>

**Application Notes**

Inject into well-cultivated, moist soil only. Before applying, always cultivate area thoroughly, breaking up clods and loosening soil deeply and thoroughly. A week before treatment, moisten soil after cultivation to desired depth with watering. Keep the soil moist with watering if necessary until time to treat. Lightly cultivate immediately before application if soil has crusted.

Seal immediately after injection. See the label for post-application cultivation and sprinkler recommendations.

Planting may take place 21 days after treatment if soil is well-drained, light-textured and relatively dry and warm. If soils are heavy or especially high in organic matter or remain wet and/or cold following application, observe a minimum interval of 30 days after application. If in doubt, transplant a seeding plant and examine for injury before planting crop. On heavy and wet soils, light surface cultivation to break up crusting and promote drying of the soil should be done 5–7 days after application. This cultivation may be repeated as necessary. To avoid re-infesting treated soils, cultural practices should be such that untreated soils are not mixed with treated soils.

¹ The product registration number (PCP#) has been placed in the guide for convenience, but the pesticide label in possession should always be used for the most accurate and current PCP#.