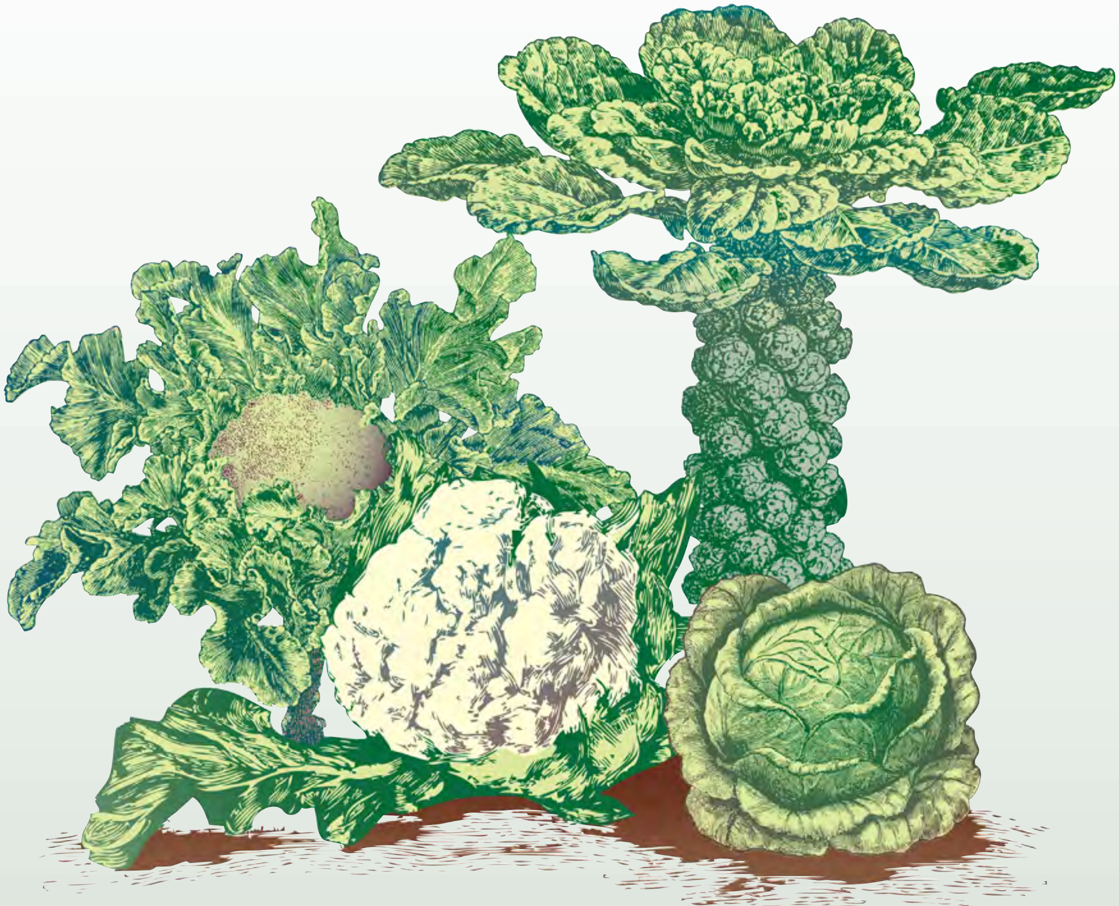
http://hdl.handle.net/1813/42893

2016

Organic Production and IPM Guide for Cole Crops



NYS IPM Publication No. 134

Cornell University Cooperative Extension

IPM Integrated Pest Management

New York State Department of Agriculture & Markets

Production and IPM Guide for Organic Cole Crops

Cabbage, Cauliflower, Broccoli, and Brussels Sprouts

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Special Appreciation

Format based on the *Integrated Crop and Pest Management Guidelines for Commercial Vegetable Production* (https://ipmguidelines.org/). Content editors: Stephen Reiners and Abby Seaman, with numerous discipline editors.

Funded in part by the New York State Department of Agriculture and Markets

This guide is not a substitute for pesticide labeling. Always read the product label before applying any pesticide.

Updates and additions to this guide are available at http://nysipm.cornell.edu/resources/publications/organic-guides. Please submit comments or suggested changes for these guides to organicguides@gmail.com.

How to cite this publication: Seaman, Abby, editor (2016). *Production Guide for Organic Cole Crops: Cabbage, Cauliflower, Broccoli, and Brussels Sprouts.* Publisher: New York State Integrated Pest Management Program, Cornell University (New York State Agricultural Experiment Station, Geneva, NY). 73 pages.

INTRODUCTION

This guide for organic production of broccoli, cauliflower, cabbage and Brussels sprouts 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.

This 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.

Key Pests of Cole Crops- perennial problems in NY:

Insects	Diseases
Imported cabbageworm	Black rot
Cabbage looper	Alternaria leaf spot
Diamondback moth	
Thrips	

Potentially Serious Pests – use management strategies to prevent buildup of these potentially serious pests

Insects	Diseases
Swede midge	Clubroot

1. GENERAL ORGANIC MANAGEMENT PRACTICES

Cabbage, broccoli, cauliflower, and Brussels sprouts are part of the Brassicaceae family, formerly Cruciferae, and include many crops grown in New York. They are cool season crops, making them particularly suitable to the New York climate. See Appendix 1 for listing of other crops, cover crops and weeds in the Brassicaceae family.

1.1 Organic Certification

To use a certified organic label, farming operations grossing 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 (reference 21) operating in New York can be found on the New York State Department of Agriculture and Markets Organic Farming Development/Assistance webpage(reference 22). See more certification details under Section 4.1: *Field Selection, Certification Requirements* and Section 13: *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 must 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 in the soil and on the root surface. However, newly incorporated organic matter can reduce seed germination and increase damping-off and cabbage root maggot.

Rotating between crop families can help prevent the buildup of diseases and nematodes that overwinter in the soil. Rotation with a grain crop, or preferably a crop or crops that will be in place for one or more seasons, deprives many, but not all, 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 a number of root damaging nematodes in the soil. Rotating between crops with late and early season planting dates can reduce 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 (reference 31). For more information, refer to the Cornell Soil Health website (reference 32).

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, carefully considering 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 the subsequent cash crops. See tables 3.1 and 3.2 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 untreated 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 cover 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. To balance optimal weed suppression and minimize effects on cole crop yield, interseed cover crops either 30 days after transplanting or during the last cultivation. An excellent resource for determining the best cover crop for your situation is Northeast Cover Crop Handbook, by Marianne Sarrantonio (reference 29) or the Cornell online decision tool to match goals, season, and cover crop (reference 30).

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 residue. 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.

Avoid growing a brassica cover crop prior to planting a brassica cash crop to prevent increases of destructive soil pathogens. If more than 50 to 70 percent of the cash crops grown on the farm are brassicas, avoid brassica cover crops throughout the farm. Many brassica pests can be reduced using a 3-year rotation out of all brassica cash and cover crops.

3.2 Legume Cover Crops

Legumes are the best cover crop for increasing available soil nitrogen for crops with a high nitrogen requirement like cole crops (see Table 4.2.1). Plant legumes in advance of cole crops to build the soil nitrogen, or after to replace the nitrogen used by the cole crop. Legumes have symbiotic bacteria in their roots called rhizobia, which convert atmospheric nitrogen gas in the soil pores to ammonium, a form of nitrogen that plant roots can use. When the cover crop is mowed, winter killed, or incorporated into the soil, the nitrogen is released and available for the next crop. Because most of this nitrogen was taken from the air, there is a net nitrogen gain to the soil (See Table 3.1). Assume approximately 50 percent of the nitrogen fixed by the cover crop will be available for the cash crop in the first season, but this will vary depending on the maturity of the legume, environmental conditions during decomposition, the type of legume grown, and soil type.

It is common to inoculate legume seed with rhizobia prior to planting, but the inoculant must be approved for use in organic systems. Request written verification of organic approval from the supplier and confirm this with your organic farm certifier prior to inoculating seed.

Hairy vetch is an example of a valuable legume cover crop for cole crops. Under the right conditions, this hardy annual can supply up to 100 lbs. of nitrogen per acre when overwintered and incorporated in late May. To maintain nitrogen levels for the next season's crop, hairy vetch can be interseeded into cabbage 30 days after transplanting, at a rate of 20-40 lbs/acre. Hairy vetch must be managed carefully to prevent potential problems. While valued for producing an abundance of biomass and suppressing weeds, it sometimes becomes a weed itself if allowed to go to seed. Although normally hardy, hairy vetch is sometimes killed in the winter. Hairy vetch is an alternate host for white mold (see Section 11.8) so should be avoided in fields where white mold is a historical problem.

