# 2016

# Organic Production and IPM Guide for Snap Beans

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# 2016 Production and IPM Guide for
# Organic Snap Beans for Processing


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Every effort has been made to provide correct, complete, and up-to-date pest management information for New York State at the time this publication was released for printing (June 2016). Changes in pesticide registrations and regulations, occurring after publication are available in county Cornell Cooperative Extension offices or from the Pesticide Management Education Program web site (***http://pmep.cce.cornell.edu***). Trade names used herein are for convenience only. No endorsement of products in intended, nor is criticism of unnamed products implied.

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## INTRODUCTION

This guide for organic production of snap beans provides an outline of cultural and pest management practices and includes topics that have an impact on improving plant health and reducing pest problems. It is divided into sections, but the interrelated quality of organic cropping systems makes each section relevant to the others.

The guide attempts to compile the most current information available, but acknowledges that effective means of control are not available for some pests. More research on growing crops organically is needed, especially in the area of pest management. Future revisions will incorporate new information, providing organic growers with a complete set of useful practices to help them achieve success.

This guide uses the term Integrated Pest Management (IPM), which like organic production, emphasizes cultural, biological, and mechanical practices to minimize pest outbreaks. With limited pest control products available for use in many organic production systems, an integrated approach to pest management is essential. IPM techniques such as identifying and assessing pest populations, keeping accurate pest history records, selecting the proper site, and preventing pest outbreaks through use of crop rotation, resistant varieties and biological controls are important to producing a high quality crop.

## 1. General Organic Management Practices

### 1.1 Organic Certification

To use a certified organic label, farming operations that gross more than $5,000 per year in organic products must be certified by a U.S. Department of Agriculture National Organic Program (NOP) accredited certifying agency. The choice of certifier may be dictated by the processor or by the target market. A list of accredited certifiers (Link 4) operating in New York can be found on the New York State Department of Agriculture and Markets Organic Farming Development/Assistance web page(Link 5). See more certification and regulatory details under Section 4.1: *Certification Requirements* and Section 10: *Using Organic Pesticides*.

### 1.2 Organic System Plan

An organic system plan (OSP) is central to the certification process. The OSP describes production, handling, and record-keeping systems, and demonstrates to certifiers an understanding of organic practices for a specific crop. The process of developing the plan can be very valuable in terms of anticipating potential issues and challenges, and fosters thinking of the farm as a whole system. Soil, nutrient, pest, and weed management are all interrelated on organic farms and must be managed in concert for success. Certifying organizations may be able to provide a template for the farm plan. The following description of the organic system plan is from the USDA National Organic Program Handbook:

"A plan of management of an organic production or handling operation that has been agreed to by the producer or handler and the certifying agent and that includes written plans concerning all aspects of agricultural production or handling described in the Organic Food Production Act of 1990 and the regulations in Subpart C, Organic Production and Handling Requirements."

The National Sustainable Agriculture Information Service, (formerly ATTRA), has produced a Guide for Organic Crop Producers that includes a chapter on writing the organic system plan. The Rodale Institute has also developed resources for transitioning to organic and developing an organic system plan.

## 2. Soil Health

Healthy soil is the basis of organic farming. Regular additions of organic matter in the form of cover crops, compost, or manure create a soil that is biologically active, with good structure and capacity to hold nutrients and water (note that any raw manure applications should occur at least 120 days before harvest). Decomposing plant materials will activate a diverse pool of microbes, including those that break down organic matter into plant-available nutrients as well as others that compete with plant pathogens on the root surface.

Rotating between crop families can help prevent the buildup of diseases that overwinter in the soil. Rotation with a grain crop, preferably a crop or crops that will be in place for one or more seasons, deprives disease-causing organisms of a host, and also contributes to a healthy soil structure that promotes vigorous plant growth. The same practices are effective for preventing the buildup of root damaging nematodes in the soil, but keep in mind that certain grain crops are also hosts for some nematode species. Rotating between crops with late and early season planting dates can help prevent the buildup of weed populations. Organic growers must attend to the connection between soil, nutrients, pests, and weeds to succeed. An excellent resource for additional information on soils and soil health is Building Soils for Better Crops by Fred Magdoff and Harold Van Es, 2010 (Link 10). For additional information, refer to the Cornell's Comprehensive Assessment of Soil Health website (Link 11).

## 3. Cover Crops

Unlike cash crops, which are grown for immediate economic benefit, cover crops are grown for their valuable effect on soil properties and on subsequent cash crops. Cover crops help maintain soil organic matter, improve soil tilth, prevent erosion and assist in nutrient management. They can also contribute to weed management, increase water infiltration, maintain populations of beneficial fungi, and may help control insects, diseases and nematodes. To be effective, cover crops should be treated as any other valuable crop on the farm, with their cultural requirements carefully considered including their cultural requirements, life span, mowing recommendations, incorporation methods, and susceptibility, tolerance, or antagonism to root pathogens and other pests. Some cover crops and cash crops share susceptibility to certain pathogens and nematodes. Careful planning and monitoring is required when choosing a cover crop sequence to avoid increasing pest problems in subsequent cash crops. See Tables 3.1 for more information on specific cover crops and Section 8: *Crop and Soil Nutrient Management* for more information about how cover crops fit into a nutrient management plan.

A certified organic farmer is required to plant certified organic cover crop seed. If, after contacting at least three suppliers, organic seed is not available, then the certifier may allow conventional seed to be used. Suppliers should provide a purity test for cover crop seed. Always inspect the seed for contamination with weed seeds and return if it is not clean. Cover crop seed is a common route for introduction of new weed species onto farms.

### 3.1 Goals and Timing for Cover Crops

Adding cover crops regularly to the crop rotation plan can result in increased yields of the subsequent cash crop. Goals should be established for choosing a cover crop; for example, the crop can add nitrogen, smother weeds, or break a pest cycle. The cover crop might best achieve some of these goals if it is in place for the entire growing season. If this is impractical, a compromise might be to grow the cover crop between summer cash crops. Allow two or more weeks between cover crop incorporation and cash crop seeding to permit decomposition of the cover crop, which will improve the seedbed and help avoid any unwanted allelopathic effects on the next cash crop. Another option is to overlap the cover crop and the cash crop life cycles by overseeding, interseeding or intercropping the cover crop between cash crop rows at final cultivation. An excellent resource for determining the best cover crop for your situation is Northeast Cover Crop Handbook, by Marianne Sarrantonio (Reference 6) or the Cornell online decision tool to match goals, season, and cover crop (Link 9).

Leaving cover crop residue on the soil surface might make it easier to fit into a crop rotation and will help to conserve soil moisture, but some of the nitrogen contained in the residue will be lost to the atmosphere, and total organic matter added to the soil will be reduced. Turning under the cover crop will speed up the decomposition and nitrogen release from the crop residue.

### 3.2 Legumes Cover Crops

Legume cover crops should be avoided before beans because many are closely related to beans and share pests.

### 3.3 Non-Legume Cover Crops

Barley, rye grain, rye grass, Sudangrass, wheat, oats, and other grain crops left on the surface or plowed under as green manures or dry residue in the spring are beneficial because these plants take up nitrogen that otherwise might be leached from the soil, and release it back to the soil as they decompose. If incorporated, allow two weeks or more for decomposition prior to planting to avoid the negative impact on stand establishment from actively decomposing material. Three weeks might not be enough if soils are very cold. In wet years, the presence of cover crop residues may increase slug damage and infections by fungal pathogens such as *Pythium* and *Rhizoctonia,* affecting stand establishment

### 3.4 Biofumigant Cover Crops

Certain cover crops have been shown to inhibit weeds, pathogens, and nematodes by releasing toxic volatile chemicals when tilled into the soil as green manures and degraded by microbes or when cells are broken down by finely chopping. Degradation is quickest when soil is warm and moist. These biofumigant cover crops include Sudangrass, sorghum-sudangrasses, and many in the brassica family. Varieties of mustard and arugula developed with high glucosinolate levels that maximize biofumigant activity have been commercialized (e.g. Caliente brands 199 and Nemat).

Attend to the cultural requirements of the cover crops to maximize growth. Fertilizer applied to the cover crops will be taken up and then returned to the soil for use by the cash crop after the cover crop is incorporated. Biofumigant cover crops like mustard should be allowed to grow to their full size, normally several weeks after flowering starts, but incorporated before the seeds become brown and hard indicating they are mature. To minimize loss of biofumigant, finely chop the tissue early in the day when temperatures are low. Incorporate immediately by tilling, preferably with a second tractor following the chopper. Lightly seal the soil surface using a culti-packer and/or ½ inch of irrigation or rain water to help trap the volatiles and prolong their persistence in the soil. Wait at least two weeks before planting a subsequent crop to reduce the potential for the breakdown products to harm the crop, also known as phytotoxicity. Scratching the soil surface before planting will release remaining biofumigant. This biofumigant effect is not predictable or consistent. The levels of the active compounds and suppressiveness can vary by season, cover crop variety, maturity at incorporation, amount of biomass, fineness of chopping, how quickly the tissue is incorporated, soil microbial diversity, soil tilth, and microbe population density.

Cover Crops for Vegetable Growers: Decision Tool (Link 9).
Northeast Cover Crops Handbook (Reference 6).
Cover Crops for Vegetable Production in the Northeast (Reference 11).
Crop Rotation on Organic Farms: A Planning Manual (Link 11a).

**Table 3.1. Non-Leguminous Cover Crops: Cultural Requirements and Crop Benefits**

| Species | Planting Dates | Life Cycle | Cold Hardiness Zone (Link 1) | Heat | Drought | Shade | pH Preference | Soil Type Preference | Seeding (Lb/A) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | --Tolerances-- | | | | | | |
| **Brassicas** e.g. mustards, rapeseed | April or late August-early Sept. | Annual / Biennial [a] | 6-8 | 4 | 6 | NI | 5.3-6.8 | Loam to clay | 5-12 | +Good dual purpose cover & forage<br>+Establishes quickly in cool weather<br>+Biofumigant properties |
| **Buckwheat** | Late spring-summer | Summer annual [a] | NFT | 7-8 | 4 | 6 | 5.0-7.0 | Most | 35-134 | +Rapid grower (warm season)<br>+Good catch or smother crop<br>+Good short-term soil improver for poor soils |
| **Cereal Rye** | August-early October | Winter annual | 3 | 6 | 8 | 7 | 5.0-7.0 | Sandy to clay loams | 60-200 | +Most cold-tolerant cover crop<br>+Excellent allelopathic weed control<br>+Good catch crop<br>+Rapid germination & growth<br>+Temporary N tie-up when turned under |
| **Fine Fescues** | Mid March-mid-May OR late Aug.-late Sept. | Long-lived perennial | 4 | 3-5 | 7-9 | 7-8 | 5.3-7.5 (red) 5.0-6.0 (hard) | Most | 16-100 | +Very good low-maintenance permanent cover, especially in infertile, acid, droughty &/or shady sites |
| **Oats** | Mid-Sept-early October | Summer annual[a] | 8 | 4 | 4 | 4 | 5.0-6.5 | Silt & clay loams | 110 | +Rapid growth<br>+Ideal quick cover and nurse crop |
| **Ryegrasses** | August-early Sept. | Winter annual (AR)/ Short-lived perennial (PR) | 6 (AR) 4 (PR) | 4 | 3 | 7 (AR) 5 (PR) | 6.0-7.0 | Most | 14-35 | +Temporary N tie-up when turned under<br>+Rapid growth<br>+Good catch crop<br>+Heavy N & moisture users |
| **Sorghum-Sudangrass** | Late spring-summer | Summer Annual [a] | NFT | 9 | 8 | NI | Near neutral | NI | 10-36 | +Tremendous biomass producers in hot weather<br>+Good catch or smother crop<br>+Biofumigant properties |

NI-No Information, NFT-No Frost Tolerance. Drought, Heat, Shade Tolerance Ratings: 1-2=low, 3-5=moderate, 6-8=high, 9-10=very high. . [a]Winter killed. AR=Annual Rye, PR=Perennial Rye. Reprinted with permission from Rodale Institute . M. Sarrantonio. 1994. Northeast Cover Crop Handbook. (Reference 6).

## 4. Field Selection

For organic production, give priority to fields with excellent soil tilth, high organic matter, good drainage and airflow. Beans do not thrive in wet soil.

### 4.1 Certifying Requirements

Certifying agencies have requirements that affect field selection. Fields cannot be treated with prohibited products for three years prior to the harvest of a certified organic crop. Adequate buffer zones are required between certified organic and conventionally grown crops. Buffer zones must be a barrier, such as a diversion ditch or dense hedgerow, or be a distance large enough to prevent drift of prohibited materials onto certified organic fields. Determining what buffer zone is needed will vary depending on equipment used on adjacent non-certified land. For example, use of high-pressure spray equipment or aerial pesticide applications in adjacent fields will increase the buffer zone size. Pollen from genetically engineered crops can also be a contaminant. An organic crop should not be grown near a genetically engineered crop of the same species. Check with your certifier for specific buffer requirements. These buffers commonly range between 20 to 250 feet depending on adjacent field practices.

## 4.2 Crop Rotation Plan

A careful crop rotation plan is the cornerstone of organic crop production because it allows the grower to improve soil quality and proactively manage pests. Although growing a wide range of crops complicates the crop rotation planning process, it ensures diversity in crop residues in the soil, and a greater variety of beneficial soil organisms. Individual organic farms vary widely in the crops grown and their ultimate goals, but some general rules apply to all organic farms regarding crop rotation. Rotating individual fields away from crops within the same family is critical and can help minimize crop-specific disease and non-mobile insect pests that persist in the soil or overwinter in the field or field borders. Pests that are persistent in the soil, have a wide host range, or are wind-borne, will be difficult to control through crop rotation. Conversely, the more host specific, non-mobile, and short-lived a pest is, the greater the ability to control it through crop rotation. The amount of time required for a crop rotation is based on the particular pest and its severity. Some particularly difficult pests may require a period of fallow. See specific recommendations in the disease and insect sections of this guide (Sections 11, 12, 13). Partitioning the farm into management units will help to organize crop rotations and ensure that all parts of the farm have sufficient breaks from each type of crop.

A well-planned crop rotation is key to weed management. Short season crops such as lettuce and spinach are harvested before many weeds go to seed, whereas vining cucurbits, with their limited cultivation time and long growing season, allow weeds to go to seed before harvest. Including short season crops in the rotation will help to reduce weed populations provided the field is cleaned up promptly after harvest. Other weed reducing rotation strategies include growing mulched crops, competitive cash crops, short-lived cover crops, or crops that can be intensively cultivated. Individual weed species emerge and mature at different times of the year, therefore alternating between spring, summer, and fall planted crops helps to interrupt weed life cycles.

Cash and cover crop sequences should also take into account the nutrient needs of different crops and the response of weeds to high nutrient levels. High soil phosphorus and potassium levels can exacerbate problem weed species. A cropping sequence that alternates crops with high and low nutrient requirements can help keep nutrients in balance. The crop with low nutrient requirements can help use up nutrients from a previous heavy feeder. A fall planting of a non-legume cover crop will help hold nitrogen not used by the previous crop. This nitrogen is then released when the cover crop is incorporated in the spring. See Section 5: *Weed Management,* and Section 3: *Cover Crops* for more specifics.

Rotating crops that produce abundant organic matter, such as hay crop and grain-legume cover crops, with ones that produce less, such as vegetables, will help to sustain organic matter levels and promote good soil tilth (see Section 2: *Soil Health* and Section 8: *Crop and Soil Nutrient Management*). Beans generally have a lower nutrient requirement (Table 4.2.1). Growing a cover crop, preferably one that includes a legume (unless the field has a history of *Pythium* or *Rhizoctonia* problems), prior to or after a bean crop, will help to renew soil nutrients, improve soil structure, and diversify soil organisms. Deep-rooted crops in the rotation to help break up compacted soil layers.

**Table 4.2.1 Crops Nutrient Requirements**

| | Nutrient Needs | | |
|---|---|---|---|
| | **Lower** | **Medium** | **Higher** |
| **Crop** | bean<br>beet<br>carrot<br>herbs<br>pea<br>radish | cucumber<br>eggplant<br>brassica greens<br>pepper<br>pumpkin<br>spinach<br>chard<br>squash<br>winter squash | broccoli<br>cabbage<br>cauliflower<br>corn<br>lettuce<br>potato<br>tomato |

From NRAES publication *Crop Rotation on Organic Farms: A Planning Manual.* Charles L. Mohler and Sue Ellen Johnson, editors, (Link 11a).

**Crop information specific to Beans**

Beans should only be grown in fields that have had no legumes for 3 years. Legumes including soybean, clovers, alfalfa and hairy vetch are hosts for many soil-borne fungal pathogens and should be avoided in fields with severe root rot problems. A good rotation helps reduce the incidence of foliar diseases and lowers the population of plant pathogens that cause root rot. Corn and cereal grains are excellent rotation crops to reduce root rot problems because they are not hosts for root rot pathogens of vegetable crops.

| Table 4.2.2 Potential Interactions of Crops Grown in Rotation with Beans | | |
|---|---|---|
| **Crops in Rotation** | **Potential Rotation Effects** | **Comments** |
| Lettuce, potato, tomato, other legumes, crucifers, or cucurbits | *Increase* Sclerotinia | Avoid growing these crops prior to or after snap beans to reduce the buildup of Sclerotinia in the soil. Grow grains or corn for several years to help reduce *Sclerotinia*. |
| Bean, tomato, cucumber, buckwheat, aromatic herbs | *Decrease* Clubroot | Clubroot in brassicas has declined more quickly in fields where tomato, cucumber, snap bean and buckwheat have been grown. Aromatic perennial herbs such as summer savory, peppermint, or garden thyme helps to reduce clubroot when grown for 2 to 3 consecutive years. |
| Soybean, dry bean | *Increases* Bacterial blight (*Xanthomonas campestris*) | *Xanthomonas campestris* is found in legumes as well as some crucifers and weeds in the mustard family. |
| Soybean, dry bean | *Increases* Soybean cyst nematode | Soybean cyst nematode *Heterodera glycines* increases to high densities on snap beans through the snap bean crop is rarely affected. |
| Snap bean, soybean, dry bean, alfalfa | *Increase* Fusarium, Pythium, and Sclerotinia | Do not plant these legumes prior to or for several years after snap beans to prevent a buildup of these soilborne diseases. |

Excerpt from Appendix 2 of *Crop Rotation on Organic Farms: A Planning Manual.* Charles L. Mohler and Sue Ellen Johnson, editors. (Link 11a)

### 4.3 Pest History

Knowledge about the pest history for each field is important for planning a successful cropping strategy. Germination may be reduced in fields with a history of *Pythium* or *Rhizoctonia*. Avoid fields that contain heavy infestations of perennial weeds such as nutsedge, bindweed, and quackgrass as these weeds are particularly difficult to control. One or more years focusing on weed population reduction using cultivated fallow and cover cropping may be needed before organic crops can be successfully grown in those fields. Susceptible crops should not be grown in fields with a history of *Sclerotinia* white mold without a rotation of several years to sweet corn or grain crops. If there is a field history of white mold, beans should not be preceded by tomato, potato, lettuce, crucifer crops, or bean (including soybean). Treat with Contans ™ to reduce fungal sclerotia in the soil immediately after an infected crop is harvested.