Legume cover crops, especially clovers and hairy vetch, are highly susceptible to several root rot pathogens (*Rhizoctonia* and *Pythium)* and root-knot and lesion nematodes. Consider the long-term rotation of cash crops when choosing what cover crop to plant. See more about managing these pests in Section 2: *Soil health.*

3.3 Non-legume Cover Crops

Barley, rye grain, rye grass, Sudangrass, wheat, oats, and other grain crops left on the surface as dead plant residues, or plowed under in the spring as green manures, 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.

3.4 Combining Legumes and Non-legumes

Interseeding a legume with non-legume cover crop combines the benefits of both. A quick–growing rye grown in late summer with a nitrogen producing vetch protects the soil from heavy harvest traffic in the fall, decreases erosion in the winter, and supplies extensive organic matter and nitrogen when incorporated in the spring. Seed rye at 50-60 lbs/acre with hairy vetch at 30 lbs/acre. Growing these cover crops together reduces the overall nitrogen contribution, but helps the vetch to survive harsh winters.

3.5 Biofumigant Cover Crops

Certain cover crops, when tilled into the soil as green manures and degraded by microbes, release volatile chemicals that have been shown to inhibit weeds, pathogens, and nematodes. These biofumigant cover crops include Sudangrass, sorghum-sudangrasses, and many in the brassica family. Degradation is quickest when soil is warm and moist. Lightly seal the soil surface using a culti-packer or 1/2 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. This biofumigant effect is not predictable or consistent and in the case of brassica cover crops in rotation with brassica cash crops, may pose more risk than benefit because they increase the potential for brassica soil-borne pathogens. The levels of the active compounds and suppressiveness can vary by season, cover crop variety, maturity at incorporation, soil microbial diversity, soil tilth, and microbe population density.

Reference

Northeast Cover Crops Handbook (reference 29).
Cover Crops for Vegetable Production in the Northeast (reference 33).
Cover Crops for Vegetable Growers: Decision Tool (reference 30).
Crop Rotations on Organic Farms: A Planning Manual (reference 5).

Table 3.1 Leguminous Cover Crops: Cultural Requirements, Nitrogen Contributions and Benefits.

Species	Planting Dates	Life Cycle	Cold Hardiness Zone	Heat (Tolerances)	Drought (Tolerances)	Shade (Tolerances)	pH Preference	Soil Type Preference	Seeding (lb/A)	Nitrogen Fixed (lb/A)[a]	Comments
CLOVERS											
Alsike	April-May	Biennial/ Perennial	4	5	5	6	6.3	Clay to silt	4-10	60-119	+Endures waterlogged soils & greater pH range than most clovers
Berseem	Early spring	Summer annual/ Winter annual[b]	7	6-7	7-8	5	6.5-7.5	Loam to silt	9-25	50-95	+Good full-season annual cover crop
Crimson	Spring	Summer annual/ Winter annual[b]	6	5	3	7	5.0-7.0	Most if well-drained	9-40	70-130	+Quick cover +Good choice for overseeding (shade tolerant) + Sometimes hardy to zone 5.
Red	Very early spring or late summer	Short-lived perennial	4	4	4	6	6.2-7.0	Loam to clay	7-18	100-110	+Strong taproot, good heavy soil conditioner +Good choice for overseeding (shade tolerant)
White	Very early spring or late summer	Long-lived perennial	4	6	7	8	6.2-7.0	Loam to clay	6-14	≤130	+Good low maintenance living cover +Low growing +Hardy under wide range of conditions
SWEET CLOVERS											
Annual White	Very early spring	Summer annual[b]	NFT	6-7	6-7	6	6.5-7.2	Most	15-30	70-90	+Good warm weather smother & catch crop +Rapid grower +High biomass producer
Biennial White and Yellow	Early spring-late summer	Biennial	4	6	7-8	4	6.5-7.5	Most	9-20	90-170	+Deep taproot breaks up compacted soils & recycles nutrients +Good catch crop +High biomass producer
OTHER LEGUMES											
Cowpeas	Late spring-late summer	Summer annual[b]	NFT	9	8	6	5.5-6.5	Sandy loam to loam	25-120	130	+Rapid hot weather growth
Fava Beans	April-May or July-August	Summer annual[b]	8	3	4	NI	5.5-7.3	Loam to silty clay	80-170 small seed 70-300 lg seed	71-220	+Strong taproot, good conditioner for compacted soils + Excellent cover & producer in cold soils +Efficient N-fixer
Hairy Vetch	Late August-early Sept.	Summer annual/ Winter annual	4	3	7	5	6.0-7.0	Most	20-40	80-250 (110 ave.)	+Prolific, viney growth +Most cold tolerant of available winter annual legumes
Field Peas	March-April OR late summer	Winter annual/ Summer annual[b]	7	3	5	4	6.5-7.5	Clay loam	70-220	172-190	+Rapid growth in chilly weather

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] Nitrogen fixed but not total available nitrogen. See Section 8 for more information. [b] Winter killed. Reprinted with permission from Rodale Institute www.rodaleinstitute.org M. Sarrantonio. (1994) Northeast Cover Crop Handbook (Reference 29).

Table 3.5.2. Non-leguminous Cover Crops: Cultural Requirements and Crop Benefits

Species	Planting Dates	Life Cycle	Cold Hardiness Zone	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 [b]	6-8	4	6	NI	5.3-6.8	Loam to clay	5-12	+Good dual purpose cover & forage +Establishes quickly in cool weather +Biofumigant properties
Buckwheat	Late spring-summer	Summer annual [b]	NFT	7-8	4	6	5.0-7.0	Most	35-134	+Rapid grower (warm season) +Good catch or smother crop +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 +Excellent allelopathic weed control +Good catch crop +Rapid germination & growth +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[b]	8	4	4	4	5.0-6.5	Silt & clay loams	110	+Rapid growth +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 +Rapid growth +Good catch crop +Heavy N & moisture users
Sorghum-Sudangrass	Late spring-summer	Summer Annual [b]	NFT	9	8	NI	Near neutral	NI	10-36	+Tremendous biomass producers in hot weather +Good catch or smother crop +Biofumigant properties

NI-No Information, NFT-No Frost Tolerance. AR=Annual Rye, PR=Perennial Rye.
Drought, Heat, Shade Tolerance Ratings: 1-2=low, 3-5=moderate, 6-8=high, 9-10=very high. [b]Winter killed. Reprinted with permission from Rodale Institute www.rodaleinstitute.org M. Sarrantonio. (1994) Northeast Cover Crop Handbook. (Reference 29).

4. Field Selection

For organic production, give priority to fields with excellent soil tilth, high organic matter, good drainage and airflow.

4.1 Certification 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 the 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 and 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 in 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, 14). 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 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. See Section 5: *Weed Management* for more specifics. 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 any nitrogen not used by the previous crop. This nitrogen is then released when the cover crop is incorporated in the spring. See Section 3: *Cover Crops* and Section 5: *Weeds* for more information.

Rotating crops that produce abundant organic matter, such as hay 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*). Cole crops generally have a high nutrient requirement (Table 4.2.1). Growing a cover crop, preferably one that includes a legume, prior to or after a cole crop will help to renew soil nutrients, improve soil structure, and diversify soil organisms. Include deep rooted crops in the rotation to help break up compacted soil layers.

Table 4.2.1 Crop Nutrient Requirements

	Nutrient Needs		
	Lower	**Medium**	**Higher**
Crop	Bean Beet Carrot Herbs Pea Radish	Cucumber Eggplant Brassica greens Pepper Pumpkin Spinach Chard Squash Winter squash	Broccoli Cabbage Cauliflower Corn Lettuce Potato Tomato

From NRAES publication *Crop Rotation on Organic Farms: A Planning Manual*. Charles L. Mohler and Sue Ellen Johnson, editors. (reference 5).

Crop Rotation Information Specific to Brassicas

Verticillium: Growing broccoli prior to crops that are susceptible to *Verticillium* has been shown to reduce the disease incidence when broccoli plant residues are incorporated into the soil immediately after harvest. The effect is strongest when temperatures are above 68^{O}F.