If possible, beans should not be grown in fields with a history of root rot problems, but if there is no choice, plant as late as possible when the soil has warmed.

Root maggots prefer to lay eggs in soil with fresh organic matter. Incorporate cover crop residues 2-3 weeks before planting to allow time for decomposition.

Snap bean is a host for root-lesion nematode, *Pratylenchus penetrans*, and therefore it is important to know whether or not lesion nematode is present in the field in order to develop long-term crop rotations and cropping sequences that either reduce the populations in heavily infested fields or minimize their increase in fields that have no to low infestation levels. Refer to Section 12 for more information on nematodes.

### 4.4 Soil and Air Drainage

Most fungal and bacterial pathogens need free water on the plant tissue or high humidity for several hours in order to infect. Any practice that promotes leaf drying or drainage of excess water from the root zone will minimize favorable conditions for infection and disease development. Fields with poor air movement, such as those surrounded by hedgerows or woods, create an environment that favors prolonged leaf wetness. Plant rows parallel to the prevailing winds, which is typically in an east-west direction and avoid overcrowding by using wide row spacing to promote drying of the soil and reduce moisture in the plant canopy.

## 5. WEED MANAGEMENT

Weed management can be one of the biggest challenges on organic farms, especially during the transition and the first several years of organic production. To be successful, weed management on organic farms must take an integrated approach that includes crop rotation, cover cropping, cultivation, and planting design, based on an understanding of dominant weed biology and ecology of dominant weed species. A multi-year approach that includes strategies for controlling problem weed species in a sequence of crops will generally be more successful than attempting to manage each year's weeds as they appear. Relying on cultivation alone to manage weeds in an organic system is a recipe for disaster.

Management plans should focus on the most challenging and potentially yield-limiting weed species in each field. Be sure, however, to emphasize options that do not increase other species that are present. Alternating between early and late-planted crops, and short and long season crops in the rotation can help minimize buildup of a particular weed or group of weeds with similar life cycles or growth habits, and will also provide windows for a variety of cover crops.

### 5.1 Record Keeping

Scout and develop a written inventory of weed species and their severity for each field. Accurate identification of weeds is essential. Weed fact sheets provide a good color reference for common weed identification. See Cornell weed ecology and Rutgers weed gallery websites (Link 13 and 14).

### 5.2 Weed Management Methods

Planting and cultivation equipment should be set up on the same number of rows to minimize crop losses and damage to crop roots during cultivation. It may be necessary to purchase specialized equipment to successfully control weeds in some crops.

Begin blind cultivation with a tine weeder, or flexible harrow, just before ground crack, when weeds are at white thread stage. Beans are very susceptible to breakage when they are in the "crook" stage – from just before ground crack until the seed leaves are unfolded and horizontal. Avoid tine weeding during this period. Correct cultivation depth is 2/3rd of seeding depth. Note, however, that penetration will vary with soil conditions and you must avoid hitting the seed with the weeder in soft spots. Effective tine weeding is an art that requires adjustment of the weeder to obtain good weed control without harming the crop. Examples of tine weeders are the Einbock, Lely and the Kovar. The tines on various brands and models of harrows differ in flexibility. Tines that are too stiff can break bean stems. Tines with a 70 to 80 degree bend work well for beans as they hook out grassy weeds without pulling out the beans, which have a taproot. Tines with a 45-degree bend can also be used effectively.

After bean emergence, make two more passes using a tine weeder at about 5 to 7 day intervals depending on weed growth. Tine weeders work best on very small weeds. The final tine weeding can be more aggressive (faster and deeper) than the pre-emergence weeding or early post-emergence weeding. Test settings on a small area and adjust.

The flex tine harrow is effective with weeds in the row, but when crop reaches the early first trifoliate stage, the tine weeders may cause damage to the crop. At this point, a row crop cultivator can be used to control weeds between the rows. Adjust row crop cultivator for close and shallow cultivation. Cultivate to minimize disturbing the soil and uprooting rocks that will cause problems with the harvester. Perennial weeds will require deeper cultivation. Bean varieties that grow higher off the ground will minimize rocks in the harvester. Using a rolling cultivator is another option.

For a field with persistent perennial weeds such as field bindweed, several tactics might be needed to reduce competition: tillage to break up rhizomes, one or more short fallow periods to exhaust rhizome reserves, and planting a crop that requires multiple cultivations.

**Resources**

Steel in the Field(Link 12).
Cornell Weed Ecology website (Link 13).
Rutgers University, New Jersey Weed Gallery (Link 14).
Univ. of Vermont videos on cultivation and cover cropping (Link 15).
ATTRA Principles of Sustainable Weed Mgt. for Croplands (Link 16).
Cultivation Tools for Mechanical Weed Control in Vegetables (Link 17).

## 6. Recommended Varieties

Variety selection is important both for the horticultural characteristics specified by the processor and the pest resistance profile that will be the foundation of a pest management program. Collaborate with processors on varieties, choosing those with some level of disease resistance if possible. Cornell research on developing CMV-resistant snap bean varieties is ongoing.

A certified organic farmer is required to plant certified organic seed. If, after contacting at least three suppliers, organic seed is not available for a particular variety, then the certifier may allow untreated conventional seed to be used.

### 6.1.1 Varieties Currently Grown for Processing in NY

| Large Sieve Green | Whole Bean Type (2-3 sieve) |
|---|---|
| Huntington<br>BA1001<br>Envy<br>Venture | Flavor Sweet<br>Masai<br>Oakley |
| **3-4 Sieve Green** | **Romano Type** |
| Bowie<br>Cabot<br>Caprice<br>Cassidy<br>Colter | Furnano<br><br>**Wax Bean Type**<br>Gold Ribbon |

### 6.1.2 Varieties Identified as Candidates for Organic Production[1]

| 3-4 Sieve Green | Whole Bean Type (2-3 sieve) |
|---|---|
| Bowie<br>Caprice<br>Cassidy<br>Lewis | Banga<br>Oakley |

[1]Suggested for trial use only until more information is available

## 7. Planting Methods

Recommended earliest planting date for untreated snap bean seed is June 1. The crop matures in 50 to 60 days, depending on the specific variety and desired pod size. Only western-grown, certified seed should be planted. Optimal germination of snap bean seed occurs at soil temperatures of 75° to 80°F. The minimum temperature at which snap bean germination will occur is 55° to 60°F. Plant rows in an east-west direction if possible and use wide row spacing, 36 inches, 5-7 plants/foot, to promote drying of the soil, increase air circulation, reduce moisture in the plant canopy and reduce risk of foliar diseases. Bean seed is sensitive to chilling during the initial stage of germination. If the soil is cold at this time, permanent damage may occur.

A good rotation helps reduce the incidence of foliar diseases and lowers the population of plant pathogens that cause root rot. Corn and cereal grains are excellent rotation crops. Planting on raised beds or ridges will help reduce root rot severity because the soil will be warmer and drier than the unridged soil. To allow for adequate aeration and drainage of excess moisture, avoid compacting the soil.

A water deficiency resulting from a lack of soil moisture or excessive transpiration can lead to deformed or pithy snap bean pods. Both yield and quality can be increased by irrigation before bloom and during pod enlargement if there is moisture stress. Irrigation during bloom with irrigation guns that produce large droplets is not advised because blossoms can be knocked off the plant.

## 8. Crop & Soil Nutrient Management

To produce a healthy crop, sufficient soluble nutrients must be available from the soil to meet the minimum requirements for the whole plant. The total nutrient needs of a crop are much higher than just the nutrients that are removed from the field when that crop is harvested. All of the roots, stems, leaves and other plant parts require nutrients at specific times during plant growth and development. Restrictions in the supply of required plant nutrients will limit growth and reduce crop quality and yields.

The challenge in organic systems is balancing soil fertility to supply these required plant nutrients at a time and at sufficient levels to support healthy plant growth. Soil microbes decompose organic matter to release nutrients and convert organic matter to more stable forms such as humus. This breakdown of soil organic matter occurs throughout the growing season, depending on soil temperatures, water availability and soil quality. The released nutrients are then held on soil particles or humus making them available to crops or cover crops for plant growth. Amending soils with compost, cover crops, or crop residues also provides a food source for soil microorganisms and when turned into the soil, starts the nutrient cycle again.

During the transition years and the early years of organic production, soil amendment with composts or animal manure can be a productive strategy for building organic matter, biological activity and soil nutrient levels. This practice of heavy compost or manure use is not, however, sustainable in the long-term. If composts and manures are applied in the amounts required to meet the nitrogen needs of the crop, phosphorous may be added at higher levels than required by most vegetable crops. This excess phosphorous will gradually build up to excessive levels, increasing risks of water pollution or invigorating weeds like purslane and pigweed. A more sustainable, long-term approach is to rely more on legume cover crops to supply most of the nitrogen needed by the crop and use grain or grass cover crops to capture excess nitrogen released from organic matter at the end of the season to minimize nitrogen losses to leaching. See Section 3: *Cover Crops*. When these cover crops are incorporated into the soil, their nitrogen, as well as carbon, feeds soil microorganisms, supporting the nutrient cycle. Harvesting alfalfa hay from the field for several years can reduce high phosphorus and potassium levels.

Some soils are naturally high in P and K, or have a history of manure applications that have resulted in elevated levels. Regular soil testing helps monitor nutrient levels, in particular phosphorus (P) and potassium (K). Choose a reputable soil-testing lab (Table 8.0.1) and use it consistently to avoid discrepancies caused by different soil extraction methods. Maintaining a soil pH between 6.3 and 6.8 will maximize the availability of all nutrients to plants.

To assess overall impact of organic matter additions on soil health, consider selecting a few target or problem fields for soil health monitoring over time via the Cornell Standard Soil Health Analysis Package. This suite of eight tests complement a standard soil chemical nutrient analysis by focusing on biological and physical soil health indicators. While the test results will provide feedback on how the soil sample compares to other New York soils, the real power is in the baseline readings for comparison in the future after implementing new soil health and nutrient management strategies.

**Table 8.0.1 Nutrient Testing Laboratories.**

| TESTING LABORATORY | SOIL | COMPOST/ MANURE | REFERENCES |
|---|---|---|---|
| The Agro One Lab (Cornell Recommendations) | x | x | 40 |
| Agri Analysis, Inc. | | x | 36 |
| A&L Eastern Ag Laboratories, Inc. | x | x | 37 |
| Cornell Soil Nutrient Analysis Lab | x | | 16 |
| Penn State Ag Analytical Services Lab. | x | x | 38 |
| University of Massachusetts | x | x | 39 |
| University of Maine | x | x | 41 |

## 8.1 Fertility

Recommendations from the Cornell Integrated Crop and Pest Management Guidelines indicate that a bean crop requires 40 lbs. of available nitrogen (N), 80 lbs. of phosphorus (P), and 60 lbs. of potassium (K) per acre. These levels are based on the total needs of the whole plant and assume the use of synthetic fertilizers. Farmer and research experience suggests that lower levels may be adequate in organic systems. See Table 8.2.2 for the recommended rates of P and K based on soil test results. Nitrogen is not included because levels of available N change in response to soil temperature and moisture, N mineralization potential, and leaching. As many of the nutrients as possible should come from cover crop, manure, and compost additions in previous seasons.

Develop a plan for estimating the amount of nutrients that will be released from soil organic matter, cover crops, compost, and manure. A strategy for doing this is outlined in Section 8.2: *Preparing an Organic Nutrient Budget*. It is important to remember that in cool soils, microorganisms are less active, and nutrient release may be too slow to meet the crop needs. Once the soil warms, nutrient release may exceed crop needs. In a long-term organic nutrient management approach, most of the required crop nutrients would be in place as organic matter before the growing season starts. Nutrients required by the crop in the early season can be supplemented by highly soluble organic amendments such as poultry manure composts or organically approved bagged fertilizer products (see Tables 8.2.4 to 8.2.6). These products can be expensive so are most efficiently used if banded at planting. The National Organic Standards Board states that no more than 20% of total N can be applied as Chilean nitrate. Be sure to confirm that the products you select are approved for use in organic by your certifier prior to field application.

## 8.2 Preparing an Organic Nutrient Budget

To create a robust organic fertility management plan, develop a plan for estimating the amount of nutrients that will be released from soil organic matter, cover crops, compost, and manure. As these practices are integrated into field and farm management, the goal is to support diverse microbial communities that will help release nutrients from the organic matter additions.

Remember that with a long-term approach to organic soil fertility, the N mineralization rates of the soil will increase. This means that more N will be available from organic amendments because of increased soil microbial activity and diversity. Feeding these organisms different types of organic matter is essential to building this type of diverse biological community and ensuring long-term organic soil and crop productivity. Included in the Soil Health Test is an analysis of soil protein content. As with the other soil health tests, this serves as an indicator of soil management and amendment history. The test measures organic soil N that is in the form of proteins- an important food source for soil microbes. Use this test to help monitor impact and target future investments of legume cover crops and compost / manure applications.

Estimating total nutrient release from the soil and comparing it with soil test results and recommendations requires record-keeping and some simple calculations. Table 8.2.1 below can be used as a worksheet for calculating nutrients supplied by the soil compared to the total crop needs. Table 8.2.3 estimates common nutrient content in animal manures; however actual compost and manure nutrient content should be tested just prior to application. Analysis of other amendments, as well as cover crops, can be estimated using published values (see Tables 8.2.4 to 8.2.6 and 3.1 for examples). Keeping records of these nutrient inputs and subsequent crop performance will help evaluate if the plan is providing adequate fertility during the season to meet production goals.

**Table 8.2.1 Calculating Nutrient Credits and Needs.**

| | Nitrogen (N) lbs/A | Phosphate ($P_2O_5$) lbs/A | Potash ($K_2O$)lbs/A |
|---|---|---|---|
| 1. Total crop nutrient needs | | | |
| 2. Recommendations based on soil test | Not provided | | |
| 3. Credits | | | |
| a. Soil organic matter | | --- | --- |
| b. Manure | | | |
| c. Compost | | | |
| d. Prior cover crop | | | |
| 4. Total credits: | | | |
| **5. Additional needs (2-4=)** | | | |

**Line 1. Total Crop Nutrient Needs:** Research indicates that an average bean crop requires 40 lbs. of available nitrogen (N), 80 lbs. of phosphorus (P), and 60 lbs. of potassium (K) per acre to support a medium to high yield crop (see Section 8.1 *Fertility* above).

**Line 2. Recommendations Based on Soil Test:** Use Table 8.2.2 to determine the amount of P and K needed based on soil test results.

**Table 8.2.2** Recommended Amounts of Phosphorus and Potassium for Beans Based on Soil Tests

| | **Soil Phosphorus Level** | | | **Soil Potassium Level** | | |
|---|---|---|---|---|---|---|
| **Level shown in soil test** | low | med | high | low | med | high |
| | **$P_2O_5$ lbs/A** | | | **$K_2O$ lbs/A** | | |
| **Total nutrient recommendation** | 80 | 60 | 40 | 60 | 40 | 20 |

**Line 3a. Soil Organic Matter:** Using the values from your soil test, estimate that 20 lbs. of nitrogen will be released from each percent organic matter in the soil. For example, a soil that has 3% organic matter could be expected to provide 60 pounds of N per acre.

**Line 3b. Manure:** Assume that applied manure will release N for 3 years. Based on the test of total N in any manure applied, estimate that 50% is available in the first year, and then 50% of the remaining is released in each of the next two years.

So, for an application rate of 100 lbs. of N as manure, in year one 50 lbs. would be available, 25 lbs. in year 2, and 12.5 lbs. in year 3. Remember to check with your certifier on the days-to-harvest interval when using raw manure and allow a minimum of 120 days between application and harvesting. Enter estimated phosphorous additions and be aware that some manures have high phosphorous content (Table 8.2.3). Assume about 80% of the phosphorous and 90% of the potassium to be available in the first year.

**Line 3c. Compost:** Estimate that between 10 and 25% of the N, 80% of the phosphorous and 90% of the potassium contained in compost will be available the first year. It is important to test each new mix of compost for actual amounts of the different nutrients available. Compost maturity will influence how much N is available. If the material is immature, more of the N may be available to the crop in the first year. A word of caution: Using compost to provide for a crop's nutrient needs is not generally a financially viable strategy. The total volume needed can be very expensive for the units of N available to the crop, especially if trucking is required. Most stable composts should be considered as soil conditioners, improving soil health, microbial diversity, tilth, and nutrient retaining capacity. Also keep in mind that manure-based composts are potentially high in salts that could become a problem if used yearly. Most compost analyses include a measure of electrical conductivity which indicates level of salts present in the finished product. Any compost applied on organic farms must be approved for use by your farm certifier. Compost generated on the farm must follow an approved process outlined by your certifier.

**Line 3d. Cover Crops:** Legume cover crops are a source of nitrogen but are not recommended prior to a bean crop.

**Line 4. Total Credits:** Add together the various nutrient values from the organic matter, compost, and cover crops to estimate the nutrient supplying potential of the soil (see example below). There is no guarantee that these amounts will actually be available in the season, since soil temperatures, water, and crop physiology all impact the release and uptake of these soil nutrients. If early in the organic transition, a grower may consider increasing the N budget supply by 25%, to help reduce some of the risk of N being limiting to the crop.

Table 8.2.3 includes general estimates of nutrient availability for manures and composts but these can vary widely depending on animal feed, management of grazing, the age of the manure, amount and type of bedding, and many other factors. See table 3.1 for estimates of the nitrogen content of various cover crops. **Manure applications may not be allowed by your certifier or marketer even if applied 120 days before harvest. Check with both these sources prior to making manure applications.**

**Table 8.2.3 Nutrient Content of Common Animal Manures and Manure Composts**

| | TOTAL N | $P_2O_5$ | $K_2O$ | N1 [1] | N2 [2] | $P_2O_5$ | $K_2O$ |
|---|---|---|---|---|---|---|---|
| | NUTRIENT CONTENT LB/TON | | | AVAILABLE NUTRIENTS LB/TON IN FIRST SEASON | | | |
| Dairy (with bedding) | 9 | 4 | 10 | 6 | 2 | 3 | 9 |
| Horse (with bedding) | 14 | 4 | 14 | 6 | 3 | 3 | 13 |
| Poultry (with litter) | 56 | 45 | 34 | 45 | 16 | 36 | 31 |
| Composted dairy manure | 12 | 12 | 26 | 3 | 2 | 10 | 23 |
| Composted poultry manure | 17 | 39 | 23 | 6 | 5 | 31 | 21 |
| Pelleted poultry manure [3] | 80 | 104 | 48 | 40 | 40 | 83 | 43 |
| Swine (no bedding) | 10 | 9 | 8 | 8 | 3 | 7 | 7 |
| | NUTRIENT CONTENT LB/1000 GAL. | | | AVAILABLE NUTRIENTS LB/1000 GAL FIRST SEASON | | | |
| Swine finishing (liquid) | 50 | 55 | 25 | 25[4] | 20[5] | 44 | 23 |
| Dairy (liquid) | 28 | 13 | 25 | 14[4] | 11[5] | 10 | 23 |

1-N1 is an estimate of the total N available for plant uptake when manure is incorporated within 12 hours of application, 2-N2 is an estimate of the total N available for plant uptake when manure is incorporated after 7 days. 3 –Pelletized poultry manure compost. (Available in New York from Kreher's.)
4- injected, 5- incorporated.
Adapted from *"Using Manure and Compost as Nutrient Sources for Fruit and Vegetable Crops"* by Carl Rosen and Peter Bierman (Link 25) and Penn State Agronomy Guide 2015-2016 (Link 25a).

Tables 8.2.4-8.2.6 lists some commonly available fertilizers and their nutrient content.

**Table 8.2.4 Available Nitrogen in Organic Fertilizer**

| | Pounds of Fertilizer/Acre to Provide X Pounds of N per Acre | | | | |
|---|---|---|---|---|---|
| Sources | 20 | 40 | 60 | 80 | 100 |
| **Blood meal**, 13% N | 150 | 310 | 460 | 620 | 770 |
| **Soy meal** 6% N (x 1.5) [1] also contains 2% P and 3% $K_2O$ | 500 | 1000 | 1500 | 2000 | 2500 |
| **Fish meal** 9% N, also contains 6% $P_2O_5$ | 220 | 440 | 670 | 890 | 1100 |
| **Alfalfa meal** 2.5% N also contains 2% P and 2% $K_2O$ | 800 | 1600 | 2400 | 3200 | 4000 |
| **Feather meal**, 15% N (x 1.5) [1] | 200 | 400 | 600 | 800 | 1000 |
| **Chilean nitrate** 16% N cannot exceed 20% of crop's need. | 125 | 250 | 375 | 500 | 625 |

[1] Application rates for some materials are multiplied to adjust for their slow to very slow release rates.

**Table 8.2.5 Available Phosphorous in Organic Fertilizer**

| | Pounds of Fertilizer/Acre to Provide X Pounds of $P_2O_5$ Per Acre | | | | |
|---|---|---|---|---|---|
| SOURCES | 20 | 40 | 60 | 80 | 100 |
| **Bonemeal** 15% $P_2O_5$ | 130 | 270 | 400 | 530 | 670 |
| **Rock Phosphate** 30% total $P_2O_5$ (x4) [1] | 270 | 530 | 800 | 1100 | 1300 |
| **Fish meal**, 6% $P_2O_5$ (also contains 9% N) | 330 | 670 | 1000 | 1330 | 1670 |

[1] Application rates for some materials are multiplied to adjust for their slow to very slow release rates.

**Table 8.2.6 Available Potassium in Organic Fertilizers.**

| | Pounds of Fertilizer/Acre to Provide X Pounds of $K_2O$ per acre: | | | | |
|---|---|---|---|---|---|
| SOURCES | 20 | 40 | 60 | 80 | 100 |
| **Sul-Po-Mag** 22% $K_2O$ also contains 11% Mg | 90 | 180 | 270 | 360 | 450 |
| **Wood ash** (dry, fine, grey) 5% $K_2O$, also raises pH | 400 | 800 | 1200 | 1600 | 2000 |
| **Alfalfa meal** 2% $K_2O$ also contains 2.5% N | 1000 | 2000 | 3000 | 4000 | 5000 |
| **Greensand or Granite dust** 1% $K_2O$ (x 4) [1] | 8000 | 16000 | 24000 | 32000 | 40000 |
| **Potassium sulfate** 50% $K_2O$ | 40 | 80 | 120 | 160 | 200 |

[1] Application rates for some materials are multiplied to adjust for their slow to very slow release rates. Tables 8.4 to 8.6 adapted by Vern Grubinger from the University of Maine soil testing lab (Link 24).

### An example of how to determine nutrient needs for beans.

You will be growing an acre of snap beans. The Cornell Integrated Crop and Pest Management Guidelines suggests a total of 40 lb. N, 80 lb. P, and 60 lb. K per acre. Your soil tests show a pH of 6.5, with medium P and K levels and recommends 60 lbs $P_2O_5$/acre and 40 lbs $K_2O$/acre (see Table 8.2.2). The field you will plant has 3% organic matter which will supply approximately 60 lbs N (line 3a). Last fall you spread but did not promptly incorporate 5 tons/acre of dairy manure with bedding before planting a rye cover crop supplying ~10 lbs N (line 3d). Nutrient credits for soil organic matter, manure, and cover crop appear in Table 8.2.7.

**Table 8.2.7 Bean Example: Calculating Nutrient Credits and Needs Based on Soil Sample Recommendations.**

| | Nitrogen (N) lbs/acre | Phosphate ($P_2O_5$) lbs/acre | Potash ($K_2O$) lbs/acre |
|---|---|---|---|
| 1. Total crop nutrient needs: | 40 | 80 | 60 |
| 2. Recommendations based on soil test | Not provided | 60 | 40 |
| 3. Credits | | | |
| a. Soil organic matter 3% | 60 | - | - |
| b. Manure – 5 ton dairy | 10 | 15 | 45 |
| c. Compost - none | 0 | 0 | 0 |
| d. Cover crop – rye | 0 | 0 | 0 |
| 4. Total credits: | 70 | 15 | 45 |
| 5. Additional needed (2-4) = | 0 | 45 | 0 |

Because of the threat of seedcorn maggot and possible N tie-up from the decomposing rye cover, wait at least three weeks between plowing and planting. This would be a good opportunity to do a shallow tine weeding just before planting. The dairy manure and soil organic matter will release N and K at adequate levels in this example; P is the only nutrient that needs to be applied. Because beans are sometimes planted into cold soils consider applying the 45 lbs/acre of P in a relatively soluble form such as composted chicken manure, which contains about 100 lbs $P_2O_5$ per ton. Thus, banding about 900 lb at planting (2-3 inches to the side and below the furrow) would provide the P needed in this example, but would provide 40 lb of additional N, which is already higher than needed. Banding about 600 lbs of rock phosphate instead could avoid too much N, but the P would be less available in colder soils.

Additional Resources
Using Organic Nutrient Sources (reference 25b)
Determining Nutrient Applications for Organic Vegetables (reference 25c)

## 9. Harvesting

All processing snap bean acreage is harvested by machine. Snap beans are processed relatively soon after harvest.

## 10. Using Organic Pesticides

Given the high cost of many pesticides and the limited amount of efficacy data from replicated trials with organic products, the importance of developing an effective system of cultural practices for insect and disease management cannot be emphasized strongly enough. **Pesticides should not be relied on as a primary method of pest control**. Scouting and forecasting are important for detecting symptoms of diseases at an early stage. When conditions do warrant an application, proper choice of materials, proper timing, and excellent spray coverage are essential.

### 10.1 Sprayer Calibration and Application

Calibrating sprayers is especially critical when using organic pesticides since their effectiveness is sometimes limited. For this reason, they tend to require the best spraying conditions to be effective. Read the label carefully to be familiar with the unique requirements of some products, especially those with live biological organisms as their active ingredient (e.g. Contans WG). The active ingredients of some biological pesticides (e.g. Serenade ) are actually metabolic byproducts of the organism. Calculating nozzle discharge and travel speed are two key components required for applying an accurate pesticide dose per acre. Applying too much pesticide is illegal, can be unsafe and is costly whereas applying too little can fail to control pests or lead to pesticide resistance.

### Resources

Cornell Integrated Crop and Pest Management Guidelines: Pesticide Information and Safety (Link 56).
Calibrating Backpack Sprayers (Link 57).
Pesticide Environmental Stewardship: Calibration (Link 58)
Knapsack Sprayers – General Guidelines for Use (Link 59)
Herbicide Application Using a Knapsack Sprayer (Link 60) This publication is relevant for non-herbicide applications).
Pesticide Environmental Stewardship, Coop Extension (reference 64)
Pesticide Environmental Stewardship, CIPM Website (reference 65)
Vegetable Spraying (reference 66)

### 10.2 Regulatory Considerations

Organic production focuses on cultural, biological, and mechanical techniques to manage pests on the farm, but in some cases pesticides, which include repellents, allowed for organic production are needed. Pesticides mentioned in this organic production guide are registered by the United States Environmental Protection Agency (EPA) or meet the EPA requirements for a "minimum risk" pesticide. At the time of publication, the pesticides mentioned in this guide meet New York State Department of Environmental Conservation (NYS DEC) registration requirements for use in New York State. See Cornell's Product, Ingredient, and Manufacturer System website (Link 2) for pesticides currently registered for use in NYS. Additional products may be available for use in other states.

To maintain organic certification, products applied must also comply with the National Organic Program (NOP) regulations as set forth in 7 CFR Part 205, sections 600-606 (Link 63). The Organic Materials Review Institute (OMRI) (Link3) is one organization that reviews products for compliance with the NOP regulations and publishes lists of compliant products, but other entities also make product assessments. Organic growers are not required to use only OMRI listed materials, but the list is a good starting point when searching for allowed pesticides.

Finally, farms grossing more than $5,000 per year and labeling products as organic must be certified by a NOP accredited certifier who must approve any material applied for pest management. ALWAYS check with the certifier before applying any pest control products. Some certifiers will review products for NOP compliance.

Note that "home remedies" may not be used. Home remedies are products that may have properties that reduce the impact of pests. Examples of home remedies include the use of beer as bait to reduce slug damage in strawberries or dish detergent to reduce aphids on plants. These materials are not regulated as pesticides, are not exempt from registration, and are therefore not legal to use.

**Do you need to be a certified pesticide applicator?** The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) defines two categories of pesticides: general-use and-restricted use. NYS DEC also defines additional restricted-use pesticides. Pesticide applicator certification is required to purchase and use restricted-use pesticides. Restricted-use pesticides mentioned in this guide are marked with an asterisk (*). Farmers who purchase and use only general-use pesticides on property they own or rent do not need to be certified pesticide applicators. However, we do encourage anyone who applies pesticides to become certified.

**Worker Protection Standard training.** If the farm has employees who will be working in fields treated with a pesticide, they must be trained as workers or handlers as required by the federal Worker Protection Standard (WPS). Having a pesticide applicator certification is one of the qualifications needed to be a WPS trainer. Certified pesticide applicators meet the WPS training requirements. For more information on the Worker Protection Standard see How To Comply with the Worker Protection Standard (Link 67). See Revisions To the Worker Protection Standard for a summary of new worker protection standards that will take effect January 2017 (Link 67a). Find more information on pesticide applicator certification from the list of State Pesticide Regulatory Agencies (Link 68) or, in New York State, see the Cornell Pesticide Management Education Program website at http://psep.cce.cornell.edu (Link 69).

### 10.3 Pollinator Protection

Honey bees, wild bees, and other insects are important for proper pollination of many crops. Poor pollination results in small or odd-shaped fruit as well as low yields.

To avoid harming bees with insecticides, remember these general points:

- Always read the label before use.
- Do not spray blooming crops;
- Mow blooming weeds before treatment or spray when the blossoms are closed;
- Avoid application during the time of day when bees are most numerous; and
- Make application in the early morning or evening.

If pesticides that are highly toxic to bees are used in strict accordance with label directions, little or no harm should be done to bees. Label statements on pesticides that are highly toxic to honey bees may carry a caution statement such as: "This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area."

In early 2015 the EPA proposed new pollinator protection label language to protect managed bees under contract pollination services. The intent of this new language is to protect bees from contact exposure to pesticides that are acutely toxic to bees. Once the new language is finalized, pesticide labels will include the new wording and requirements. As part of this proposal, EPA identified certain active ingredients that are acutely toxic to bees. Active ingredients mentioned in this publication meeting this criteria are noted with a bee symbol ( ).

For more information on pollinator protection, visit www.epa.gov/opp00001/ecosystem/pollinator/index.html and pesticidestewardship.org/PollinatorProtection/Pages/default.aspx

### 10.4 Optimizing Pesticide Effectiveness

Information on the effectiveness of a particular pesticide against a given pest can sometimes be difficult to find. Some university researchers include pesticides approved for organic production in their trials; some manufacturers provide trial results on their web sites; some farmers have conducted trials on their own. Efficacy ratings for pesticides listed in this guide were summarized from university trials and are only provided for some products. The Resource Guide for Organic Insect and Disease Management (Reference 1) provides efficacy information for many approved materials.

In general, pesticides allowed for organic production may kill a smaller percentage of the pest population, could have a shorter residual, and may be quickly broken down in the environment. Microbial-based products often have a shorter shelf life than other products, so be sure to use them by the expiration date. Read the pesticide label carefully to determine if water pH or hardness will negatively impact the pesticide's effectiveness. Use of a surfactant may improve organic pesticide performance. OMRI lists adjuvants on their website (Link 3). Regular scouting and accurate pest identification are essential for effective pest management. Thresholds used for conventional production may not be useful for organic systems because of the typically lower percent mortality and shorter residual of pesticides allowed for organic production. When pesticides are needed, it is important to target the most vulnerable stages of the pest. The use of pheromone traps or other monitoring or prediction techniques can provide an early warning for pest problems, and help effectively focus scouting efforts. When using pesticides, be sure you have sufficient coverage to provide adequate control. Consult the pesticide label for guidance.

## 11. Disease Management

In organic systems, cultural practices form the basis of a disease management program. Promote plant health by maintaining a biologically active, well-structured, adequately drained and aerated soil that supplies the requisite amount and balance of nutrients. Choose varieties resistant to one or more important diseases whenever possible. Plant only clean, disease-free seed and maintain the best growing conditions possible.

Rotation is an important management practice for pathogens that overwinter in crop debris. Rotating between crop families is useful for many diseases, but may not be effective for pathogens with a wide host range, such as *Sclerotinia* white mold. Rotation with a grain crop, preferably a crop or crops that will be in place for one or more seasons, deprives disease-causing organisms of a host, and also contributes to a healthy soil structure that promotes vigorous plant growth. The same practices are effective for preventing the buildup of root damaging nematodes in the soil, but keep in mind that certain grain crops are also hosts for some nematode species. See more on crop rotation in Section 4.2: *Crop Rotation Plan.*

Other important cultural practices can be found under each individual disease listed below. Maximizing air movement and leaf drying is a common theme. Many plant diseases are favored by long periods of leaf wetness. Any practice that promotes faster leaf drying, such as orienting rows with the prevailing wind, or using a wider row or plant spacing, can slow disease development. Fields surrounded by trees or brush that tend to hold moisture after rain, fog or dew, should be avoided if possible.

Scouting fields weekly is key to early detection and evaluating control measures. The earlier a disease is detected, the more likely it can be suppressed with organic fungicides. When available, scouting protocols can be found in the sections listed below for each individual disease. While following a systematic scouting plan, keep watch for other disease problems. Removing infected plants during scouting is possible on a small operation. Accurate identification of disease problems, especially recognizing whether they are caused by a bacterium or fungus, is essential for choosing an effective control strategy. Anticipate which diseases are likely to be problems that could affect yield and be ready to take control action as soon as symptoms are seen. Allowing pathogen populations to build can quickly lead to a situation where there are few or no options for control.

All currently available fungicides allowed for organic production are protectants meaning they must be present on the plant surface before disease inoculum arrives to effectively prevent infection. They have no activity on pathogens once they are inside the plant. A few fungicides induce plant resistance and must be applied several days in advance of infection to be effective. Biological products must be handled carefully to keep the microbes alive. Follow label instructions carefully to achieve the best results.