***Plasmodiophora brassicae* (clubroot)**: Clubroot infestations decline more quickly when tomato, cucumber, snap bean, or buckwheat are included in the crop rotation. Growing aromatic perennial herbs such as summer savory, peppermint, and garden thyme for 2 to 3 years also can reduce clubroot.

***Sclerotinia sclerotiorum* (lettuce drop)**: Broccoli grown in rotation with lettuce helps to reduce lettuce drop.

Rhizoctonia: Highly susceptible crops include beans, beet, cabbage, lettuce, pea, and potato. Rotate away from these crops for at least 3 years. Other host crops include broccoli, kale, radish, turnip, carrot, cress, cucumber, eggplant, pepper, and tomato. Cereal crops are useful for reducing *Rhizoctonia*.

For most pests, maintaining at least 3 years between brassica crops is recommended, although heavy infestations of diseases like clubroot, wirestem (*Rhizoctonia)*, and white mold may require longer rotations. Avoid brassica cover crops during the rotation. See Appendix 1 for a listing of crops, cover crops and weeds in the Brassica family. For more details, see Crop Rotation on Organic Farms: A Planning Manual, Charles L. Mohler and Sue Ellen Johnson (ref 5).

Table 4.2.2 Potential Interactions of Crops Grown in Rotation with Crucifer Crops

Crop	Potential Rotation Consequences	Comments
Annual ryegrass	*Reduces* **clubroot**	Ryegrass reduces clubroot infection rates more than other rotation species.
Snap bean, buckwheat, cucumber, tomato	*Reduces* **clubroot**	Clubroot declines more quickly when snap bean, buckwheat, cucumber, and tomato are grown in the rotation.
Collards, crucifer greens, kale, radish, rutabaga, turnip, oilseed radish, rape, canola	*Increases* **clubroot**	Clubroot attacks many crops in the mustard family including cabbage and its relatives (see Appendix 1).
Barley, corn, oat, wheat grain cover crops	*Reduces* **white mold**	Use grain crops or sweet corn in rotation with cabbage and related species to decrease white mold.
Beet	*Increases* **beet cyst nematode**	Beet cyst nematode attacks crops and weeds in the cabbage and beet families.
Spring grain cover crop	*Reduces* weeds	An oat cover crop (often with field pea) controls weeds and improves soil structure before summer transplanted brassicas.
Field pea	*Reduces* **weeds**, *Increases* **nitrogen**	A field pea cover crop (often with oat) controls weeds and provides nitrogen for summer transplanted brassicas.
Bell, fava, or faba bean	*Increases* **nitrogen**	An incorporated bell bean crop provides the higher levels of N required by heading cole crops.
Beet, field pea, fava bean	*Increases* **disease and nematode**	While these crops may help with weed reduction and improve soil nitrogen levels, they are good hosts for root rot diseases such as *Rhizoctonia* and *Pythium* as well as root-knot and lesion nematodes. Consider this when choosing a crop rotation sequence.

Excerpt from Appendix 2 of *Crop Rotation on Organic Farms: A Planning Manual*. Charles L. Mohler and Sue Ellen Johnson, editors (reference 5).

4.3 Pest History

Knowledge about the pest history of each field is important for planning a successful cropping strategy. For example, 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. Treat with Contans™ to reduce fungal sclerotia in the soil immediately after an infected crop is harvested.

Brassica plants and crops in the beet family are hosts to the sugar-beet cyst nematode, *Heterodera schachtii*. It is important to know if this nematode is present in the field 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 low infestation levels. Refer to Section 12 for more information on nematodes.

4.4 Soil and Air Drainage

A number of diseases of brassicas are favored by wet conditions. Any practice that promotes leaf drying can slow development of these foliar diseases because pathogens often need wet surfaces to infect. Fields with poor air movement such as those surrounded by hedgerows or woods are a poor choice for brassica crops. Plant rows in an east-west direction and avoid overcrowding 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, use an integrated approach to weed management that includes crop rotation, cover cropping, cultivation, and planting design based on an understanding of the 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.

Reduce disease and insect pressure by planting cole crops in fields that have been free from alternate hosts such as wild mustard, shepherd's purse, and other weeds in the mustard family for at least 3 years.

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 (reference 45-46).

5.2 Weed Management Methods

Planting and cultivation equipment should be set up on the same number of rows to minimize crop damage during cultivation. A set of "best management" practices for weed management in cole crops is outlined below. Growers may not have access to the recommended specialized equipment, in which case weed management practices will need to be adapted to the available tools. See the resources at the end of this section to help fine-tune your weed management system.

Broccoli, cauliflower, cabbage, and Brussels sprouts should be transplanted, not direct seeded. These crops have relatively small seeds and are slow to establish. Transplanting these crops makes the crop more competitive relative to weeds and allows earlier cultivation.

If weed pressure is high, precede plantings for fall harvest with one month of cultivated fallow to reduce the seed bank. Till in early June and prepare a seed bed. Harrow thoroughly but shallowly at two week intervals until planting time. Use shallow tillage to prepare the final seedbed to avoid bringing new seeds to the soil surface. A cultivated fallow will greatly reduce species like pigweed and galinsoga that often plague mid-summer plantings of brassicas. To minimize damage to the soil caused by leaving the soil surface bare during the fallow, plan to mow and incorporate a heavy cover crop, for example, rye with hairy vetch, before beginning the fallow. This will leave some small pieces of cover crop residue on the surface to intercept rain drops and create a spongy soil consistency that will absorb rain and avoid crusting.

For early cultivations after planting, use vegetable knives on a belly mounted cultivator. Set the knives shallow (1 to 1.5 inches) below the soil surface with the blades pointed away from the row. Cultivate as closely as possible. Use sweeps or duck foot shovels with at least 25 percent overlap to clean weeds out of the inter-row areas and loosen soil behind the tractor tires. Cultivate every 7 to 10 days as necessary. Avoid letting weeds grow taller than 2 inches. If crop leaves are in danger of being damaged by the shanks of the vegetable knives, turn the knives around so that the point is toward the row. This may require shifting shanks around. Changing the orientation of the knife blades allows the blades to reach under the leaves and continue cultivation close to the row. This is especially useful for cabbage, which has large leaves close to the ground, but may not be necessary with some varieties and row spacings. To minimize root pruning, set knives to run as shallow as possible without creating skips. If field preparation has created a highly uniform surface, a cultivation depth of 3/4 to 1 inch is sufficient. Continue cultivating until the crop canopy is too closed to allow tractor traffic.

To control weeds between plants in the row, hand hoe at least once, coinciding with the 2nd or 3rd machine cultivation, when the biggest weeds are no larger than 2 inches. The goal is to kill weeds while they are still small. Use a stirrup hoe (shuffle hoe) pulling toward the plant stalk, throwing about 1 inch of soil in around base of the plant to cover small weeds that are too close to the crop plants to cut with the hoe. Following the above practices, only one hand hoeing should be required, but if weed pressure is high or the cultivation or first hoeing was untimely, a second hoeing may be useful.

For small plantings, mulching with straw or hay is a partial alternative to cultivation and hand hoeing. Cole crops tolerate the cool soil conditions under straw mulch, and the mulch will reduce the need for irrigation. The mulch material should be free of weed seeds. Winter grain straw and first cutting hay are usually clean. Straw from spring grains and hay from late season cuttings should be inspected carefully for weed seeds. Many vegetable farms in New York have land that is too steep or poorly drained for vegetable production, and with some planning, such land can be used as a source of mulch for high value vegetable crops. Reed canary grass tolerates restricted drainage that makes soil unsuitable for vegetables, and it produces a large mass of soft, easy to handle mulch early in the growing season.

Apply the mulch as soon as the crop is large enough to tolerate at least 3 inches of mulch. Cultivate shortly before mulch application, and if the weeds are greater than 1 inch, hand hoe as well. Tuck the mulch in closely around the plants. Apply enough mulch to insure that the material is 2 to 3 inches thick after settling. A dense layer that is 2 inches thick is better than a thicker layer that is loose since the latter allows more light penetration and provides pathways for weeds to grow up through the mulch. If the mulch has been baled, overlap slabs to insure complete ground coverage.