Contact your local cooperative extension office to see if newsletters and pest management updates are available for your region. For example, in western New York, the Cornell Vegetable Program offers subscriptions to *VegEdge* a report that gives timely information regarding crop development, pest activity and control. Enrollment in the Eastern New York Commercial Horticulture Program includes a subscription to *Produce Pages* and weekly seasonal newsletters for vegetables, tree fruit, grapes and small fruit. On Long Island, see the *Long Island Fruit and Vegetable Update.*

Organic farms must comply with all other regulations regarding pesticide applications. See Section 10. Using Organic Pesticides for details. **ALWAYS check with your organic farm certifier when planning pesticide applications**.

**Resources:**

Cornell Vegetable MD Online (Reference 7)
Resource Guide for Organic Insect and Disease Management (Reference 1)

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System [(PIMS) website] (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

## Table 11.0 Pesticides for Organic Bean Disease Control

| Class of Compound<br>Product name - *Active ingredient* | Bacterial Diseases | | | Bean Rust | Botrytis Grey Mold | Pod-Flecking Complex | Root Rot & Damping Off | Sclerotinia White Mold |
|---|---|---|---|---|---|---|---|---|
| | Bacterial Brown Spot | Common Bacterial Blight | Halo blight | | | | | |
| **MICROBIALS** | | | | | | | | |
| Actinovate AG (*Streptomyces lydicus*) | | | | | X | X | X | X |
| Actinovate STP Fungicide (*Streptomyces lydicus* ) | | | | | | | X | |
| BIO-TAM (*Trichoderma asperellum, Trichoderma gamsii*) | | | | | | | X | |
| Bio-Tam 2.0 (*Trichoderm asperellum, T. gamsii*) | | | | | | | X | X |
| Contans WG (*Coniothyrium minitans* ) | | | | | | | | X |
| Double Nickel 55 Biofungicide (*Bacillus amyloliquefaciens str. D747)* | | | | X | X | | X | X |
| Double Nickel LC Biofungicide (*Bacillus amyloliquefaciens str. D747)* | | | | X | X | | X | X |
| Mycostop Biofungicide (*Streptomyces griseoviridis)* | | | | | | | X | |
| Mycostop Mix (*Streptomyces griseoviridis)* | | | | | | | X | |
| Optiva (*Bacillus subtilis str. QST 713)* | | | | | X | | | X |
| Prestop Biofungicide Powder (*Gliocladium catenulatum str. J1446)* | | | | | X | X | X | |
| Regalia Biofungicide (*Reynoutria sachalinensis)* | | X | | X | X | | X | X |
| RootShield Granules (*Trichoderma)* | | | | | | | X | |
| RootShield PLUS+ Granules (*Trichoderma)* | | | | | | | X | |
| RootShield PLUS+ WP (*Trichoderma)* | | | | | | | X | |
| Serenade ASO (*Bacillus subtilis* str *QST 713)*<br>Serenade MAX (*Bacillus subtilis* str *QST 713)*<br>Serenade Opti *(Bacillus subtilis* str *QST 713)*<br>Serenade Soil (*Bacillus subtilis* str *QST 713)* | | | | X<br>X | X | | X | X<br>X<br>X |
| SoilGard (*Gliocladium virens str. GL-21)* | | | | | | | X | |
| Taegro (*Bacillus subtilis)* | | | | | | | X | |
| Zonix (*Rhamnolipid Biosurfactant)* | | | | | | | X | |
| **BOTANICALS** | | | | | | | | |
| Cinnerate (*cinnamon oil)* | | | | X | | | | |
| Trilogy (*neem extract)* | | | | X | X | X | | X |
| **COPPER** | | | | | | | | |
| Badge X2 (*copper oxychloride, copper hydroxide)* | X | X | X | | | | | |
| Basic Copper 53 (*basic copper sulfate)* | X | X | X | | | | | |
| Champ WG (*copper hydroxide)* | X | X | X | | | | | |
| ChampION++ (*copper hydroxide*) | | | | | | | X | |
| CS 2005 (*copper sulfate pentahydrate)* | X | X | X | | | | | |
| Cueva Fungicide Concentrate (*copper octanoate)* | X | X | X | | X | | | X |
| Nu-Cop 50DF (*copper hydroxide)* | X | X | X | | | | | |

| **Class of Compound**<br>**Product name - *Active ingredient*** | **Bacterial Diseases** | | | **Bean Rust** | **Botrytis Grey Mold** | **Pod-Flecking Complex** | **Root Rot & Damping Off** | **Sclerotinia White Mold** |
|---|---|---|---|---|---|---|---|---|
| | **Bacterial Brown Spot** | **Common Bacterial Blight** | **Halo blight** | | | | | |
| Nu-Cop HB (*copper hydroxide)* | X | X | X | | | | | |
| Nu-Cop 50 WP (*copper hydroxide)* | X | X | X | | | | | |
| Nordox 75 WG (*cuprous oxide)* | | | X | | | | | |
| **SULFUR** | | | | | | | | |
| Micro Sulf (*sulfur)* | X | | | X | | | | |
| Microthiol Disperss (*sulfur)* | X | | | X | | | | |
| **OIL** | | | | | | | | |
| Organic JMS Stylet Oil (*paraffinic oil)* | | | | X | | | | |
| PureSpray Green (*petroleum oil)* | | | | X | | | | |
| **OTHER** | | | | | | | | |
| Agricure (*potassium bicarbonate*) | | | | | X | | | |
| OxiDate 2.0 (*hydrogen dioxide, peroxyacetic acid)* | | | | X | X | | X | X |
| PERpose Plus (*hydrogen peroxide/dioxide)* | X | X | X | X | X | X | X | X |
| TerraClean 5.0 (*hydrogen dioxide, peroxyacetic acid)* | | | | | X | | X | |

X- can be used against this pest and OMRI listed product

## 11.1 Sclerotinia White Mold, *Sclerotinia sclerotiorum*

**Time for concern:** From open blossoms through the end of harvest

**Key characteristics:** The fungus will initially attack bean blossoms, as blossoms are a readily available source of food. Symptoms appear as white, fluffy cottony growth on blossoms, stems and pods. As the fungus grows, mounds of white mycelium harden and darken. These dark, black structures become sclerotia that enable the fungus to overwinter. Bean blossoms are an excellent source of nutrients for the fungus. Therefore control measures must be initiated at bloom. See Link 26. See Cornell photo and bulletin (Links 27-28) and learn more at the Dillard Lab Vegetable Pathology website (Link 28a).

| Management Option | Recommendation for White Mold |
|---|---|
| **Scouting/thresholds** | Scout field prior to harvest to determine the need for treatment with Contans WG after harvest to reduce overwintering inoculum. Keep an accurate history of white mold incidence and severity in all fields. |
| **Coverage** | The best coverage can be obtained by using a minimum of 50 gallons per acre and high pressure (100 to 200 psi). Thoroughly cover initials, buds, and blossoms. |
| **Resistant varieties** | No resistant varieties are available, however plant architecture influences disease development. Select varieties with open canopies that hold pods high off the ground. |
| **Crop rotation** | If there is a field history of white mold, beans should not be preceded by a bean, tomato, potato, lettuce, or crucifer crop for several years. Grains and corn are good rotation crops. |
| **Site selection** | Avoid planting in shaded areas and in small fields surrounded by trees; do not plant in fields that drain poorly or have a history of severe white mold. |
| **Planting** | Plant rows in an east-west direction and use wide row spacing, 36 inches, to promote drying of the soil and reduce moisture in the plant canopy. |
| **Fertilization** | Avoid over fertilization. |

| Management Option | Recommendation for White Mold |
|---|---|
| **Postharvest** | Incorporate crop debris immediately following harvest to allow soil microorganisms the opportunity to feed on the survival structures called sclerotia or degrade disease organisms/overwintering structures. |
| **Seed selection/treatment** | This is not currently a viable management options. |
| **Note(s)** | White mold tends to develop in dense plant canopies. The disease tends to be worse in fields where there is poor weed management, where leaves have mechanical damage or pesticide injury, and where dead leaves are on the ground. The fungus can grow on dead and living material. White mold tends to develop when wet weather is persistent. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 11.1 Pesticides for Management of Sclerotinia White Mold**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Actinovate AG (*Streptomyces lydicus* WYEC 108) | 3-12 oz/acre | 0 | 1 or until dry | 3 | *Streptomyces lydicus* products effective in 0/2 trials. Reapply every 7-14 days. Use a spreader sticker. Foliar spray or soil treatment. |
| Bio-Tam 2.0 (*Trichoderma asperellum, Trichoderma gamsii*) | 2.5-5 lb/acre | - | 1 | ? | |
| Contans WG (*Coniothyrium minitans*) | 1-4 lb/acre soil treatment | - | 4 | 2 | Contans effective in 4/11 trials. Apply Contans WG to a Sclerotinia-infected crop immediately following harvest at 1 lb/A and incorporate the debris into the soil or apply at 2 lb/acre to a planted crop right after planting followed by shallow incorporation (or irrigate) to about a 1 to 2 inch depth. Do not turn the soil profile after application of Contans WG to avoid bringing untreated soil containing viable sclerotia near the surface. The seller recommends applying Contans WG for at least 3 to 4 years to reduce soil levels, or every year a susceptible crop is grown in that field. Enhance storage life by keeping product in the refrigerator or freezer. |
| Cueva Fungicide Concentrate (copper octanoate) | 0.5-2 gal/acre | up to day | 4 | 2 | Copper products effective in 1/2 trials. Apply at 25% bloom. |
| Double Nickel 55 (*Bacillus amyloliquefaciens* str. D747) | 0.125-1 lb/acre soil treatment<br>0.25-3 lb/acre foliar spray | 0 | 4 | ? | |
| Double Nickel LC (*Bacillus amyloliquefaciens* str. D747) | 0.5-4.5 pt/acre soil treatment<br>0.5-6 qt/acre foliar spray | 0 | 4 | ? | |

**Table 11.1 Pesticides for Management of Sclerotinia White Mold**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Optiva (*Bacillus subtilis* str. QST 713) | 14-24 oz/acre | 0 | 4 | ? | Repeat on 7-10 day intervals or as needed. |
| Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid) | 32 fl oz-1 gal/100 gal water | 0 | until dry | ? | Bee Hazard. This product is toxic to bees exposed to direct contact. |
| PERpose Plus (hydrogen peroxide) | 1 fl oz/gal (initial/curative) | - | until dry | 3 | Hydrogen peroxide products effective in 0/1 trial. For initial or curative use, apply higher rate for 1 to 3 consecutive days. Then follow with weekly/preventative treatment. |
| PERpose Plus (hydrogen peroxide) | 0.25-.33 fl oz/gal (weekly/preventative) | - | until dry | 3 | Hydrogen peroxide products effective in 0/1 trial. For weekly or preventative treatments, apply lower rate every five to seven days. At first signs of disease, use curative rate then resume weekly preventative treatment. |
| Regalia (*Reynoutria sachalinensis*) | 1 - 4 qt/acre | 0 | 4 | ? | Apply every 7-14 days as needed. Foliar spray or soil treatment. |
| Serenade ASO[1] (*Bacillus subtilis* str QST 713) | 2-6 qt/acre | 0 | 4 | 3 | Effective in 0/1 trial. |
| Serenade MAX[1] (*Bacillus subtilis* str QST 713) | 1-3 lb/acre | 0 | 4 | 3 | |
| Serenade Opti[1] (*Bacillus subtilis* str QST 713) | 14-20 oz/acre | 0 | 4 | ? | |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available . PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [1]Serenade Opti and Serenade ASO (labeled for foliar and soil uses) will be the only formulations in the future. Formulations may differ in efficacy, especially older and newer ones. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest
Active ingredient meets EPA criteria for acute toxicity to bees

## 11.2 *Botrytis* Gray Mold, *Botrytis cinerea*

**Time for concern:** From open blossoms through the end of harvest

**Key characteristics:** Gray mold develops in dense plant canopies when the weather is warm and moist. Large necrotic lesions produce gray spores on the pods, leaves and stems. This disease is worse in fields where leaves have mechanical damage or other injury. See Cornell photo (Link 29) and learn more at the Dillard Lab Vegetable Pathology website (Link 28a).

| Management Option | Recommendations for Botrytis Gray Mold |
|---|---|
| **Scouting/thresholds** | *Botrytis cinerea* can infect many species of plants. A reliable forecasting system has not been developed for gray mold on beans. However, here are a few helpful hints on the development of gray mold. Gray mold tends to develop in dense plant canopies. The disease tends to be worse in fields where leaves have mechanical damage and where dead leaves are on the ground. The fungus grows and produces spores on dead and living material. These spores will subsequently infect bean pods. Gray mold tends to develop when the weather is warm and moist. Begin scouting when the first buds are showing. Record the occurrence and severity of gray mold. See Reference 5. |

| Management Option | Recommendations for Botrytis Gray Mold |
|---|---|
| **Coverage** | The best coverage can be obtained by using a minimum of 50 gallons per acre and high pressure (100 to 200 psi). |
| **Resistant varieties** | No resistant varieties are available. |
| **Crop rotation** | Regular crop rotation is recommended. Grains and corn are good rotation crops. |
| **Site selection** | Avoid planting in shaded areas and in small fields surrounded by trees; do not plant in fields that drain poorly. |
| **Planting** | Plant rows in an east-west direction, and use wide row spacing (36 inches) to promote drying of the soil and reduce moisture in the plant canopy. |
| **Fertilization** | Avoid over-fertilization with nitrogen. |
| **Postharvest** | Incorporate debris immediately after harvest to hasten decomposition of the material. |
| **Seed selection/treatment** | This is not currently a viable management options. |
| **Note(s)** | Avoid mechanical damage to leaves. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 11.2 Pesticides for Management of *Botrytis* Gray Mold**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Actinovate AG (*Streptomyces lydicus* WYEC 108) | 3-12 oz/acre soil treatment | 0 | 1 or until dry | ? | |
| Agricure (potassium bicarbonate) | 2-5 lb/acre | 0 | 1 | ? | |
| Cueva Fungicide Concentrate (copper octanoate) | 0.5-2 gal/acre | up to day | 4 | ? | |
| Double Nickel 55 (*Bacillus amyloliquefaciens* str. D747) | 0.25-3 lb/acre | 0 | 4 | ? | |
| Double Nickel LC (*Bacillus amyloliquefaciens* str. D747) | 0.5-6 qt/acre | 0 | 4 | ? | |
| Optiva (*Bacillus subtilis* str. QST 713) | 14-24 oz/acre | 0 | 4 | ? | Repeat on 7-10 day intervals or as needed. |
| Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid) | 32 fl oz-1 gal/100 gal water | 0 | until dry | ? | Bee Hazard. This product is toxic to bees exposed to direct contact. |
| PERpose Plus (hydrogen peroxide) | 1 fl oz/gal (initial/curative)<br><br>0.25-.33 fl oz/gal (weekly/preventative) | - | until dry | 3 | Effective in 0/1 trial. For initial or curative use, apply higher rate for 1 to 3 consecutive days. Then follow with weekly/preventative treatment.<br>For weekly or preventative treatments, apply lower rate every five to seven days. At first signs of disease, use curative rate then resume weekly preventative |

| Table 11.2 Pesticides for Management of *Botrytis* Gray Mold | | | | | |
|---|---|---|---|---|---|
| **Product Name (Active Ingredient)** | **Product Rate** | **PHI[2] (Days)** | **REI (Hours)** | **Efficacy** | **Comments** |
| | | | | | treatment. |
| Prestop (*Gliocladium catenulatum*) | 3.5 oz/ 5 gal water, 0.5 gal suspension per 100 sq ft | - | 0 | ? | Apply only when no above-ground harvestable food commodities are present. |
| Regalia (*Reynoutria sachalinensis*) | 1-4 qt/acre | 0 | 4 | ? | Apply every 7-14 days as needed. |
| Serenade Opti[1] (*Bacillus subtilis* str QST 713) | 14-20 oz/acre | 0 | 4 | ? | |
| TerraClean 5.0 (hydrogen dioxide, peroxyacetic acid) | 128 fl oz/100 gal water<br>soil treatment<br>25 fl oz/ 200 gal water/1000 sq ft<br>soil drench | - | 0 | ? | Soil treatment prior to seeding or transplanting. See label for amount of mixed solution to apply.<br>Soil drench with established plants or seedlings. |
| Trilogy (neem oil) | 0.5-1.0% in 25-100 gal water/acre | up to day | 4 | 1 | Apply every 7-14 days as needed. Effective in 1/1 trial. Apply sufficient water to achieve complete coverage of foliage. Maximum of 2 gal/acre /application. Bee Hazard. This product is toxic to bees exposed to direct contact. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available. PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [1]Serenade Opti and Serenade ASO (labeled for foliar and soil uses) will be the only formulations in the future. Formulations may differ in efficacy, especially older and newer ones. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest
Active ingredient meets EPA criteria for acute toxicity to bees

## 11.3 Pod-flecking complex (PFC), *Alternaria alternata and Plectosporium tabacinum*

**Time for concern:** From pod fill through the end of harvest

**Key characteristics:** Pod-flecking complex is sometimes referred to by consultants and producers as russet, seam rust, spots, or rusty or spotty beans. PFC symptoms on pods intensify with pod maturity, and are most prevalent mid- to late August following periods of prolonged rainfall or rainfall of high intensity. Symptoms on pods include tan, orange, or black discolorations in the suture and/or small dark superficial specks, flecks, or spots (sometimes sunken) on the pod surfaces. See more at the Dillard Lab Vegetable Pathology website (Link 28a).

| ***Management Options*** | ***Recommendations for Pod-Flecking Complex*** |
|---|---|
| **Scouting/thresholds** | Pod-flecking complex can infect many species of plants. A reliable forecasting system has not been developed for PFC on beans. However, here are a few helpful hints on the development of PFC. Pod-flecking complex symptoms on pods intensify with pod maturity, and are most prevalent mid- to late August following periods of prolonged rainfall or rainfall of high intensity. Only the pods are affected. Symptoms include tan, orange, or black discolorations in the suture and/or small dark superficial specks, flecks, or spots (sometimes sunken) on the pod surfaces. Begin scouting at pod fill. Record the occurrence and severity of PFC. See Reference 12. |

| ***Management Options*** | ***Recommendations for Pod-Flecking Complex*** |
|---|---|
| **Coverage** | The best coverage can be obtained by using a minimum of 50 gallons per acre and high pressure (100 to 200 psi). |
| **Resistant varieties** | No resistant varieties are available. |
| **Crop rotation** | Regular crop rotation is recommended to improve plant health. |
| **Site selection** | Avoid planting in shaded areas and in small fields surrounded by trees; do not plant in fields that drain poorly. |
| **Planting** | Plant rows in an east-west direction, and use wide row spacing (36 inches) to promote drying of the soil and reduce moisture in the plant canopy. |
| **Fertilization** | Avoid over-fertilization with nitrogen. |
| **Harvest / Postharvest** | To mitigate disease, harvest at or near peak maturity and avoid harvest delays that would result in overripe pods. Don't store infected beans.<br>Incorporate debris immediately after harvest to hasten decomposition of the material. |
| **Seed selection/treatment** | This is not currently a viable management options. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 11.3 Pesticides for Management of Pod-Flecking Complex**

| **Product Name (Active Ingredient)** | **Product Rate** | **PHI[2](Days)** | **REI (Hours)** | **Efficacy** | **Comments** |
|---|---|---|---|---|---|
| Actinovate AG (*Streptomyces lydicus* WYEC 108) | 3-12 oz/acre | 0 | 1 or until dry | ? | Reapply every 7-14 days. Labeled for *Alternaria* only. The label recommends use of a spreader-sticker for foliar sprays. |
| Trilogy (neem oil) | 0.5-1.0% in 25-100 gal water/acre | up to day | 4 | ? | Maximum of 2 gal/acre/application. Bee Hazard. This product is toxic to bees exposed to direct contact. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available. PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.
Active ingredient meets EPA criteria for acute toxicity to bees

## 11.4 Root Rot and Damping-Off.

There are four pathogenic fungi, *Pythium*, *Rhizoctonia*, *Thielaviopsis*, and *Fusarium* that are often found attacking bean roots and causing yield losses.

**Time for concern:** Planting through end of bloom stage. Long term planning is required for sustainable management.

**Key characteristics:** Pythium is seen early in the season when it causes rotting of seeds and damping-off of young seedlings. In older plants, it causes reduction and discoloration of the root system. Pythium can also attack pods, causing lesions that generally develop at the tip of the pod and expand toward the stem. See Cornell Pythium photo (Link 31). Rhizoctonia is also capable of causing seed decay and damping-off diseases on seedlings. See Cornell Rhizoctonia photo (Link 32). On older plants it produces reddish brown, sunken lesions on the stem and tap root, and is generally favored by warm soil conditions.

In addition, the sexual stage of Rhizoctonia may also be detected on the stem, petioles, and pods as a thin, whitish, compact growth. Thielaviopsis is often referred to as black root rot because the initial elongated lesions and later large infected areas on the stems and roots are dark brown to charcoal. This disease is favored by hot, wet conditions. Fusarium rot causes longitudinal, brick red lesions on the stem and tap root and is very common. See Reference 9 and Cornell Bulletin 110 (Link 30) for more photos and information.

| Management Option | Recommendations for Root Rot and Damping-Off |
|---|---|
| **Scouting/thresholds** | Record the occurrence, type, and severity of root rot. No thresholds are available. |
| **Resistant varieties** | All commercially acceptable varieties are susceptible, but a number yield better under severe root rot. |
| **Crop rotation** | Rotate away from vegetables. One or two years with a grain crop such as barley, oats, rye, wheat, or corn will prevent severe root rot development when practiced on relatively clean fields; longer rotations are necessary in heavily infested fields. Avoid planting legumes as rotational crops or cover crops in heavily infested areas. |
| **Site selection** | Choose healthy and well-drained soils. A soil Bio-Assay procedure that differentiates relatively pathogen-free fields from those with severe root rot problems is available. See the Bean Root Bio links at Cornell Comprehensive Assessment of Soil Health website (Link 11) for directions to do this yourself or to send a sample to Cornell for testing. |
| **Seed selection/treatment** | Select vigorous, disease-free seeds. |
| **Soil treatment** | Breaking hard pans, plowing deep, or ripping and planting on raised ridges or beds will reduce damage from root rot diseases. |
| **Cover crop** | Barley, rye grain, rye grass, wheat, oats, and other grain crops left on surface or plowed under as green manures or dry residue in the spring are beneficial. If incorporated as green manures, allow 2 weeks or more for decomposition prior to planting. Sudangrass or sorghum sudangrass hybrids can also be used as green manures. In wet years, using green manures may increase slug damage and affect stand establishment. |
| **Planting** | Avoid planting in heavily infested fields, but if there is no choice, plant shallow and late. Plantings exhibiting symptoms of severe root rot damage will benefit from a shallow cultivation not too close to the stems. Also, covering the lower stem tissues with soil will promote further root formation and reduce root rot damage. However, the latter should be done on an emergency basis, as this practice has been observed to increase foliar infections with Rhizoctonia in wet seasons. |
| **Postharvest** | Crop debris should be plowed down to initiate decomposition, if tillage system in use permits. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 11.4 Pesticides for Management of Root Rot and Damping-Off**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Actinovate AG (*Streptomyces lydicus* WYEC 108) | 3-12 oz/acre soil treatment | 0 | 1 or until dry | ? | Not labeled for *Thielaviopsis*. |

| Table 11.4 Pesticides for Management of Root Rot and Damping-Off | | | | | |
|---|---|---|---|---|---|
| **Product Name (Active Ingredient)** | **Product Rate** | **PHI[2] (Days)** | **REI (Hours)** | **Efficacy** | **Comments** |
| Actinovate STP (*Streptomyces lydicus*) | 4-32 oz/ 100 lb seed<br>seed treatment | - | 1 or until dry | ? | |
| BIO-TAM (*Trichoderma asperellum, Trichoderma gamsii*) | 1.5-3.0 oz/1000 ft row<br>in-furrow treatment | - | 1 | ? | |
| Bio-Tam 2.0 (*Trichoderma asperellum, Trichoderma gamsii*) | 1.5-3 oz/ 1000 ft row<br>in-furrow treatment | - | 1 | ? | |
| Double Nickel 55 (*Bacillus amyloliquefaciens* str. D747) | 0.125-1 lb/acre<br>soil treatment | 0 | 4 | ? | |
| Double Nickel LC (*Bacillus amyloliquefaciens* str. D747) | 0.5-4.5 pts/acre<br>soil treatment | 0 | 4 | ? | |
| MycoStop Biofungicide (*Streptomyces grieoviridis* str. K61) | 7 oz/cwt seed<br>seed treatment<br>15-30 oz/acre<br>soil treatment | - | 4 | ? | Labeled only for root rots and damping off caused by Fusarium spp.<br>Irrigate within 6 hours after soil spray or drench with enough water to move Mycostop into the root zone. |
| MycoStop Mix (*Streptomyces grieoviridis* str. K61) | 5-8 oz/100 lbs of seed<br>seed treatment<br>7.6-30 oz/acre<br>soil treatment<br>0.5-1 lb/ treated acre<br>band, in-furrow- or side-dress treatment | 0 | 4 | ? | Labeled only for root rots and damping off caused by Fusarium spp.<br>Use at planting; no pre-harvest interval noted. Irrigate within 6 hours after soil spray or drench with enough water to move Mycostop into the root zone.<br>Lightly incorporate furrow or band applications. Band, in-furrow or side dress. |
| Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid) | 0.5-1 gal/acre<br>in-furrow treatment | 0 | until dry | ? | Bee Hazard. This product is toxic to bees exposed to direct contact. |
| PERpose Plus (hydrogen peroxide) | 1 fl oz/gal (initial/curative)<br>soil drench<br>0.25-.33 fl oz/gal (weekly/preventative)<br>soil drench | - | until dry | ? | For initial or curative use, apply higher rate for 1 to 3 consecutive days. Then follow with weekly/preventative treatment.<br>For weekly or preventative treatments, apply lower rate every five to seven days. At first signs of disease, use curative rate then resume weekly preventative treatment. |
| Prestop (*Gliocladium catenulatum*) | 1.4-3.5 oz/2.5 gal water<br>soil drench | - | 0 | ? | Treat only the growth substrate when above-ground harvestable food commodities are present. Not labeled for *Thielaviopsis*. |
| Regalia (*Reynoutria sachalinensis*) | 1-4 qt/acre<br>in-furrow treatment | 0 | 4 | ? | Not labeled for *Thielaviopsis*. |

| Table 11.4 Pesticides for Management of Root Rot and Damping-Off | | | | | |
|---|---|---|---|---|---|
| **Product Name (Active Ingredient)** | **Product Rate** | **PHI[2] (Days)** | **REI (Hours)** | **Efficacy** | **Comments** |
| RootShield Granules (*Trichoderma harzianum*) | 2.5-6 lb/ half acre in-furrow treatment | - | 0 | 2 | *Trichoderma harzianum* products effective against seedling diseases in 1/8 trials. |
| RootShield PLUS+ Granules (*Trichoderma harzianum, Trichoderma virens*) | 2.5-6 lb/ half acre in-furrow treatment | - | 0 | 2 | *Trichoderma harzianum* products effective against seedling diseases in 1/8 trials. *T. virens* products effective against Fusarium root rot in 0/2 trials. |
| RootShield PLUS+ WP (*Trichoderma harzianum, Trichoderma virens*) | 3-8 oz/100 gal water chemigation | 0 | 4 | 2 | *Trichoderma harzianum* products effective against seedling diseases in 1/8 trials. Do not apply when above-ground harvestable food commodities are present. *T. virens* products effective against *Fusarium* root rot in 0/2 trials. |
| Serenade Soil[1] (*Bacillus subtilis* str QST 713) | 2-6 qt/acre soil treatment | 0 | 4 | ? | Not labeled for *Thielaviopsis*. |
| Soilgard (*Gliocladium virens*) | 2-10 lb/acre in-furrow treatment | - | 0 | ? | |
| Taegro (*Bacillus subtilis*) | 3 tsp/gal water seed treatment | - | 24 | ? | Only labeled for *Fusarium* and *Rhizoctonia*. |
| Taegro (*Bacillus subtilis*) | 2.6 oz/100 gal water in-furrow treatment | - | 24 | ? | Only labeled for *Fusarium* and *Rhizoctonia*. Over furrow at time of planting |
| TerraClean 5.0 (hydrogen dioxide, peroxyacetic acid) | 128 fl oz/100 gal water soil treatment | - | 0 | ? | Soil treatment prior to seeding or transplanting. See label for amount of mixed solution to apply. |
| TerraClean 5.0 (hydrogen dioxide, peroxyacetic acid) | 25 fl oz/ 200 gal water/1000 sq ft soil drench | - | 0 | ? | Soil drench with established plants or seedlings. |
| Zonix (Rhamnolipid Biosurfactant) | 0.5-0.8 oz/ gal water | - | 4 | ? | Labeled for *Pythium* only. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?-not reviewed or no research available PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [1]Serenade Opti and Serenade ASO (labeled for foliar and soil uses) will be the only formulations in the future. Formulations may differ in efficacy, especially older and newer ones. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

## 11.5 Bacterial Diseases

Bacterial brown spot *(Pseudomonas syringae pv. syringae);* Common bacterial blight, *(Xanthomonas campestris pv. phaseoli);* and Halo blight, *(Pseudomonas syringae pv. phaseolicola)*

**Time for concern:** From seeding stage through the end of harvest

**Key characteristics:** Brown spot - small, brown spots, 3/25 to 8/25 inch in diameter, often with a narrow, diffuse, pale margin, appear on leaves. Sunken, brown spots can form on the pods. Common bacterial blight - light brown lesions of irregular shape with distinct, bright yellow margins, 2/5 inch long, appear on leaves. Spots form on the pods and enlarge into reddish brown lesions. In humid weather, yellow bacteria may be present on the lesions. Halo blight - small, water-soaked spots on the undersides of leaves develop into numerous, small, reddish brown lesions with pale to yellow margins or halos. Pod symptoms are similar to those of common blight. See Cornell fact sheet (Link 33).

| Management Option | Recommendations for Bacterial Diseases |
|---|---|
| **Scouting/thresholds** | Fields should be scouted at least twice between midseason and harvest. Record the occurrence and severity of the bacterial blights. |
| **Resistant varieties** | Some varieties have tolerance and/or resistance to one or more of these diseases. Depending on the variety, brown spot development on leaves may or may not result in significant damage to pods. Wisconsin growers report that 'Hystyle' shows resistance to brown spot. |
| **Crop rotation** | In the case of halo blight, rotate away from fields where this disease has occurred for a minimum of three years. Use a two-year minimum rotation for bacterial brown spot or common bacterial blight. Xanthomonas campestris also harbors in weeds within the mustard family. |
| **Site selection** | Avoid planting snap bean fields near dry bean fields. |
| **Seed selection/treatment** | Plant only western-grown, certified seed. |
| **Postharvest** | Crop debris should be destroyed as soon as possible to remove this source of disease for future plantings and to initiate decomposition. |
| **Sanitation** | Equipment used in fields with bacterial diseases should be thoroughly cleaned before being moved to disease-free fields. To reduce the spread of bacteria on equipment or in spray water, avoid making pesticide applications or cultivating when the leaves are wet. If possible, plow under bean stubble immediately after harvest. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 11.5 Pesticides for Management of Bacterial Diseases**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Badge X2 (copper hydroxide, copper oxychloride) | 0.5-2 lb/acre | 0 | 48 | 2 | |
| Basic Copper 53 (basic copper sulfate) | 1.5 lb/acre | up to day | 48 | 2 | If possible time applications so that 12 hours of dry weather follow application. |
| Champ WG (copper hydroxide) | 1.58 lb/acre | - | 48 | 2 | |
| ChampION++ (copper hydroxide) | 0.5-1.25 lb/acre | 0 | 48 | ? | |
| CS 2005 (copper sulfate pentahydrate) | 19.2-25.6 oz/acre | - | 48 | 2 | |
| Cueva Fungicide Concentrate (copper octanoate) | 0.5-2 gal/acre | up to day | 4 | 2 | |
| Micro Sulf (sulfur) | 7 lb/acre | - | 24 | ? | Consult processor before using sulfur. |
| Microthiol Disperss (sulfur) | 3-10 lb/acre | - | 24 | ? | Consult processor before using sulfur. Only labeled for bacterial brown spot. |

| **Table 11.5 Pesticides for Management of Bacterial Diseases** | | | | | |
|---|---|---|---|---|---|
| **Product Name (Active Ingredient)** | **Product Rate** | **PHI[2] (Days)** | **REI (Hours)** | **Efficacy** | **Comments** |
| Nordox 75 WG (cuprous oxide) | 0.6-2.5 lb/acre | - | 12 | 2 | Apply every 7-14 days as needed. Labeled only for halo blight. Apply when plants are 5-6 inches tall. |
| Nu-Cop 50 WP (copper hydroxide) | 1.5-3 lb/acre | 1 | 24 | 2 | |
| Nu-Cop 50DF (copper hydroxide) | 1-1.5lb/acre | 1 | 48 | 2 | |
| Nu-Cop HB (copper hydroxide) | 0.5-1.5 lb/acre | - | 48 | 2 | Use higher rate for more severe disease. Repeat on 7-14 day schedule depending on local conditions. |
| PERpose Plus (hydrogen peroxide) | 1 fl oz/gal (initial/curative)<br><br>0.25-.33 fl oz/gal (weekly/preventative) | - | until dry | ? | For initial or curative use, apply higher rate for 1 to 3 consecutive days. Then follow with weekly/preventative treatment.<br>For weekly or preventative treatments, apply lower rate every five to seven days. At first signs of disease, use curative rate then resume weekly preventative treatment. |
| Regalia (*Reynoutria sachalinensis*) | 1-4 qt/acre | 0 | 4 | ? | Labeled only for *Xanthomonas*. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?-not reviewed or no research available PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

## 11.6 Virus Diseases

Virus diseases of bean are spread by infected seed or by aphids. However, controlling aphids is not effective for reducing these viruses. Virus expression is lower when the crop has adequate water. Irrigating in dry years may help mitigate impacts of virus infection. Record the occurrence and severity of any viruses present. See Cornell photos (Link 35), fact sheet (Link 34), and a list of weed and crop hosts (Link 36). Information about aphid vector activity and spread of CMV in snap bean fields can be found in References 3 and 6. Cornell research on developing CMV-resistant snap bean varieties is on going.

| **Disease/Symptoms** | **Spread by** | **Time for concern** | **Resistant Varieties** | **Notes** |
|---|---|---|---|---|
| Cucumber Mosaic Virus (CMV)<br>Leaf curl, green mottle, blistering, and a rugged zipper-like appearance along the main veins involving only a few leaves. Infected plants may also not express symptoms. | Soybean aphid, yellow clover aphid, pea aphid, corn leaf aphid; rarely seed transmitted | Primarily in plantings from late June through late July. | None available | Use certified, disease-free seed. CMV does not persist in plant debris, in the soil, or on equipment. For CMV and the other aphid-transmitted viruses listed below, there will be less risk of yield loss if fields are planted early (mid May to late June) than if planted after this period. |
| Bean Common Mosaic Virus (BCMV)<br>Symptoms include a green mosaic and | Seed,<br>bean aphid, | Seeding through harvest | Most varieties carry the I-gene for resistance | Use certified, disease-free seed. |

| Disease/Symptoms | Spread by | Time for concern | Resistant Varieties | Notes |
|---|---|---|---|---|
| downward cupping along the main vein of each leaflet. Green vein banding, blistering, and malformation are common in leaves of the same plant. Plants are small, and pods may be mottled and malformed. Symptoms are persistent. | cowpea aphid, pea aphid, potato aphid, green peach aphid | | to BCMV. | |
| Bean Yellow Mosaic Virus (BYMV)<br>Leaf mosaic formed by contrasting yellow or green mosaic areas. Pods generally are not affected, but the number of seeds per pod may be reduced. | Bean aphid, cowpea aphid, pea aphid, potato aphid, and green peach aphid. | June through harvest | None available | BYMV does not persist in plant debris, in the soil, or on equipment. |
| Clover Yellow Vein Virus (CYVV)<br>In addition to deforming pods, this virus also causes a prominent yellow mosaic, malformation, and reduction in plant size. | Aphids | June through harvest | None available | |