Resources

Crop Rotation on Organic Farms: A Planning Manual, Appendix 4 (ref 5)
Steel in the Field (reference 43)
New Cultivation Tools for Mechanical Weed Control in Vegetables (ref 44)
Cornell Weed Ecology website (reference 45)
New Jersey Weed Gallery (reference 46)
Principles of Sustainable Weed Management for Croplands: (ref 47)
Weed 'Em and Reap Videos (reference 48)

Flame Weeding for Vegetable Crops (reference 49)
Vegetable Farmers and their Weed-Control Machines (reference 50)
Twelve Steps Toward Ecological Weed Management(reference 50a)

6. Recommended Varieties

Variety selection is important both for the horticultural characteristics specified by the market and the pest resistance profile that will be the foundation of a pest management program. If a field has a known disease history, Tables 6.1 to 6.4 can help to determine which varieties will be more successful in reducing disease problems. Consider the market when choosing varieties, selecting those with some level of disease resistance if possible.

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.

Table 6.1 Disease and Insect Resistance of Cabbage

	Pest Tolerance[1]			
Cabbage Variety	**Yellows**	**Black Rot**	**Tipburn**	**Thrips**
Fresh-market, Green				
Artost (68)	H		H	
Atlantis (70) [2]	H	H	-	1
Blue Dynasty (75)	H	H		
Blue Lagoon (75)	H	M		
Blue Vantage (80)	H	L	H	H
Bobcat (76)	-	-	-	6
Bravo (85)	H	H	-	-
Bronco B (78)	-	-	-	3
Brutus[3]	-	-	H	L
Caramba (62)				
Cecile (80)	-	-	-	2
Charmant (65)	H	H	-	L
Cheers (85)	H	H	-	H
Early Thunder (72)	H	M	M	H
Emblem (85)	H	H	H	-
Fast Vantage (59)				
Fresco (75)	H	H	-	4-6
Gazelle (70)			H	
General (62)	-	-	-	2
Gideon B (83)	H	H	-	2
Golden Dynasty (65)	H			
Greenboy (85)	H	T	S	M
Green Cup (78)	H	H	H	H
Headstart (65)				
Leopold (80)			H	
Lynx (78)	-	-	-	5
Matsumo (80)	H	H	H	3-4
Morris (67)	H	-	-	1
Pacifica (64)	H	H	H	M
Platinum Dynasty (75)	H	H	H	
Royal Vantage (82)	H	H	H	H
Quick Start (64)	H	S	H	M
Quisor (90)	M		M	
Quisto (89)	H	H	H	
Ramada (83)	H	H	-	1
Rio Verde[3]	H	H	-	H
Rocket (62)	H	S	H	H
Rotunda (83)	H			L
Royal Vantage (70)	H	H		
Silver Dynasty	H	H	H	
Solid Blue 790 (79)	H	M	H	H
Stonehead (67)	H			
SuperElite (85)	H	M	H	3
Superstar (85-88)	H	H	H	M
Thunderhead (74)	H	H	H	H
Vantage Point (85)	H	H	H	H
Winner (58)	H			
Fresh-market Cabbage, Red				
Azurro (78)			H	5
Cairo (85)			H	5
Primero (72)			H	5
Red Jewel (75)	-	-	H	-
Rio Grande Red (83)		L	M	
Rinda (785)				1
Royale (78)	H	L	H	-
Ruby Perfection (95)	M	M	M	H[3]
Super Red 80 (80)		M	H	2
Super Red 90 (90)	H	L	H	-
Savoy Cabbage				
Alcosa (62)			H	
Atlanta (78)				
Bountivoy (84)	H	-	-	-
Clarissa (78)	H	-	H	-
Comparsa (63)			H	
Famosa (70)	-	-	H	-
Miletta (88)			H	
Primavoy (98)				
Savoy Ace (78-83)	M	-	-	-
Savoy Blue (85)				
Savoy Master (87)				
SC100 (100)				
Taler (85)				
Wirosa (110)			H	
Storage Cabbage				
Amtrak (115)	H	M	H	4
Arena (100)	H	H	H	
Balaton				2
Bartolo (115)	-	L-M	H	1
Bently (120)			H	
Bloktor (112)	H		H	H
Brutus			H	L
Candella (100)	H			
Constellation (120)	H			H

Cabbage Variety	Pest Tolerance[1]			
	Yellows	Black Rot	Tipburn	Thrips
Counter (118)	H	H	H	
Huron (115)	H	M	-	5
Loughton (115)	H	M-H	-	2
Missouri (120)				5
Multikeeper (86)	H	H		H
Novator (110)	H	H		
Ontario (110)	H			2
Rinda (75)		M	H	L
Safekeeper II (98)	H	H		
Saratoga (105)	H	L-M	H	2
Shelton (115)			H	
Storage #4 (112)	H	L-M	-	1
SuperDane (100)	H	L	H	L
Superstor 112	H			
Topgun (105)			H	
Red Storage				
Autoro (115)			H	
Buscaro (100)				
Futurita (110)		S	H	
Induro (115)				
Lectro (117)		H	2	
Rona (115)			M	5
RS 4024				4
RS 6696				4
Super Red (115)				
Vitaro (105)	H	S	H	5
Processing Cabbage - Kraut and Slaw				
Almanac (slaw) (70)	-	-	H	L
Cabton (100)				
Cecile (80)	H	L-M	H	2
Deuce (95)	H	S	T	L
Hinova (100)	H	H	H	2
Kaitlan (94)			H	2
Krautman (78)				3-5
Mandy (103)				
Megaton (85)			H	2-3
Mentor (90)			H	4
Milestone (85)				
Moreton (105)	H	M	T	2-3
Otorino (90)		S	T	L
Padoc (70)	H	S		
Rinda (75)		M	H	L
Score (90)				2
SuperDane (100)	H	L	H	L
Superkraut 86		H	H	H
Tobia (87)	H			
Transam (105)	H	L-M	H	4

When disease tolerance for a particular variety is unknown, line is left blank. 1: L = low, M = moderate, and H = high level of tolerance to pest/problem. T=tolerant, S=susceptible. 2: ( ) Days to maturity. 3: from New England Vegetable Management Guide. Thrips resistance: 1=susceptible, 6=tolerant. Information from *Cornell Integrated Crop and Pest Management Guidelines* (reference 1), breeding research by Phillip Griffiths, and seed catalogues.

Table 6.2 Disease and Insect Resistance of Broccoli

Most broccoli varieties tend to be susceptible to black rot.

Variety	Black Rot	Downy Mildew	Bacterial Head Rot	Yellows	Swede Midge	Cold	Heat
Alborada							
Arcadia (86)	X	X				X	
B1 10 (75)							
Belstar							
Captain (79)		X					
Concord (85)							X
Diplomat (100)		X				X	X
Emerald Pride (95)		X					X
Eureka (87)	X	X			S	X	
Everest (Sp,F)[1]		X					X
Goliath (76)							
Green Magic							X
Greenbelt	X	X					
Gypsy (97)		X					
Imperial (102)							X
Ironman (92)							
Major (F)[1]		X					X
Marathon F1	X	X				X	
Monaco							
Patron (77)		X					
Premium Crop Sp)[1]		X					
Packman(Sp)[1]					S		
Patron		X					
Premium Crop		X					
Triathlon		X					
Waltham 29							
Windsor (90)		X	X			X	X

[1] recommended variety for New York by the *Cornell Integrated Crop and Pest Management Guidelines* (reference 1) , X=shows tolerance or resistance to disease. S=susceptible.
Sp – Spring, F- Fall, tr – trial.
Swede midge: S=more susceptible, R=more resistant.

Table 6.3 Recommended Brussels Sprout Varieties.

Brussels sprouts tend to be fairly resistant to most diseases but specifics on disease resistance are not available.

Diablo (Tr)	Prince Marvel
Jade Cross E	Rowena (Tr)
Oliver	Vancover (Tr)

Tr = trial

Table 6.4 Recommended Cauliflower Varieties

Most cauliflower varieties tend to be susceptible to black rot. Specific disease resistance information is not available.

Amazing (S,F)	Icon (F)
Apex (S,F)	Minuteman (S, F,Tr)
Candid Charm (F)	Sentinel (S)
Cumberland (S,F)	Serrano (F,Tr)
Fremont (S)	Shasta (F, Tr)
Guardian (F, Tr)	Starbrite Y (F,Tr)

S = spring; F = fall; Tr = trial

7. PLANTING

7.1 Direct Seeding and Seed Treatments.

Although most cabbage, broccoli, cauliflower, and Brussels sprouts in New York are grown from transplants, they can be direct seeded. Early season weed and insect control can be more challenging in direct seeded crops. See more detail in Section 7.7: *Specific Planting Methods* and Section 5: *Weed Management.*

If the seed source is unknown, or if saved seed has a potential risk of a seed-borne pathogen, a hot water treatment may reduce inoculum on and in the seed. Strict adherence to the recommended time and temperature is essential to minimize potential damage to the seed. Use a large pot of water to moderate temperature changes and stir constantly. Purchase a scientific grade thermometer. Soak broccoli and cauliflower seed for 20 minutes in 122°F water, and cabbage and Brussels sprouts for 25 minutes. This treatment may reduce germination, especially on less vigorous seed, and may not eradicate the pathogen from heavily infected seed lots. Due to its potential negative effect on seed vigor, hot water treatments are not recommended unless disease potential is present. For instructions see Managing Pathogens Inside Seed With Hot Water (Reference 18b) and also Cornell Treatments for Managing Bacterial Pathogens in Vegetable Seeds. (Reference 18a).

Some companies offer seed pre-treated with bleach or hot water to kill seed-borne bacteria while guaranteeing a minimum percent seed viability, although not all desired cultivars are available in seed treated condition. Private laboratories will test seed for pathogens, for example STA Laboratories (reference 57). To test seed vigor, send samples to the New York State Seed Testing Laboratory (reference 58).

7.2 Transplant Production

Most cabbage, broccoli, cauliflower, and Brussels sprouts are transplanted in New York because of the advantage it gives plants against weed competition, and the potential to reach earlier markets in the relative short New York growing season. A good transplant is healthy, stocky, and relatively young with four to six true leaves. Planting transplants that are at the same stage of growth will help reduce variability at harvest time. Producing such plants requires good light, proper temperature, adequate moisture and a uniform, fertile planting mix. Maintaining optimum soil temperature and moisture will also help to prevent damping-off losses in seedlings. Harden transplants near the end of their growing period by withholding water or moving them outside to a sheltered area. See Section 7.5: *Transplanting.*

Using cell or plug flats will improve transplant uniformity and reduce plant shock at field setting. Plug flats are sold based upon the number of cells per flat (24 to 800 cell plug trays are available). Generally, the more cells per flat, the smaller the volume per cell. Selection of cell number depends on several factors including the desired final plant size, fertility options, and the time between seeding and transplanting. Plants grown in smaller cells will require more careful monitoring of nutrients and water, but will be ready to transplant sooner. Larger cells provide more soil media, and thus more moisture and nutrients to developing seedlings, but make less efficient use of greenhouse bench space. Heading cole crops are commonly grown in flats with 200 to 288 cells.

Seeds are placed singly in individual cells, either by hand or via seeders. Optimum germination temperature for cole crops is 75 to 80°F. Minimum temperature is 40°F. After germination, move flats to an area with the desired temperatures outlined in Table 7.2.1. The greater the difference between daytime and nighttime temperatures, the more plants will "stretch" (stems elongate).

Table 7.2.1 Optimal Day and Night Temperatures for Growing Transplants

Optimal Day Temperature	Night Temperature	Weeks from Seeding to Planting.
65	55-60	4-6

7.3 Greenhouse Sanitation and Pest Management

The greenhouse environment is favorable for plant pathogens, and these pathogens are difficult to control. Plants can become infected as seedlings without showing symptoms until they are maturing in the field. No single strategy will prevent greenhouse diseases, however by utilizing multiple management strategies, damage and losses can be minimized. Bacterial diseases, such as black rot, are commonly spread during transplant production.

Preseason Sanitation: Clean and disinfect all greenhouse tables, benches, floors, hoses, flats, containers or anything that comes in contact with plants. It is important to thoroughly clean **even if there was no disease last year**.

Persistent pathogens could still be present and spread to healthy transplants under optimal environmental conditions. Clean all seedling flats prior to reuse to remove any clinging soil or plant material that may be contaminated with fungi capable of causing damping-off in seedlings. At a minimum, use soap and water with a stiff brush to wash flats and then dry thoroughly in a hot greenhouse prior to storage, or flats could be steamed or sanitized prior to use. If you plan to use chlorine, **CHECK WITH YOUR CERTIFIER** to determine its proper use. NOP limits the chlorine concentration in discharge water. Table 7.3.1 lists sanitizers. Thoroughly rinse flats after using sanitizers. Use new flats to help avoid carry-over of pathogens if disease was severe the previous season.

IPM Strategies in the Greenhouse: Keep the greenhouse weed-free. Many pathogens survive on weed hosts and then move to transplants in the greenhouse. Scout greenhouses weekly for any sign of disease. Remove diseased plants immediately. If a diseased plant is identified in a flat, remove the whole flat. Control insects that may spread viruses. Keep foliage as dry as possible to prevent infection. Water in the morning since foliage is likely to dry quickly during the day. Do not brush against or trim when plants are wet to reduce the spread of pathogens.

Table 7.3.1 Disinfectants

Compound Common name Active ingredient	Rate
CDG Solution 3000 *(chlorine dioxide)*	*For surfaces, equipment and structures:* use 12:1 dilution. *For pots, flats, trays and tools:* use 6:1 dilution.
***GreenClean PRO** *(sodium carbonate peroxyhydrate)*	*For surfaces, equipment and structures:* 0.5-2 lbs/1000 ft^2 (*NOTE:* can only be used on unpainted surfaces.) *For pots, flats, trays and tools:* 0.25 lbs/gal water
* Restricted-use pesticide. Only certified applicators can purchase and use restricted-use pesticides.	

Use power sprayer to wash all surfaces and remove plant debris and other organic material before treating. Use to disinfect pots, flats and trays, surfaces, equipment and structures.

7.4 Transplant Growing Mix

A good transplant mix is well drained, provides a reserve of nutrients, has good aeration, and provides adequate support to developing seedlings. Most organic transplant mixes are based upon a combination of peat moss, vermiculite or perlite and a proportion of stable, cured compost. Soil may be included in an organic mix, but could harbor damping-off pathogens. Organic transplant mixes must not contain any materials prohibited by the NOP, including synthetic fertilizers and most wetting agents. Commercial organic potting media is available. See the OMRI listing for approved media, wetting agents, and soil amendments (reference 20).

7.5 Transplanting

Prior to field setting, transplants should be exposed to full outdoor sun or reduced temperature and watering for 5 to 7 days. This 'hardening' process helps greenhouse-grown transplants develop a thicker leaf cuticle to reduce water stress and also helps accumulate food reserves for starting the new root system after field setting. Overmature or stressed transplants usually resume growth slowly and rarely achieve full yields. Cabbage, broccoli, cauliflower, plants used for early spring planting may go to seed prematurely or "button" if subjected to cool temperatures or excessive transplant stress during the growing period.

To transplant, set plants deep enough to completely cover the media of the plug and firm the soil around the plants to minimize water loss from the plug. Apply water using the transplanter or irrigate immediately after transplanting, especially if the soil is somewhat dry. High temperatures or strong drying winds at the time of transplanting contribute to delayed recovery from transplanting stress and increased mortality. If possible, avoid planting under such conditions or be prepared to irrigate immediately.

7.6 Planting Dates

Table 7.6.1 includes the range of dates on which heading cole crops are normally planted in New York. Usual frost dates and other local weather or soil conditions must be considered in making final determinations of planting dates in each area. Most growers start planting when the first, favorable weather break occurs in or near the planting ranges listed below. Earlier plantings are possible with the use of row covers, hot caps, and other season extension systems.

Table 7.6.1 Planting Dates for Commercial Production in New York.

	Usual Planting Period	
Crop	**Fresh Market**	**Processing**
Cabbage		
transplants	4/1-7/31	5/1-7/10
direct seed	4/15-7/10	4/25-6/25
Broccoli	4/1-7/31	7/1-7/20
Cauliflower	4/1-7/31	7/10-7/31
Brussels Sprouts	6/1-6/15	6/1-6/15

Resources:

Plugs and Transplant Production for Organic Systems (reference 18).