## 11.7 Bean Rust, *Uromyces appendiculatus*

**Time for concern:** Early in the growing season

**Key characteristics:** Regular occurrence of dew favors infection and development of severe epidemics. Bean rust is characterized by reddish brown, circular pustules on leaves or pods. See University of Connecticut fact sheet (Link 37). Bean rust is rarely seen in New York. However, growers commonly use the name "rust" to describe a diffuse light brown discoloration that sometimes occurs on the pods. See section 11.3 on Pod-flecking complex (Reference 12). Also see the Dillard Lab Vegetable Pathology website (Link 28a).

| Management Option | Recommendations for Bean Rust |
|---|---|
| **Scouting/thresholds** | Record the occurrence and severity of bean rust. No thresholds are available. |
| **Resistant varieties** | No resistant varieties are available. |
| **Crop rotation** | A minimum one-year rotation is recommended. |
| **Site selection** | Avoid areas with poor air and soil-moisture drainage. |
| **Planting** | Wider row spacing reduces leaf wetness and may slow epidemic development. |
| **Postharvest** | Incorporate infested debris immediately after harvest to hasten decomposition of the material. |
| **Sanitation** | Avoid walking through the crop when the leaves are wet. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 11.7 Products for Management of Bean Rust**

| **Product Name (Active Ingredient)** | **Product Rate** | **PHI[2] (Days)** | **REI (Hours)** | **Efficacy** | **Comments** |
|---|---|---|---|---|---|
| Cinnerate (cinnamon oil) | 13-30 fl.oz./100 gal water | - | - | ? | 25(b) pesticide. |
| Double Nickel 55 (*Bacillus amyloliquefaciens* str. D747) | 0.25-3 lb/acre | 0 | 4 | ? | |
| Double Nickel LC (*Bacillus amyloliquefaciens* str. D747) | 0.5-6 qt/acre | 0 | 4 | ? | |
| Organic JMS Stylet-Oil (parrafinic oil) | 3-6 qt/100 gal water | 0 | 4 | ? | |
| Micro Sulf (sulfur) | 7 lb/acre | - | 24 | 3 | Consult processor before using sulfur. Elemental sulfur effective in 0/2 trials. |
| Microthiol Disperss (sulfur) | 3-10 lb/acre | - | 24 | 3 | Elemental sulfur effective in 0/2 trials. Do not apply within 2 weeks of an oil application nor at temperatures over 90 degrees. |
| Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid) | 32 fl oz-1 gal/100 gal water | 0 | until dry | ? | Bee Hazard. This product is toxic to bees exposed to direct contact. |
| PERpose Plus (hydrogen peroxide) | 1 fl oz/gal (initial/curative)<br>0.25-.033 fl oz/gal (weekly/preventative) | - | until dry | ? | For initial or curative use, apply higher rate for 1 to 3 consecutive days. Then follow with weekly/preventative treatment.<br>For weekly or preventative treatments, apply lower rate every five to seven days. At first signs of disease, use curative rate then resume weekly preventative treatment. |
| PureSpray Green (white mineral oil) | 0.75-1.5 gal/acre | up to day | 4 | ? | |
| Regalia (*Reynoutria sachalinensis*) | 1-4 qt/acre | 0 | 4 | ? | Apply every 7-14 days as needed. |
| Serenade ASO[1] (*Bacillus subtilis* str QST 713) | 2-6 qt/acre | 0 | 4 | ? | |
| Serenade MAX[1] (*Bacillus subtilis* str QST 713) | 1-3 lb/acre | 0 | 4 | ? | |
| Trilogy (neem oil) | 0.5-1.0% in 25-100 gal water/acre | up to day | 4 | ? | Maximum of 2 gal/acre/application. Bee Hazard. This product is toxic to bees exposed to direct contact. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [1]Serenade Opti and Serenade ASO (labeled for foliar and soil uses) will be the only formulations in the future. Formulations may differ in efficacy, especially older and newer ones. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

Active ingredient meets EPA criteria for acute toxicity to bees

## 12. Root-Lesion Nematode, *Pratylenchus penetrans*

**Time of concern:** Before planting. Long term planning is required for sustainable management

**Key characteristics:** The root lesion nematode typically does not cause characteristic symptoms on snap bean roots. However, severely infected plants may show general chlorosis and stunting as well as a reduced root system. Infection by this nematode may predispose plants to infection and damage by other soil borne pathogens. See Cornell fact sheet for more information and photos of damage (Link 40).

| Management Option | Recommendations for Root-Lesion Nematode |
|---|---|
| **Scouting/thresholds** | Use a soil bioassay with soybean to assess soil root-lesion nematode infestation levels. Or, submit the soil sample(s) for nematode analysis at a public or private nematology lab (Link 38). See Section 4: Field Selection for more information as well as the following Cornell publications for instructions:<br>Soil Sampling for Plant-Parasitic Nematode Assessment (Link 39).<br>A Soil Bioassay for the Visual Assessment of Soil Infestations of Lesion Nematode (Link 40). |
| **Resistant Varieties** | No resistant snap bean varieties are available. |
| **Crop Rotation** | Root-lesion nematode has over 400 hosts including many vegetable and grain crops that are planted in rotation with snap bean thus making it difficult to manage lesion nematode strictly using crop rotation once populations have reached damaging levels. Depending on the size of the infested site, marigold varieties such as 'Polynema' and 'Nemagone' are very effective at reducing nematode populations, where marigold can be established successfully. |
| **Site Selection** | Assay soil for nematode infestation, if needed. |
| **Biofumigant Cover Crops** | Cover crops with a biofumigant effect, used as green manure, may be used for managing root-lesion nematode. It is important to note that many biofumigant crops including Sudangrass, white mustard, and rapeseed are hosts to root-lesion nematode and will increase the population until they are incorporated into the soil as a green manure, at which point their decomposition products are toxic to nematodes. Research has suggested that Sudangrass hybrid 'Trudan 8' can be used effectively as a biofumigant to reduce root-lesion nematode populations. Cover crops such as forage pearl millet 'CFPM 101' and 'Tifgrain 102', rapeseed 'Dwarf Essex', and ryegrass 'Pennant' are poor hosts, and thus will limit the build-up or reduce root-lesion nematode populations when used as a "standard" cover crop. |
| **Sanitation** | Avoid moving soil from infested fields to un-infested fields via equipment and vehicles, etc. Also limit/avoid surface run-off from infested fields. |
| **Weed control** | Many common weed species including lambsquarters, redroot pigweed, common purslane, common ragweed, common dandelion and wild mustard are also hosts therefore effective weed management is also important. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 12.1 Products for Management of Nematodes**

| Product Name (Active Ingredient) | Product Rate | PHI[2](days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| DiTera DF (*Myrothecium verrucaria*) | 0.31-2.4 lbs/ 1000 sq ft | - | 4 | ? | |
| Ecozin Plus 1.2% ME (azadirachtin) | 25-56 oz/acre soil drench | 0 | 4 | ? | |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

Active ingredient meets EPA criteria for acute toxicity to bees

# 13. Insect Management

Effective insect management relies on accurate identification of pests and beneficial insects, an understanding of their biology and life cycle, knowledge of economically important levels of pest damage, and a familiarity with the effectiveness of allowable control practices, in other words, Integrated Pest Management (IPM).

Regular scouting and accurate pest identification are essential for effective insect management. Thresholds used for conventional production may not be useful for organic systems because of the typically lower percent mortality and shorter residual of control products allowed for organic production. The use of pheromone traps or other monitoring and prediction techniques can provide an early warning for pest problems, and help effectively focus scouting efforts.

The contribution of crop rotation as an insect management strategy is highly dependent on the mobility of the pest. Crop rotation tends to make a greater impact on reducing pest populations if the pest has limited mobility. In cases where the insects are highly mobile, leaving a greater distance between past and present plantings is better.

## Natural Enemies

Learn to identify naturally occurring beneficial insects, and attract and conserve them in your fields by providing a wide variety of flowering plants in or near the field and by avoiding use of broad-spectrum insecticides during periods when natural enemies are present. In most cases, a variety of natural enemies are present in the field, each helping to reduce pest populations. The additive effects of multiple species of natural enemies, attacking different host stages, is more likely to make an important contribution to reducing pest populations than individual natural enemy species operating alone. Natural enemies need a reason to be present in the field, either a substantial pest population, alternative hosts, or a source of pollen or nectar, and may not respond to a buildup of pests quickly enough to keep pest populations below damaging levels. Releasing insectary-reared beneficial organisms into the crop early in the pest outbreak may help control some pests but sometimes these biocontrol agents simply leave the area. For more information, see Cornell's Natural Enemies of Vegetable Insect Pests (Reference 3) and Biological Control: A Guide to Natural Enemies in North America (Link 41).

## Regulatory

Organic farms must comply with all other regulations regarding pesticide applications. See Section 10 for details. ALWAYS check with your organic farm certifier when planning pesticide applications.

## Efficacy

In general, insecticides allowed for organic production kill a smaller percentage of the pest population and have a shorter residual than non-organic insecticides. University –based efficacy testing is not available for many organic pesticides. See Section 10.3 for more information on application techniques that can optimize effectiveness.

## Resources:

Natural enemies of Vegetable Insect Pests (Reference 3)
Biological Control: A Guide to Natural Enemies in North America (Link 41).

Resource guide for Organic Insect and Disease Management (Reference 1)

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 13.0 Pesticides for Organic Bean Insect Control**

| | European Corn Borer | Mexican Bean Beetle | Potato Leafhopper | Seedcorn Maggot | Two-Spotted Mite | Tarnished Plant Bug |
|---|---|---|---|---|---|---|
| **BOTANICALS** | | | | | | |
| Aza-Direct (*azadirachtin)* | X | X | X | X | X | X |
| AzaGuard (*azadirachtin)* | | X | X | | X | X |
| AzaMax (*azadirachtin)* | X | X | X | | X | X |
| AzaSol (*azadirachtin)* | | X | | | | |
| Azatrol EC (*azadirachtin)* | X | X | X | | X | X |
| Azera (*azadirachtin and pyrethrins)* | X | X | X | | X | X |
| BioLink *(garlic juice)* | X | X | X | | X | X |
| BioLink Insect & Bird Repellant *(garlic juice)* | X | X | X | | X | X |
| Ecozin Plus 1.2% ME (*azadirachtin)* | X | X | X | X | | X |
| Envirepel 20 (*garlic juice)* | X | X | X | | X | X |
| Garlic Barrier (*garlic juice)* | X | X | X | | X | X |
| Molt-X (*azadirachtin)* | X | X | X | | | X |
| Neemix 4.5 (*azadirachtin)* | | X | X | | | |
| PyGanic EC 1.4 II (*pyrethrin)* | X | X | X | | X | X |
| PyGanic EC 5.0 II (*pyrethrin)* | X | X | X | | X | X |
| Safer Brand #567 (*pyrethrin & potassium salts of fatty acids)* | | X | X | | X | X |
| **MICROBIALS** | | | | | | |
| Deliver (*Bacillus thuringiensis subsp. Kurstaki)* | X | | | | | |
| DiPel DF (*Bacillus thuringiensis subsp. Kurstaki)* | X | | | | | |
| Entrust (*spinosad)* | X | | | | | |
| Entrust SC (*spinosad)* | X | | | | | |
| Grandevo (*Chromobacterium subtsugae str. PRAA4-1)* | | | X | | X | |
| Javelin (*Bacillus thuringiensis subsp. Kurstaki)* | X | | | | | |
| PFR-97 20% WDG (*Isaria fumosorosea Apopka str. 97)* | | | | | X | X |

| | | | | | | |
|---|---|---|---|---|---|---|
| **OILS** | | | | | | |
| BioRepel Natural Insect Repellent (*garlic oil)* | | | X | | | |
| Cedar Gard (*cedar oil)* | X | X | X | | | X |
| Cinnerate (*cinnamon oil)* | | | | | X | |
| Ecotec (*rosemary and peppermint oils)* | X | X | | | X | X |
| GC-Mite (*cottonseed, clove and garlic oils)* | | | | | X | |
| Glacial Spray Fluid (*mineral oil)* | | X | X | | X | |
| GrasRoots (*cinnamon oil)* | | | | | X | |
| Organic JMS Stylet Oil (*paraffinic oil)* | | | X | | X | |
| Oleotrol-I Bio-Insecticide Concentrate (*soybean oil)* | | | | | X | |
| Omni Supreme Spray (*mineral oil)* | | X | | | X | |
| Organocide 3-in-1 Garden Spray (*sesame oil)* | | | | | X | |
| PureSpray Green (*petroleum oil)* | | X | X | | X | |
| SuffOil-X (*petroleum oil)* | | X | X | | X | |
| TriTek (*mineral oil)* | | X | X | | X | |
| **OTHER** | | | | | | |
| DES-X (*insecticidal soap*) | | | X | | X | X |
| Micro Sulf (*sulfur)* | | | | | X | |
| Microthiol Disperss *(sulfur)* | | | | | X | |
| M-pede *(potassium salts of fatty acids*) | | | X | | X | X |
| Nuke Em (*citric acid)* | | | | | X | |
| Sil-Matrix (*potassium silicate)* | | | | | X | |
| Surround WP Crop Protectant (*kaolin)* | | X | X | | | |
| Trilogy (*neem extract)* | | | | | X | |

X-may be used against this pest and also OMRI listed

Active ingredient meets EPA criteria for acute toxicity to bees

## 13.1 Mexican Bean Beetle

**Time for concern:** June through September

**Key characteristics:** Adults are 1/4 -1/3 inch long, convex, and oval /in form. They vary in color from yellow when newly emerged to a coppery brown when mature. Each wing has eight black dots in three rows across the back. Eggs are orange to yellow in color and deposited in groups of 40 to 50 the underside of leaves. Larvae are yellow, and the bodies are covered with six rows of long, black-tipped spines. Feeding by adults and larvae results in the skeletonizing of leaves. See Cornell fact sheet and photo of damage (Links 42, 43).

| Management Option | Recommendations for Mexican Bean Beetle |
|---|---|
| **Scouting/thresholds** | Overwintering adults move into fields and feed for 1-2 weeks and then lay their eggs. Monitor fields by scouting for adults, eggs, and larvae. Because populations vary within a field and between fields in an area, it is difficult to determine when population numbers present a threat. |

| Management Option | Recommendations for Mexican Bean Beetle |
|---|---|
| **Natural Enemies** | Natural enemies such as parasitic flies, wasps, and predators help to control Mexican bean beetle populations. An imported parasitoid, *Pebiobus foveolatus*, can be important for control. The parasitoid does not overwinter successfully, so it must be reared and released each year. Use Reference 3 or see Cornell's *Biological Control: A Guide to Natural Enemies in North America* for identification of natural enemies (Link 41). |
| **Trap Crop** | A small strip of early-planted beans in the previous year's snap bean field could be used as a trap crop to attract overwintered beetles where they can be managed with foliar applications of products listed below or tilled under after adults have completed oviposition. |
| **Resistant Varieties** | No resistant varieties are available. |
| **Planting Date** | Avoiding early plantings can reduce damage. |
| **Cultural** | Avoid planting sequential crops adjacent to each other. Rotating fields as far away as possible from the previous season's fields should help to reduce populations. |
| **Postharvest** | Soon after harvest, plow under the infested crop to prevent immature beetles from completing development on the foliage and to destroy potential overwintering beetles. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

## Table 13.1 Pesticides for Management of Mexican Bean Beetle

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Aza-Direct (azadirachtin) | 1-2 pt/acre | 0 | 4 | 1 | Aza-Direct may be tank mixed /at rates as low as 4 oz/acre. Maximum rate is 3.5 pt/acre for heavy pest infestations. |
| AzaGuard (azadirachtin) | 8-16 fl.oz./acre | 0 | 4 | 1 | Use in combination with OMRI approved 0.25-1% non-phytotoxic spray oil in sufficient water to cover undersides of leaves. |
| AzaMax (azadirachtin) | 1.33 fl.oz/1000 sq ft | 0 | 4 | 1 | |
| AzaSol (azadirachtin) | 6 oz/acre | - | 4 | 1 | |
| Azatrol-EC (azadirachtin) | 0.29-0.96 fl oz/1000 sq ft | 0 | 4 | 1 | |
| BioLink (garlic juice) | 0.5-2 qt/acre | - | - | ? | 25(b) pesticide. |
| BioLink Insect & Bird Repellant (garlic juice) | 0.5-4 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| Cedar Gard (cedar oil) | 1 qt/acre | - | - | ? | 25(b) pesticide. |
| Ecotec (Rosemary oil, Peppermint oil) | 1-4 pts/ 100 gal spray | - | - | ? | 25(b) pesticide. |
| Ecozin Plus 1.2% ME (azadirachtin) | 15-30 oz/acre | 0 | 4 | 1 | Make at least 2 applications in sequence 7-10 days apart for maximum efficacy. |
| Envirepel 20 (garlic juice) | 10-32 oz/acre | - | - | ? | 25(b) pesticide. Repellant. |