7.7 Crop Specific Planting Information

Cabbage: Cabbage in New York is most successful on organic farms when transplanted due mostly to improved weed control. Transplanting for fresh-market cabbage usually starts in late April or early May in upstate New York and one to two weeks earlier on Long Island. Cabbage for medium- to long-term storage is usually transplanted to the field in June or early July for mid- to late-fall harvest.

Direct seeding requires greater attention to detail than transplanting and can be a problem in fields with high weed pressure. Seed can be planted outdoors relatively early in the spring because germination will occur at soil temperatures as low as 45^0F. Precision seeders should be used to obtain a uniform, well-spaced stand. Good soil preparation and shallow seed placement (1/2 to 3/4 inch) are necessary for direct seeding to be successful. Control of root maggot and flea beetle can be difficult, but is especially important, in direct-seeded fields.

Broccoli. Planting methods are similar to those for cabbage. Transplants are set starting in late April in upstate New York and continuing through mid- to late August. Direct seeding can be successful, but careful attention to detail is required. Direct-seeded fields should be planted 15 to 20 days before transplants are set out if simultaneous crop maturity is desired. Seed size is important for emergence through crusted soils, and seeds greater than 1/14 inch in diameter will produce better stands than smaller seeds.

Cauliflower. Most cauliflower in New York is grown for fall harvest from transplants set from mid- to late July. Some growers in cooler areas may have success with spring-planted crops transplanted in early April. Spring planted broccoli and cauliflower may be subject to "buttoning". See Table 13.1: *Nonpathogenic Disorders* for an explanation.

Brussels sprouts. Brussels sprouts are best transplanted beginning in late June.

Table 7.7.1 Recommended Spacing

Crop	Between Rows (inches)	In-Row (inches)
Cabbage		
Fresh Market	24-36	10-14
Kraut	24-36	18-24
Broccoli		
Field seeded	3-4 rows/bed at 17"	7-10
Transplants	24-36	12-18
Cauliflower	34-36	15-18
Brussels sprouts	34-36	24

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 complements 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	39
Agri Analysis, Inc.		x	36
A&L Eastern Ag Laboratories, Inc.	x	x	35
Cornell Soil Nutrient Analysis Lab	x		38
Penn State Ag Analytical Services Lab.	x	x	40
University of Massachusetts	x	x	42
University of Maine	x	x	37

8.1 Fertility

Recommendations from the *Cornell Integrated Crop and Pest Management Guidelines* indicate that a head-forming cole crop requires 100 lbs. of available nitrogen (N), 120 lbs. of phosphorus (P), and 160 lbs. of potassium (K) per acre to support a medium to high yield. These levels are based on the total nutrient needs of the whole plant and assume the use of synthetic fertilizers. Farmer and research experience suggests that somewhat lower levels may be adequate in organic systems. See Table 8.2.2 for the recommended rates of N, P, and K based upon soil chemical test results. Nitrogen is not included because levels of available N change in response to soil temperature, 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 needed (2-4=)			

Line 1. Total Crop Nutrient Needs: Agricultural research indicates that a head-forming cole crop requires 100 lbs. nitrogen (N), 120 lbs. phosphorus (P), and 160 lbs. potassium (K) per acre to support a medium to high yield (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 Cole Crops Based on Soil Tests

	N Level	Soil Phosphorus Level			Soil Potassium Level		
Level shown in soil test	Not provided	low	med	high	low	med	high
	N lbs/A	**Pounds/A P_2O_5**			**Pounds/A K_2O**		
Total nutrient recommendation	100-120	120	80	40	160	120	60

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 2% organic matter could be expected to provide 40 lbs N per acre.

Line 3b. Manure: Assume that applied manure will release N for three years. Based on the nutrient test of total N in any manure applied, estimate that roughly 50% of N is available to the crop in the first year, and 50% of the remaining N 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 to 25% of the N, 80% of the phosphorous and 90% of the potassium contained in most composts is available to the crop 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 N tends to 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 high 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 retention 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 the farm certifier. Compost generated on the farm must follow an approved process outlined by the certifier.

Line 3d. Cover Crops: Estimate that 50 percent of the fixed N is released for plant uptake during the season it is incorporated. Consult Table 3.1 to estimate the amount of N fixed by various legume cover crops.

Line 4. Total Credits: Add together the various nutrient values from soil organic matter, manure, compost, and cover crops to estimate the total 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 the available N does not equal the minimum requirement for this crop (100 lbs/acre), a sidedress application of organic N may be needed. There are several options for N sources for organic sidedressing (see Table 8.2.4) as well as pelleted composts. Early in the organic transition, a grower may consider increasing the budgeted N supply by 25%, to help reduce 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 on crops intended for fresh consumption.

Table 8.2.3 Estimated 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. Table adapted from *"Using Manure and Compost as Nutrient Sources for Fruit and Vegetable Crops"* by Carl Rosen and Peter Bierman (reference 41) and Penn State Agronomy Guide 2015-2016 (reference 41a).

Tables 8.2.4-8.2.6 lists some commonly available fertilizers, their nutrient content, and the amount needed to provide different levels of available nutrients.

Table 8.2.4 Available Nitrogen in Organic Fertilizer

Sources	Pounds of Fertilizer/Acre to Provide X Pounds of N per Acre				
	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. Adapted by Vern Grubinger from the University of Maine soil testing lab (reference 37).

Table 8.2.5 Available Phosphorous in Organic Fertilizers.

Sources	Pounds of Fertilizer/Acre to Provide X Pounds of P_2O_5 per Acre				
	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. Should be broadcast and incorporated prior to planting. Adapted by Vern Grubinger from the University of Maine soil testing lab (reference 37).

Table 8.2.6 Available Potassium in Organic Fertilizers.

Sources	Pounds of Fertilizer/Acre to Provide X Pounds of K_2O per Acre:				
	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. Should be broadcast and incorporated prior to planting. Adapted by Vern Grubinger from the University of Maine soil testing lab (reference 37).

An example of how to determine nutrient needs for cole crops. You will be growing an acre of cabbage. The *Cornell Integrated Crop and Pest Management Guidelines* suggests a total need of 100 lb. N, 120 lb. P, and 160 lb. K per acre to grow a high yielding crop. Soil tests show a pH of 6.5, with high P and medium K levels and recommends 40 lbs P_20_5/acre and 120 lbs K_20/acre (see Table 8.2.2). The field has 2% organic matter. Last fall 5 tons/acre of dairy manure with bedding was spread and immediately incorporated prior to planting a cover crop of hairy vetch. Nutrient credits for soil organic matter, manure, and cover crops appear in Table 8.2.7.

Table 8.2.7 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:	100	120	160
2. Recommendations based on soil test	# not provided	40	120
3. Credits			
a. Soil organic matter 2%	40	---	---
b. Manure – 5 T/A dairy	30	15	45
c. Compost - none			
d. Cover crop – hairy vetch	55		
4. Total credits:	125	15	45
5. Additional needed (2-4) =	0	25	75

Table 8.2.3 indicates about 30 lbs N will be released in the first season from the 5 tons/acres of dairy manure (N1). Estimate that each percent organic matter will release about 20 lbs of N, so the 2% organic matter will supply 40 lbs (line 3a). Looking at Table 3.1, the hairy vetch will release about half its fixed N, or 55 lbs as it decomposes. The total estimated N released and available for plant uptake is 125 lbs per acre (line 4). Line 5 suggests that no additional N is needed but P and K will need to be supplemented. Apply ~140 lbs of bonemeal to meet the soil test phosphorus recommendation of 25 lbs per acre (Table 8.2.5). The manure supplies 45 lbs of the 120 lbs needed potassium. The remaining 75 lbs K_2O/acre can be added by applying ~340 lbs. of Sul-Po-Mag, broadcast and then incorporated (Table 8.2.6).

Additional Resources
Using Organic Nutrient Sources (reference 42a)
Determining Nutrient Applications for Organic Vegetables (reference 42b)

9. Harvest and Storage

9.1 Harvest Recommendations by Crop

Cabbage

Fresh-market cabbage harvest may begin as early as the first week of July and continue through the summer. Storage and kraut cabbage harvests begin in mid-October and may continue through November. Fresh-market cabbage is cut with four to five wrapper leaves and is usually packed at 14 to 18 heads per box. Storage cabbage is usually harvested with one to two wrapper leaves and placed directly in pallet bins that hold approximately one ton of cabbage. Trim outer leaves in the field. Don't cut heads with any evidence of disease or bird droppings.

Kraut cabbage is harvested almost entirely by machine, but fresh-market and storage crops are cut by hand because machine harvest damages the head and wrapper leaves. Harvest aids such as conveyer belts that carry cabbage into pallet boxes in the field are frequently used for the large storage cabbage fields. Cabbage that has been handled carefully can be stored for weeks or even months longer than bruised cabbage. Bruised cabbage also takes longer to trim and suffers greater product loss. Overmature cabbage will have a shorter storage life than mature or slightly immature cabbage.

Broccoli

Broccoli to be sold by the head should be firm, well developed, but not opening. Leaves are trimmed and heads are sold either individually or by weight. Trim outer leaves in the field. Bunched broccoli is usually trimmed to eight inches in length and two or more heads are banded together. Bunched broccoli is generally stored in containers holding 14 to 18 bunches (about 23 pounds of broccoli). Cooling after harvest is important to maintain quality. Use potable water for top icing. See Section 9.3: *Microbial Food Safety*.

Cauliflower

Harvest cauliflower when curds are tight and compact and still surrounded by healthy wrapper leaves. Trim outer leaves in the field. When wrapper leaves are left on, cauliflower loses its moisture very quickly. Refrigerate at 32°F and 95 percent relative humidity with good ventilation. Under ideal conditions, cauliflower may be stored for four to five weeks. Cauliflower is normally packed in cartons of 12 to 16 heads weighing 25 to 30 pounds.

Brussels sprouts

Brussels sprouts are harvested when they are about one to two inches in diameter, firm, and with good color. They can either be stored on the stalk, ideally with roots attached, or stripped from the main stalk. Store at 32°F, with high relative humidity and good air circulation. Under these conditions, sprouts will maintain good quality for up to five weeks. Stored too long, outer leaves become yellow, and texture becomes poor. Brussels sprouts are normally packed in flats or cartons consisting of sixteen 12-ounce bags. Marketing Brussels sprouts by the stalk is practiced at the retail level.

9.2 Storage

Caution: All brassica crops are sensitive to ethylene in storage. Symptoms include leaf yellowing and abscission. Storage facilities should be thoroughly cleaned prior to fall use (see Table 9.3.1 Rates for Sanitizers for Postharvest Cole Crops and/or Postharvest Facilities). All crop debris should be removed and the floors mopped and disinfected. After cleaning, the storage facility should be ventilated to remove all vapors and odors from the cleaning solutions. The floor must be completely dry. Wooden storage boxes are often disinfected to remove pathogens and contaminating organisms that may cause decay. Storage boxes should be treated prior to fall harvest. Whether or not the storage boxes are treated with a disinfectant, air-drying the boxes outside during the warm summer months will promote desiccation and death of potential pathogens.

9.3 Microbial Food Safety

Attention to microbial food safety is important for crops that are eaten raw. Continuing produce-associated foodborne illness outbreaks have resulted in many buyers requiring the implementation of food safety practices on the farm and the development of the first ever produce safety regulations as part of the Food Safety Modernization Act (FSMA). Pathogens can contaminate food during all phases of production, harvesting, and packing. Wild and domesticated animals, manure, irrigation water, inadequate worker hygiene, unclean picking containers, unsanitized post-harvest water, and unclean packaging materials are all potential vectors of microbiological contaminants. Growers should conduct a risk assessment to identify microbial hazards and then implement appropriate practices to reduce risks. There are many resources available to help including those at the National GAPs Program (reference 12) or the Produce Safety Alliance (reference 12a). Regardless of farm size, commodities or cultural practices, Good Agricultural Practices can be used to identify and possibly reduce microbial risks.

Implementing just a few simple practices can reduce risks significantly. One of these is to wash hands prior to any contact with the crop using potable water and sanitizer, particularly after using the restroom or eating. Do not allow workers who are ill to handle produce. If they are able to work, assign jobs that do not involve contact with produce or customers. Prevent animals or animal manure from contacting produce, by discouraging animals (including pets) from entering production fields and by not using irrigation water that may have been contaminated with manure. Manure must be properly composted or applied well in advance of harvesting a fresh market cole crop, but check with your certifier or marketer for separate restrictions for manure use on lettuce. Ensure that picking containers are clean and free from animal droppings. Following these steps can dramatically reduce risks of pathogen contamination. Conduct a full assessment of your farm to identify other high risk practices.

> The Food Safety Modernization Act (FSMA) will apply to farms that grow, harvest, pack or hold most fruits and vegetables when those fruits and vegetables are in an unprocessed state, and will govern practices affecting: water, worker hygiene, manure and other soil additions, animals in the growing area, and equipment, tools and buildings When the FSMA is finalized, the Food and Drug Administration (FDA) will be mandated to enforce preventive control measures, and to conduct inspections across the food supply system. Updates and information on this proposed rule are available at the United States Food and Drug Administration's Food Safety Modernization Act webpage.

At the time this guide was produced, the following materials were available in New York State as sanitizers 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 9.3.1 Rates for Sanitizers for Postharvest Cole Crops and/or Postharvest Facilities

Active ingredient **Product name**	***Uses***			
	Food contact surfaces[1]	**Hard surface, non-food contact**[1]	**Vegetable surface (spray or drench)**	**Vegetable rinse water**
chlorine dioxide				
CDG Solution 3000	50 ppm solution	500 ppm dilution	-	5 ppm solution
Oxine[2]	100 ppm solution	500 ppm solution	-	In tanks, use a 5 ppm solution; for process waters use a chemical feed pump or other injector system at 3 ¼ fl oz per 10 gal water.[3]
Pro Oxine[2]	50-200 ppm solution	500 ppm solution	-	-
hydrogen peroxide/peroxyacetic acid				
Enviroguard Sanitizer	-	2.5-20 fl oz/5 gal water	1 fl oz/20 gal water	1 fl oz/20 gal water
Oxonia Active	1-1.4 oz/4 gal water	1 oz/8 gal water.	-	-
Peraclean 5	1-1.5 fl oz/5 gal water	-	-	-
Peraclean 15	0.33 fl oz/5 gal water	-	-	-
Perasan A	1-6.1 oz/6 gal	-	4 oz/20 gal water	-
Per-Ox	1-2.25 fl oz/5 gal water	1-10 fl oz/15 gal water	1 fl oz/5 gal water	1 fl oz/5 gal water
SaniDate 5.0	1.6 fl oz/ 5 gal water	1.6 fl oz/ 5 gal water	59.1 to 209.5 fl oz/ 1,000 gallons water	59.1 to 209.5 fl oz/ 1,000 gallons water
SaniDate 12.0	-	-	25.6 to 89.6 fl oz / 1,000 gallons water	25.6 to 89.6 fl oz / 1,000 gallons water
Shield-Brite PAA 5.0	1.6fl oz/5 gal water	1.6fl oz/5 gal water	59.1 to 209.5 fl. oz./1,000 gal water	59.1 to 209.5 fl. oz./1,000 gal water
Shield-Brite PAA 12.0			25.6 to 107 fl.oz/1,000 gal water	25.6 to 107 fl.oz/1,000 gal water
StorOx 2.0	0.5 fl oz/1 gal water	0.5 fl oz/1 gal water	1:220 – 1:1,000 dilution (on process/packing line); .035-0.58 fl. oz./gal water (post-harvest spray treatment)	
Tsunami 100	-	-	2.5-6.7 fl oz/100 gal water	2.5-6.7 fl oz/100 gal water
Victory	-	-	1 fl oz/16.4 gal water	1 fl oz/16.4 gal water
VigorOx 15 F & V	0.31-0.45 fl oz/5 gal water-	1.1-9.5 fl oz/5 gal water -	1 fl oz/ 16 gal water as spray or dip	0.54 fl oz/ 16 gal water (processing water)
VigorOx LS-15	0.31-0.45 fl oz/5 gal water	1.1-9.5 fl oz/5 gal water	-	-
sodium hypochlorite				
San-I-King No. 451	100 ppm chlorine in solution	-	-	-

1. Thoroughly clean all surfaces and rinse with potable water prior to treatment. 2. Requires acid activator. 3. After treatment, rinse with potable water.

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 pests at an early stage. When conditions do warrant an application, proper choice of materials, proper timing, and excellent spray coverage are all 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 biocontrol organisms as their active ingredient (e.g. Contans). The active ingredients of some biological pesticides (e.g. Serenade) are actually a metabolic byproduct 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, while applying too little can fail to control pests or lead to pesticide resistance.