**Table 13.1 Pesticides for Management of Mexican Bean Beetle**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Garlic Barrier AG (garlic juice) | See comments | - | - | ? | 25(b) pesticide. See label for specific information. |
| Glacial Spray Fluid (mineral oil) | 0.75-1 gal/100 gal water | up to day | 4 | ? | Target larvae. See label for specific application volumes. |
| Molt-X (azadirachtin) | 8 oz/acre | 0 | 4 | 1 | |
| Neemix 4.5 (azadirachtin) | 7-16 oz/acre | - | 4 | 1 | Neemix effective in 1/1 trial. Neemix controls larvae only; apply early and often for best control. |
| Omni Supreme Spray (mineral oil) | 1-2 gal/acre | - | 12 | ? | Target larvae. |
| PureSpray Green (white mineral oil) | 0.75-1.5 gal/acre | up to day | 4 | ? | Target larvae. |
| PyGanic EC 1.4 II (pyrethrins) | 16-64 fl.oz./acre | until dry | 12 | 3 | |
| PyGanic EC 5.0 II (pyrethrins) | 4.5-17 fl.oz./acre | - | 12 | 3 | |
| Pyganic EC 1.4 II (pyrethrins)<br>***Or***<br>PyGanic EC 5.0 II (pyrethrins)<br>***Plus***<br>Neemix 4.5 (azadirachtin) | 32 oz/acre<br><br>10 oz/acre<br><br>8 oz/acre | until dry<br>-<br> | 4 | 1 | Pyganic effective in 3/3 trials. Pyganic in combination with Neemix, provided even better protection than Pyganic alone in 1/1 trial. |
| PyGanic EC 1.4 II (pyrethrins)<br>***Or***<br>PyGanic EC 5.0 II (pyrethrins)<br>***Plus***<br>Nu Film P | 32 oz/acre<br><br>10 oz/acre<br><br>4-6 oz/acre | until dry<br>-<br> | 12 | 1 | Pyganic in combination with Nufilm provided better protection than Pyganic alone in 1/1 trial. |
| Safer Brand #567 II (potassium laurate, pyrethrins) | 1 gal of mixed spray/700 sq ft of plant surface area | until dry | 12 | ? | See label for specific mixing instructions. |
| SuffOil-X (aliphatic petroleum solvent) | 1-2 gal/100 gal water | up to day | 4 | ? | Target larvae. Do not mix with sulfur products. |
| Surround WP (kaolin clay) | 25-50 lb/acre | up to day | 4 | ? | |
| TriTek (mineral oil) | 1-2 gal/100 gal water | up to day | 4 | ? | Target larvae. Apply as needed. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?-not reviewed or no research available PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

Active ingredient meets EPA criteria for acute toxicity to bees

## 13.2 Potato Leafhopper (PLH), *Empoasca fabae*

**Time for concern:** Early June through pre-bloom

**Key characteristics:** The adult is wedge-shaped, iridescent green in color, and 1/8 inch long. The body is widest at the head. See Cornell fact sheet for photo (Link 44). Eggs are laid singly on the underside of leaves. Both adults and nymphs are very active, running forwards, backwards, or sideways. The symptoms produced by feeding have been termed "hopperburn." The first sign of hopperburn is whitening of the veins. These areas become flaccid and yellow in color, then desiccate, turn brown, and die. Leaf curling is also very common. The entire process takes four to five days. See Cornell photo of damage (Link 45) or Reference 10.

| Management Option | Recommendations for Potato Leafhopper |
|---|---|
| **Resistant varieties** | Resistance of the varieties currently grown is not known. |
| **Scouting/thresholds** | Potato leafhoppers migrate from southern areas each year and their time of arrival varies. Check for the presence of adult potato leafhoppers by using a sweep net or by placing yellow, sticky traps near field edges. Nymphs are best sampled by visual examination of the undersides of leaves on the lower half of the plant. Bean yields are most likely to be reduced by potato leafhoppers if damage occurs before bloom. Management should occur when a threshold is met of one nymph per trifoliate leaf or when adults exceed 100/20 sweeps. On newly emerged beans, lower densities of leafhoppers than those mentioned above may be damaging. See Reference 10. |
| **Natural enemies** | Although a variety of natural enemies of potato leafhoppers have been reported, their impact on infestations is not well known. Use Reference 3 or see Cornell *Biological Control: A Guide to Natural Enemies in North America* (Link 41). |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 13.2 Pesticides for Management of Potato Leafhopper**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Aza-Direct (azadirachtin) | 1-2 pts/acre | 0 | 4 | 1 | |
| AzaGuard (azadirachtin) | 10-16 fl oz/acre | 0 | 4 | 1 | Use in combination with OMRI approved 0.25-1% non-phytotoxic spray oil in sufficient water to cover undersides of leaves. |
| AzaMax (azadirachtin) | 1.33 fl oz/1000 sq ft | 0 | 4 | 1 | |
| Azatrol-EC (azadirachtin) | 0.24-0.96 fl oz/1000 sq ft | 0 | 4 | 1 | |
| Azera (azadirachtin, pyrethrins) | 1-3 pts/acre | - | 12 | 1 | |
| BioLink (garlic juice) | 0.5-2 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| BioLink Insect & Bird Repellant (garlic juice) | 0.5-4 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| BioRepel (garlic oil) | 1 part product to 100 parts water | - | - | ? | 25(b) pesticide. |
| Cedar Gard (cedar oil) | 1 qt/acre | - | - | ? | 25(b) pesticide. |
| Ecozin Plus 1.2% ME (azadirachtin) | 15-30 oz/acre | 0 | 4 | 1 | Make at least 2 applications in sequence 7-10 days apart for maximum efficacy. |

**Table 13.2 Pesticides for Management of Potato Leafhopper**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Envirepel 20 (garlic juice) | 10-32 oz/acre | - | - | ? | 25(b) pesticide. Repellant. |
| Garlic Barrier AG (garlic juice) | See comments | - | - | ? | 25(b) pesticide. See label for specific information. |
| Glacial Spray Fluid (mineral oil) | 0.75-1 gal/100 gal water | up to day | 4 | ? | See label for specific application volumes. |
| Grandevo *(Chromobacterium subtsugae* str. PRAA4-1) | 2-3 lb/acre | 0 | 4 | ? | |
| Organic JMS Stylet-Oil (paraffinic oil) | 3-6 qt/100 gal water | 0 | 4 | ? | |
| Molt-X (azadirachtin) | 10 oz/acre | 0 | 4 | 1 | |
| M-Pede (insecticidal soap) | 0.25%-4% volume to volume | 0 | 12 | ? | |
| Neemix 4.5 (azadirachtin) | 7-16 oz/acre | - | 4 | 3 | Neemix alone effective in 0/1 trial. Neemix in combination with Pyganic effective in 1/1 trial. |
| PureSpray Green (white mineral oil) | 0.75-1.5 gal/acre | up to day | 4 | ? | |
| PyGanic EC 1.4 II (pyrethrins) | 16-64 fl oz/acre | until dry | 12 | 1 | Pyganic alone effective in 2/3 trials. Two applications of Pyganic may be needed to reduce adult and nymph leafhopper populations. Pyganic in combination with Neemix effective in 1/1 trial. |
| PyGanic EC 5.0 II (pyrethrins) | 4.5-17 fl oz/acre | - | 12 | 1 | |
| Safer Brand #567 II (potassium laurate, pyrethrins) | 1 gal of mixed spray/700 sq ft of plant surface area | until dry | 12 | ? | See label for specific mixing instructions. |
| SuffOil-X (aliphatic petroleum solvent) | 1-2 gal/100 gal water | up to day | 4 | ? | Do not mix with sulfur products. |
| Surround WP (kaolin clay) | 25-50 lb/acre | up to day | 4 | ? | |
| TriTek (mineral oil) | 1-2 gal/100 gal water | up to day | 4 | ? | Apply as needed. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available. PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

Active ingredient meets EPA criteria for acute toxicity to bees

## 13.3 Seedcorn Maggot, *Delia platura*

**Time for concern:** Mid-May through late June

**Key characteristics:** Adult flies resemble small house flies, are slender, 1/4 inch long, and grayish black in color. Maggots are yellowish white and infest seeds and other below-ground plant parts. See Cornell fact sheet for photo (Link 46). Maggots are only a problem from planting to plant emergence. Damaged plants are weak, may not develop, or may be delayed in maturity. Stand may be poor. See Cornell photo of damage (Link 47) or see a Cornell bulletin with more information about damage (Link 48).

| Management Option | Recommendations for Seedcorn Maggot |
|---|---|
| **Scouting/thresholds** | Although there are multiple generations per year, the first generation is the important one. No thresholds are available. Five maggots per seed are required to significantly reduce stands of snap beans. |
| **Resistant varieties** | Snap beans are particularly susceptible. |
| **Planting date** | Planting after the first generation maggots have pupated will reduce damage. In New York, this occurs around June 21. Additionally, plantings after this period are less susceptible to maggot damage because warmer soil temperatures allow seedlings to emerge soon after planting, reducing the adult egg-laying period and young larval feeding period. |
| **Site selection/preparation** | Seedcorn maggots prefer soil with high organic matter. Incorporate crop residues at least 2 weeks before planting. Using shallow planting and other means to speed up germination and emergence will reduce damage. |
| **Seed selection/treatment** | No seed treatments are currently approved for organic production. |
| **Natural enemies** | Natural enemies can be conserved by using pesticides that are less harmful to them. Use Reference 3. See Cornell *Biological Control: A Guide to Natural Enemies in North America* (Link 41). |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

### 13.4 Products for Management of Seedcorn maggot

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Aza-Direct (azadirachtin) | 1-2 pt/acre | 0 | 4 | ? | Foliar spray or soil treatment. |
| Ecozin Plus 1.2% ME (azadirachtin) | 15-30 oz/acre soil drench | 0 | 4 | ? | Make at least 2 applications in sequence 7-10 days apart for maximum efficacy. Time sprays to anticipate egg hatch or when pests first appear. Drench soil to kill larvae. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available. PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

Active ingredient meets EPA criteria for acute toxicity to bees

## 13.4 European Corn Borer (ECB), *Ostrinia nubilalis*

**Time for concern:** June through September.

**Key characteristics:** The eggs are laid in fish scale-like masses on the undersides of leaves. Larvae are cream colored and have a relatively smooth appearance with rows of brown spots. The head capsule is dark brown, and mature larvae are 3/4 inch long. Pupae are reddish brown, but the bean crop is harvested before pupation occurs. Adults are light yellow with reddish brown markings and are about one inch in length. See Cornell fact sheet for photo (Link 49) or Reference 2. European corn borer feeding will damage pods and their feeding within the pod will cause contamination at harvest. See Cornell photo of damage (Link 50). See reference 9.

| Management Option | Recommendations for European Corn Borer |
|---|---|
| **Scouting/thresholds** | There are no formal thresholds for this pest on snap bean. Because tolerance for this pest is extremely low, and it is difficult to accurately scout for, insecticide use is relied upon. Decision for control should be based on the stage of the bean crop and level of moth activity. Beans should be treated only when they are in the vulnerable stage, i.e., from early bud until early pod development, in areas with known risk of infestation or high pheromone trap catches. Moth activity can be monitored using pheromone traps, and trap catch information is updated on the following website: Penn State Pest Watch (Link 51). |
| **Natural enemies** | A variety of natural enemies help suppress ECB populations including predatory lady beetles, minute pirate bugs and lacewings, and fly and wasp parasitoids. Natural enemies can be preserved using pesticides that are less harmful to them. Use Reference 3 or see the Cornell publication *Biological Control: A Guide to Natural Enemies in North America* (Link 41). Trichogramma ostriniae, a parasitoid of eggs, has been used successfully for ECB control in sweet corn and is commercially available. Releases should be timed to susceptible crop stage and ECB flight peaks. |
| **Resistant varieties** | No resistant varieties are available. |
| **Crop rotation** | This is not a viable management option |
| **Site selection** | Avoid planting in or adjacent to a field that was planted with corn the previous year. However, this is likely applicable only to early-planted fields. Late-planted snap bean fields adjacent to mature untreated corn could be at risk for attack by second-generation corn borers that emerge from the mature corn. |
| **Postharvest and Sanitation** | These are not currently viable management options |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**13.4 Products for Management of European Corn Borer**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Aza-Direct (azadirachtin) | 1-2 pt/acre | 0 | 4 | ? | Can use for ECB, but requires an intensive scouting program. Foliar spray or soil treatment. |
| AzaMax (azadirachtin) | 1.33 fl oz/1000 sq ft | 0 | 4 | ? | |

| | | | | | |
|---|---|---|---|---|---|
| Azatrol-EC (azadirachtin) | 0.24-0.96 fl oz/1000 sq ft | 0 | 4 | ? | |
| Azera (azadirachtin, pyrethrins) | 1-3 pts/acre | - | 12 | ? | |
| BioLink (garlic juice) | 0.5-2 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| BioLink Insect & Bird Repellant (garlic juice) | 0.5-4 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| Cedar Gard (cedar oil) | 1 qt/acre | - | - | ? | 25(b) pesticide. |
| Deliver (*Bacillus thuringinensis* subsp. Kurstaki) | 0.25-1.5 lb/acre | 0 | 4 | 3 | *Bacillus thuringiensis* products effective in 0/2 trials. Must be eaten by the larvae to be effective; most effective against small, newly hatched larvae, so good scouting program to determine early infestations is recommended. |
| Dipel DF (*Bacillus thuringinensis* subsp. Kurstaki) | 0.5-2 lb/acre | 0 | 4 | 3 | See comment for Deliver. |
| Ecotec (rosemary oil, peppermint oil) | 1-4 pts/ 100 gal spray | - | - | ? | 25(b) pesticide. Early stages only. |
| Ecozin Plus 1.2% ME (azadirachtin) | 15-30 oz/acre | 0 | 4 | ? | Make at least 2 applications in sequence 7-10 days apart for maximum efficacy. Spray soon after egg hatch. Foliar spray or soil treatment. |
| Entrust (spinosad) | 1-2 oz/acre | 3 | 4 | 1 | Spinosad products effective in 41/47 trials. 33 studies showed good control of caterpillars, including ECB. |
| Entrust SC (spinosad) | 3-6 fl oz/acre | 3 | 4 | 1 | See comment for Entrust. |
| Envirepel 20 (garlic juice) | 10-32 oz/acre | - | - | ? | 25(b) pesticide. Repellant. |
| Garlic Barrier AG (garlic juice) | See comments | - | - | ? | 25(b) pesticide. See label for specific information. |
| Javelin WG (*Bacillus thuringinensis* subsp. Kurstaki) | 0.12-1.5 lb/acre | 0 | 4 | 3 | See comment for Deliver. |
| Molt-X (azadirachtin) | 8 oz/acre | 0 | 4 | ? | |
| PyGanic EC 1.4 II (pyrethrins) | 16-64 fl oz/acre | until dry | 12 | ? | |
| PyGanic EC 5.0 II (pyrethrins) | 4.5-17 fl oz/acre | - | 12 | ? | |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available. . PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

Active ingredient meets EPA criteria for acute toxicity to bees

## 13.5 Two-Spotted Spider Mite, *Tetranychus urticae*

**Time for concern:** June through September.

**Key characteristics:** The adult mite is yellow to dark green with two or four black, dorsal spots. See Cornell fact sheet (Link 52). Heavy damage may cause leaves to drop. Hot, dry weather favors spider mite outbreaks.

| Management Option | Recommendation for Two-Spotted Spider Mite |
|---|---|
| **Natural enemies** | Natural enemies help to control spider mite populations and several species can be purchased from commercial insectaries. See the Cornell guide *Biological Control: A Guide to Natural Enemies in North America* (Link 41) or use Reference 3. |
| **Resistant varieties** | No resistant varieties are available. |
| **Crop rotation, Site selection, and Sanitation, Postharvest** | These are not currently viable management options. |
| **Note(s)** | Dry, warm conditions may increase the chance of a two-spotted spider mite infestation. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 13.5 Pesticides for Management of Two-Spotted Spider Mites**

| Product Name (Active Ingredient) | Product Rate | PHI[2] (Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| Aza-Direct (azadirachtin) | 1-2 pts/acre | 0 | 4 | ? | |
| AzaGuard (azadirachtin) | 10-16 fl oz/acre | 0 | 4 | ? | Use in combination with OMRI approved 0.25-1% non-phytotoxic spray oil in sufficient water to cover leaves. |
| AzaMax (azadirachtin) | 1.33 fl oz/1000 sq ft | 0 | 4 | ? | |
| Azatrol-EC (azadirachtin) | 0.24-0.96 fl oz/1000 sq ft | 0 | 4 | ? | |
| Azera (azadirachtin, pyrethrins) | 1-3 pts/acre | - | 12 | ? | |
| BioLink (garlic juice) | 0.5-2 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| BioLink Insect & Bird Repellant (garlic juice) | 0.5-4 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| Cinnerate (cinnamon oil) | 13-30 fl oz/100 gal water | - | - | ? | 25(b) pesticide. |
| DES-X (insecticidal soap) | 2% solution 2% solution sprayed at 75-200 gallons/acre | 1/2 | 12 | ? | |
| Ecotec (rosemary oil, peppermint oil) | 1-4 pts/ 100 gal spray | - | - | ? | 25(b) pesticide. |
| Envirepel 20 (garlic juice) | 10-32 oz/acre | - | - | ? | 25(b) pesticide. Repellant. |
| Garlic Barrier AG (garlic juice) | See comments | - | - | ? | 25(b) pesticide. See label for specific information. |

| **Table 13.5 Pesticides for Management of Two-Spotted Spider Mites** | | | | | |
|---|---|---|---|---|---|
| **Product Name (Active Ingredient)** | **Product Rate** | **PHI[2] (Days)** | **REI (Hours)** | **Efficacy** | **Comments** |
| GC-Mite (garlic oil, clove oil, cottonseed oil) | 1 gal/ 100 gal spray water | - | - | ? | 25(b) pesticide. |
| Glacial Spray Fluid (mineral oil) | 0.75-1 gal/100 gal water | up to day | 4 | ? | See label for specific application volumes. |
| Grandevo (*Chromobacterium subtsugae* str. PRAA4-1) | 2-3 lb/acre | 0 | 4 | ? | |
| GrasRoots (cinnamon oil) | 1 part GrasRoots to 9 parts water | -0 | - | ? | 25(b) pesticide. |
| Organic JMS Stylet-Oil (paraffinic oil) | 3-6 qt/100 gal water | 0 | 4 | ? | |
| Micro Sulf (sulfur) | 7 lb/acre | - | 24 | ? | Consult processor before using sulfur. |
| Microthiol Disperss (sulfur) | 3-10 lb/acre | - | 24 | ? | Consult processor before using sulfur. |
| M-Pede (insecticidal soap) | 0.25%-4% vol:vol | 0 | 12 | ? | |
| Nuke Em (citric acid) | 1 fl oz/31 oz water to 2 fl oz/30 fl oz water | - | - | ? | 25(b) pesticide. |
| Oleotrol-I Bio-Insecticide Concentrate (soybean oil) | 1 part concentrate: 300 parts water | - | - | ? | 25(b) pesticide. |
| Omni Supreme Spray (mineral oil) | 1-2 gal/acre | - | 12 | ? | |
| Organocide (sesame oil) | 2 oz/gal water | - | - | ? | 25(b) pesticide. |
| PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97) | 1-2 lb/acre | - | 4 | ? | Repeat at 3-10 day intervals as needed to maintain control. |
| PureSpray Green (white mineral oil) | 0.75-1.5 gal/acre | up to day | 4 | ? | |
| PyGanic EC 1.4 II (pyrethrins) | 16-64 fl oz/acre | until dry | 12 | ? | |
| PyGanic EC 5.0 II (pyrethrins) | 4.5-17 fl oz/acre | - | 12 | ? | |
| Safer Brand #567 II (potassium laurate, pyrethrins) | 1 gal of mixed spray/700 sq ft of plant surface area | until dry | 12 | ? | See label for specific mixing instructions. |
| Sil-Matrix (potassium silicate) | 0.5-1% solution | 0 | 4 | ? | Mix 2-4 qts in 100 gallons of water and apply at 20 gallons finished spray/acre. |
| SuffOil-X (aliphatic petroleum solvent) | 1-2 gal/100 gal water | up to day | 4 | ? | Do not mix with sulfur products. |
| Trilogy (neem oil) | 0.5-2.0% in 25-100 gal water/acre | up to day | 4 | ? | Bee Hazard. This product is toxic to bees exposed to direct contact. |

| Table 13.5 Pesticides for Management of Two-Spotted Spider Mites | | | | | |
|---|---|---|---|---|---|
| **Product Name (Active Ingredient)** | **Product Rate** | **PHI[2] (Days)** | **REI (Hours)** | **Efficacy** | **Comments** |
| TriTek (mineral oil) | 1-2 gal/100 gal water | up to day | 4 | ? | Apply as needed. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available. PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.
Active ingredient meets EPA criteria for acute toxicity to bees

## 13.6 Tarnished Plant Bug (TPB), *Lygus lineolaris*

**Time for concern:** June through September

**Key characteristics:** The adult is an oval, brown bug, mottled with various shades of reddish and yellowish brown, and about 1/4 inch long. The eggs are elongated and curved with a square outer end. Nymphs are small and greenish yellow. See Cornell fact sheet (Link 53). The nymphs feed more than the adults. The sucking injury from the nymphs causes buds to drop, pods to be misshapen, and plants to be stunted and distorted. Tarnished plant bug can be a problem from bloom through harvest. See Cornell photo of damage (Link 54) or Reference 8.

| Management Option | Recommendations for Tarnished Plant Bug |
|---|---|
| **Scouting/thresholds** | Check for TPB on pigweed seed heads or by using a sweep net. Trials on snap beans indicated no yield reductions occurred with five adult TPBs or less per plant at blossom through pin pod stages. |
| **Natural enemies** | Natural enemies that can help control TPB populations can be preserved by using pesticides that are less harmful to them. See the Cornell guide *Biological Control: A Guide to Natural Enemies in North America* (Link 41) or use Reference 3. |
| **Resistant varieties** | No resistant varieties are available. Although the TPB will feed on bean pods under New York's growing conditions, most snap bean varieties are somewhat tolerant with minimal pod-spotting resulting at harvest. It is advisable to schedule plantings of susceptible varieties for early-season harvests since TPB numbers increase in bean fields as the season progresses. |
| **Crop rotation, Site selection, Postharvest, and Sanitation** | Effective weed management could eliminate potential hosts for tarnished plant bugs in fields and thereby minimize risk of injury to the snap bean crop. TPB has a wide-range of hosts including many weeds and is particularly attracted to flower buds. Minimizing weeds that tend to bloom prior to bean blooms can help reduce the overall population of TPB in the field. Avoid situations in which snap beans, in a vulnerable stage, are near hayfields where TPB numbers may build up and move into beans when the hay is cut. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

| Table 13.6 Pesticides for Management of Tarnished Plant Bug | | | | | |
|---|---|---|---|---|---|
| **Class of Compounds Product Name (Active Ingredient)** | **Product Rate** | **PHI[2](Days)** | **REI (Hours)** | **Efficacy** | **Comments** |
| Aza-Direct (azadirachtin) | 1-2 pt/acre | 0 | 4 | ? | |
| AzaGuard (azadirachtin) | 10-16 fl oz/acre | 0 | 4 | ? | Spray nymphs early. |

**Table 13.6 Pesticides for Management of Tarnished Plant Bug**

| | | | | | |
|---|---|---|---|---|---|
| AzaMax (azadirachtin) | 1.33 fl oz/1000 sq ft | 0 | 4 | ? | |
| Azatrol-EC (azadirachtin) | 0.24-0.96 fl oz /1000 sq ft | 0 | 4 | ? | |
| Azera (azadirachtin, pyrethrins) | 1-3 pts/acre | - | 12 | ? | |
| BioLink (garlic juice) | 0.5-2 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| BioLink Insect & Bird Repellant (garlic juice) | 0.5-4 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| Cedar Gard (cedar oil) | 1 qt/acre | - | - | ? | 25(b) pesticide. |
| DES-X (insecticidal soap) | 2% solution 2% solution sprayed at 75-200 gallons/acre | 1/2 | 12 | ? | |
| Ecotec (rosemary oil, peppermint oil) | 1-4 pts/ 100 gal spray | - | - | ? | 25(b) pesticide. |
| Ecozin Plus 1.2% ME (azadirachtin) | 15-30 oz/acre | 0 | 4 | ? | Make at least 2 applications in sequence 7-10 days apart for maximum efficacy. Spray nymphs early and repeat application after 7 days. |
| Envirepel 20 (garlic juice) | 10-32 oz/acre | - | - | ? | 25(b) pesticide. Repellant. |
| Garlic Barrier AG (garlic juice) | See comments | - | - | ? | 25(b) pesticide. See label for specific information. |
| Molt-X (azadirachtin) | 10 oz/acre | 0 | 4 | ? | |
| M-Pede (insecticidal soap) | 0.25%-4% vol:vol | 0 | 12 | ? | |
| PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97) | 1-2 lb/acre | - | 4 | ? | Repeat at 3-10 day intervals as needed to maintain control. |
| PyGanic EC 1.4 II (pyrethrins) | 16-64 fl oz/acre | until dry | 12 | ? | |
| PyGanic EC 5.0 II (pyrethrins) | 4.5-17 fl oz/acre | - | 12 | ? | |
| Safer Brand #567 II (potassium laurate, pyrethrins) | 1 gal of mixed spray/700 sq ft of plant surface area | until dry | 12 | ? | See label for specific mixing instructions. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available. . PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

Active ingredient meets EPA criteria for acute toxicity to bees

## 14. Slugs

**Time of concern:** May through September.

**Key characteristics:** Adult slugs are between one and two inches in length. See Cornell fact sheet (Link 55). Slugs can overwinter at any stage of development. Although slugs cannot survive prolonged subzero temperatures or desiccation, the burrows of small mammals and worms provide insulation from the weather. Slugs begin to move, hatch, feed, and lay eggs in the spring when temperatures are consistently above 40°F. There is often little or no slug activity in the field during periods of dry weather; however, there may be extensive feeding when the weather is damp.

| Management Option | Recommendations for Management of Slugs |
|---|---|
| **Scouting/thresholds** | Record the occurrence and severity of slug damage. No thresholds have been established. |
| **Resistant varieties** | No resistant varieties are available. |
| **Cultural** | Practices that help dry the soil surface for example conventional tillage, good weed control, and using raised beds that dry out more readily than flat beds, will reduce slug populations. Heavy organic mulch creates an ideal environment for slugs. |

At the time this guide was produced, the following materials were available in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

**Table 14. Pesticides for Management of Slugs**

| Product Name (Active Ingredient) | Product Rate | PHI[2](Days) | REI (Hours) | Efficacy | Comments |
|---|---|---|---|---|---|
| BioLink (garlic juice) | 0.5-2 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| BioLink Insect & Bird Repellant (garlic juice) | 0.5-4 qt/acre | - | - | ? | 25(b) pesticide. Repellant. |
| Bug-N-Sluggo (spinosad, iron phosphate) | 20-44 lb/acre Soil treatment | 3 | 4 | ? | |
| Sluggo AG (iron phosphate) | 20-44 lb/acre Soil treatment | 0 | 0 | ? | Treat field perimeter. Lasts up to 4 weeks. |
| Sluggo Slug and Snail Bait (iron phosphate) | 20-44 lb/acre Soil treatment | - | 0 | ? | Scatter bait around the perimeter of the vegetable plantings. |

Efficacy: 1- effective in half or more of recent university trials, 2- effective in less than half of recent university trials, 3-not effective in any known trials, ?- not reviewed or no research available. PHI = pre-harvest interval, REI = restricted-entry interval. - = pre-harvest interval isn't specified on label. [2]Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

Active ingredient meets EPA criteria for acute toxicity to bees

## 15. Pesticides & Abbreviations Mentioned in this Publication

**Table 1. Insecticides, nematicides and molluscicides mentioned in this publication**

| TRADE NAME | COMMON NAME | EPA REG. NO. |
|---|---|---|
| Aza-Direct | *azadirachtin* | 71908-1-10163 |
| AzaGuard | *azadirachtin* | 70299-17 |
| AzaMax | *azadirachtin* | 71908-1-81268 |
| AzaSol | *azadirachtin* | 81899-4 |
| Azatrol EC | *azadirachtin* | 2217-836 |
| Azera | *azadirachtin, pyrethrins* | 1021-1872 |
| BioLink | *garlic juice* | exempt-25(b) pesticide |
| BioLink Insect & Bird Repellant | *garlic juice* | exempt 25(b) pesticide |
| BioRepel Natural Insect Repellent | *garlic oil* | exempt-25(b) pesticide |

**Table 1. Insecticides, nematicides and molluscicides mentioned in this publication**

| TRADE NAME | COMMON NAME | EPA REG. NO. |
|---|---|---|
| Bug-N-Sluggo | *iron phosphate and spinosad* | 67702-24-70051 |
| Cedar Gard | *cedar oil* | exempt-25(b) pesticide |
| Cinnerate | *cinnamon oil* | exempt-25(b) pesticide |
| Deliver | *Bacillus thuringiensis subsp. kurstaki* | 70051-69 |
| DES-X | *insecticidal soap* | 67702-22-70051 |
| DiPel DF | *Bacillus thuringiensis subsp. kurstaki* | 73049-39 |
| DiTera DF | *Myrothecium verrucaria* | 73049-67 |
| Ecotec | *rosemary and peppermint oil* | exempt-25(b) pesticide |
| Ecozin Plus 1.2% ME | *azadirachtin* | 5481-559 |
| Entrust | *spinosad* | 62719-282 |
| Entrust SC | *spinosad* | 62719-621 |
| Envirepel | *garlic juice* | exempt-25(b) pesticide |
| Garlic Barrier | *garlic juice* | exempt-25(b) pesticide |
| GC-Mite | *cottonseed, clove and garlic oils* | exempt-25(b) pesticide |
| Glacial Spray Fluid | *mineral oil* | 34704-849 |
| Grandevo | *Chromobacterium subtsugae str. PRAA4-1* | 84059-17 |
| GrasRoots | *cinnamon oil* | exempt-25(b) pesticide |
| Javelin WG | *Bacillus thuringiensis subsp. kurstaki* | 70051-66 |
| Micro Sulf | *sulfur* | 55146-75 |
| Molt-X | *azadirachtin* | 68539-11 |
| M-pede | *potassium salts of fatty acids* | 10163-324 |
| Neemix 4.5 | *azadirachtin (neem)* | 70051-9 |
| Nuke Em | *citric acid* | exempt-25(b) pesticide |
| Oleotrol-I Bio-Insecticide Concentrate | *soybean oil* | exempt-25(b) pesticide |
| Omni Supreme Spray | *mineral oil* | 5905-368 |
| Organic JMS Stylet Oil | *paraffinic oil* | 65564-1 |
| Organocide 3-in-1 Garden Spray | *sesame oil* | exempt-25(b) pesticide |
| PureSpray Green | *petroleum oil* | 69526-9 |
| PFR-97 20% WDG | *Isaria fumosorosea Apopka str. 97* | 70051-19 |
| Pyganic EC 1.4 II | *pyrethrin* | 1021-1771 |
| Pyganic EC 5.0 II | *pyrethrin* | 1021-1772 |
| Safer Brand #567 Pyrethrin & Insecticidal Soap Concentrate II | *pyrethrin & potassium salts of fatty acids* | 59913-9 |
| Sil-Matrix | *potassium silicate* | 82100-1 |
| SuffOil-X | *petroleum oil* | 48813-1-68539 |
| Sluggo AG | *iron phosphate* | 67702-3-54705 |
| Sluggo Slug & Snail Bait | *iron phosphate* | 67702-3-70051 |
| Surround WP | *kaolin* | 61842-18 |
| Trilogy | *neem extract* | 70051-2 |
| TriTek | *mineral oil* | 48813-1 |

Active ingredient meets EPA criteria for acute toxicity to bees

**Table 2. Fungicides mentioned in this publication**

| TRADE NAME | COMMON NAME | EPA REG. NO. |
|---|---|---|
| Actinovate AG | *Streptomyces lydicus WYEC 108* | 73314-1 |
| Actinovate STP | *Streptomyces lydicus WYEC 108* | 73314-4 |
| Agricure | *potassium bicarbonate* | 70870-1 |
| Badge X2 | *copper oxychloride, copper hydroxide* | 80289-12 |
| Basic Copper 53 | *basic copper sulfate* | 45002-8 |
| BIO-TAM | *Trichoderma asperellum,* | 80289-9-69592 |

**Table 2. Fungicides mentioned in this publication**

| TRADE NAME | COMMON NAME | EPA REG. NO. |
|---|---|---|
| Bio-Tam 2.0 | *Trichoderma gamsii* (*Trichoderm asperellum, T. gamsii*) | 80289-9 |
| Champ WG | *copper hydroxide* | 55146-1 |
| ChampION++ | *copper hydroxide* | 55146-115 |
| Cueva Fungicide Concentrate | *copper octanoate* | 67702-2-70051 |
| Contans WG | *Coniothyrium minitans* | 72444-1 |
| CS 2005 | *copper sulfate pentahydrate* | 66675-3 |
| Double Nickel 55 Biofungicide | *Bacillus amyloliquefaciens str. D747* | 70051-108 |
| Double Nickel LC Biofungicide | *Bacillus amyloliquefaciens str. D747* | 70051-107 |
| Micro Sulf | *sulfur* | 55146-75 |
| Microthiol Disperss | *sulfur* | 70506-187 |
| Mycostop Biofungicide | *Streptomyces griseoviridis* | 64137-5 |
| Mycostop Mix | *Streptomyces griseoviridis* | 64137-9 |
| Nordox 75 WG | *cuprous oxide* | 48142-4 |
| Nu-Cop 50DF | *copper hydroxide* | 45002-4 |
| Nu-Cop HB | *copper hydroxide* | 42750-132 |
| Nu-Cop 50 WP | *copper hydroxide* | 45002-7 |
| Optiva | *Bacillus subtillis str. QST 713* | 69592-26 |
| Organic JMS Stylet Oil | *paraffinic oil* | 65564-1 |
| Oxidate 2.0 | *hydrogen dioxide* | 70299-12 |
| PERpose Plus | *hydrogen peroxide/dioxide* | 86729-1 |
| Prestop Biofungicide Powder | *Gliocladium catenulatum str. J1446* | 64137-11 |
| PureSpray Green | *petroleum oil* | 69526-9 |
| Regalia Biofungicide | *Reynoutria sachalinensis* | 84059-3 |
| RootShield Granules | *Trichoderma* | 68539-3 |
| RootShield PLUS+ Granules | *Trichoderma species* | 68539-10 |
| RootShield PLUS+ WP | *Trichoderma species* | 68539-9 |
| Serenade ASO | *Bacillus subtilis* str QST 713 | 69592-12 and 264-1152 |
| Serenade MAX | *Bacillus subtilis* str QST 713 | 69592-11 and 264-1151 |
| Serenade Opti | *Bacillus subtilis* str QST 713 | 264-1160 |
| Serenade Soil | *Bacillus subtilis* str QST 713 | 69592-12 and 264-1152 |
| SoilGard Microbial Fungicide | *Gliocladium virens str. GL-21* | 70051-3 |
| Taegro | *Bacillus subtilis* | 70127-5 |
| TerraClean 5.0 | *hydrogen dioxide, peroxyacetic acid* | 70299-13 |
| Trilogy | *neem oil* | 70051-2 |
| Zonix | *Rhamnolipid Biosurfactant* | 72431-1 |

Active ingredient meets EPA criteria for acute toxicity to bees

| Abbreviations and Symbols Used in This Publication | | | |
|---|---|---|---|
| A | acre | NE | not effective |
| AG | agricultural use label | NI | no information |
| AR | annual rye | NFT | not frost tolerant |
| ASO | aqueous suspension-organic | P | phosphorus |
| AS | aqueous suspension | PHI | pre-harvest interval |
| DF | dry flowable | $P_2O_5$ | phosphorus oxide |
| EC | emulsifiable concentrate | PR | perennial rye |
| F | flowable | R | resistant varieties |
| HC | high concentrate | REI | restricted entry interval |
| K | potassium | WP | wettable powder |
| $K_2O$ | potassium oxide | WG | water dispersible granular |
| N | nitrogen | WPS | Worker Protection Standard |

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**All links accessed 15 April 2016**

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