Resources

Calibrating Backpack Sprayers (reference 52)
Cornell Integrated Crop and Pest Management Guidelines Section 6.12 (reference 53)
Pesticide Environmental Stewardship: Calibration (reference 54)
Knapsack Sprayers – General Guidelines for Use (reference 55)
Herbicide Application Using a Knapsack Sprayer This publication is also relevant for non-herbicide applications. (reference 56).
Pesticide Environmental Stewardship, Coop Extension (reference 56a)
Pesticide Environmental Stewardship, CIPM (reference 56b)
Vegetable Spraying (reference 56c)

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 (reference 14) 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 (reference 28). The Organic Materials Review Institute (OMRI) (reference 19) 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 (reference 28b). See Revisions To the Worker Protection Standard for a summary of new worker protection standards that will take effect January 2017 (Reference 28e). Find more information on pesticide applicator certification from the list of State Pesticide Regulatory Agencies (reference 28c) or, in New York State, see the Cornell Pesticide Management Education Program website at http://psep.cce.cornell.edu (reference 28d).

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 6) 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 (reference 20). 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 important diseases whenever possible (see Section 6: *Varieties*). Plant only clean, vigorous and pathogen-free seed or transplants and maintain the best growing conditions possible.

Rotation is an important management practice for pathogens that overwinter in soil or 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* causing white mold and *Rhizoctonia*. Rotation with a grain crop, preferably a crop or crops that will be in place for one or more seasons, deprives many disease-causing organisms of a host, and also contributes to a healthy soil structure that promotes vigorous plant growth. 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 or dew, should be avoided.

Scouting fields weekly is key to early detection and evaluation of 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 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**.

Table 11.0 Pesticides for Organic Cole Crops Disease Management.

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.

CLASS OF COMPOUNDS **Product Name** ***(active ingredient)***	**Alternaria leaf spot**	**Black Rot**	**Clubroot**	**Damping off/ Wirestem**	**Downy mildew**	**Fusarium Yellows**	**Head Rot of Broccoli**	**Sclerotinia White Mold**
BIOLOGICAL								
Actinovate AG (*Streptomyces lydicus*)	X			X	X			X
Actinovate STP *(Streptomyces lydicus)*				X				
BIO-TAM *(Trichoderma spp.)*				X				X
BIO-TAM 2.0 (*Trichoderma asperellum, Trichoderma 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			

CLASS OF COMPOUNDS **Product Name** (***active ingredient***)	**Alternaria leaf spot**	**Black Rot**	**Clubroot**	**Damping off/ Wirestem**	**Downy mildew**	**Fusarium Yellows**	**Head Rot of Broccoli**	**Sclerotinia White Mold**
Mycostop Biofungicide (*Streptomyces griseoviridis* K61)	X			X				
Mycostop Mix (*Streptomyces griseoviridis* K61)	X			X				
Optiva *(Bacillus subtilis* str. *QST 713)*	X							
Prestop *(Gliocladium catenulatum str. J1446)*				X				
Regalia Biofungicide (*Reynoutria sachalinensis*)	X	X			X			
RootShield WP *(Trichoderma harzianum Rifai strain KRL-AG2*)				X				
RootShield Granules (*Trichoderma harzianum* str. T-22)				X				
RootShield PLUS+ Granules *(Trichoderma)*				X				
RootShield PLUS+ WP (Trichoderma)				X				
Serenade ASO (*Bacillus subtilis* str. QST 713)	X	X			X			
Serenade MAX (*Bacillus subtilis* str. QST 713)	X	X			X			
Serenade Opti (*Bacillus subtilis* str. QST 713)	X							
Serenade SOIL *(Bacillus subtilis* str. QST 713*)*			X	X				
SoilGard *(Gliocladium virens str. GL-21)*				X				
Taegro Biofungicide (*Bacillus subtilis var. amyloliquefaciens str FZB24*)				X				
Zonix *(Rhamnolipid Biosurfactant)*			X					
BOTANICAL								
Organocide 3 in 1 Garden Spray (*sesame oil*)					X			
Trilogy (*neem oil*)	X				X			X
COPPER								
Badge X2 (*copper oxychloride, copper hydroxide*)	X	X			X			
Basic Copper 53 (*basic copper sulfate*)	X	X			X			
Champ (*copper hydroxide*)	X	X			X			
ChampION++ (*copper hydroxide*)		X			X			
CS 2005 (*copper sulfate pentahydrate)*	X	X			X			
Cueva Fungicide Concentrate (*copper octanoate*)	X				X			X
Nordox 75 WG (*cuprous oxide*)	X	X			X			
Nu-Cop 50DF (*copper hydroxide*)	X	X			X			
Nu Cop 50WP (*copper hydroxide*)	X	X			X			
Nu-Cop HB *(cupric hydroxide)*	X	X			X			
OTHER								
Agricure (*potassium bicarbonate)*	X				X			
Milstop (*potassium bicarbonate*)	X				X			
OxiDate 2.0 *(hydrogen dioxide, peroxyacetic acid)*	X				X			
Organic JMS Stylet Oil (*paraffinic oil*)	X							
PERpose Plus (*hydrogen peroxide/dioxide*)	X	X		X	X		X	X
PureSpray Green *(petroleum oil)*	X							

CLASS OF COMPOUNDS Product Name (*active ingredient*)	Alternaria leaf spot	Black Rot	Clubroot	Damping off/ Wirestem	Downy mildew	Fusarium Yellows	Head Rot of Broccoli	Sclerotinia White Mold
TerraClean 5.0 *(hydrogen dioxide, peroxyacetic acid)*				X	X			

X – May be used against on cole crops. Efficacy is not indicated.
Active ingredient meets EPA criteria for acute toxicity to bees

11.1 Alternaria Leaf Spot, *Alternaria spp.*

Time for concern: Seedling through harvest. Alternaria is favored by cool weather and long periods of leaf wetness. Normally the disease will slow down during the hot dry summer months but will return again in the fall when weather turns wet and cool.

Key characteristics: Also known as black leaf spot. Alternaria fungi most commonly cause leaf spotting but damping-off and damage to the flowers and seed can also occur. Leaf lesions begin as small black dots and enlarge to form target-like dark spots on the leaf or stem surfaces. Curds on cauliflower have sunken brown lesions whereas broccoli head lesions first appear as yellow. Spores are spread by wind and rain but rarely farther than adjacent fields. Infested seed is the main means of introduction. Lesions can provide an avenue for bacterial soft rot infections. Infections beginning in the greenhouse are amplified in the field. Flea beetles can spread this pathogen. See Cornell photo (reference 61) and fact sheet (reference 61a), and University of Massachusetts fact sheet (reference 62). **Relative risk**: This is the most common disease of cole crops but not necessarily the most destructive, depending on weather conditions. If transplants are clean and long rotations are used, this disease is unlikely to be serious.

Management Option	Recommendation for Alternaria
Scouting/thresholds	Inspect greenhouse transplants and production fields weekly for pinpoint black circular spots especially on lower leaves, as these are the first signs of the disease. Alternaria is not usually evident in the summer unless weather is cool and wet. Do not spray preventatively. Record first occurrence and weather conditions for farm history records. If incidence is low, affected plants should be removed from the field if possible at the first sign of disease and/or a spray program initiated. Be aware of the presence of flea beetles. Research has documented that flea beetles can spread this pathogen. (See Section 14.2: *Flea beetles*.)
Site selection	Plant late season brassicas upwind from early season crops. Select a well-drained field. Avoid fields near hedgerows or woods where air movement is restricted. Plant rows in the direction of the prevailing winds to promote quick drying of plants and soil.
Crop rotation	Use a 3-year minimum rotation out of cruciferous plants including crops, and cover crops. Manage cruciferous weeds (see Appendix 1). Avoid fields where brassica plant waste was disposed.
Resistant varieties	Resistant or tolerant varieties are not known.
Seed selection/treatment	Alternaria can be seed-borne. A hot water treatment may reduce inoculum in and on seed from infested plants, but may also reduce seed vigor and germination rates. Soak broccoli and cauliflower seed for 20 minutes in 122°F water, 25 minutes for Brussels sprouts and cabbage. This treatment may not eradicate the pathogen from heavily infested lots. For instructions see Managing Pathogens Inside Seed With Hot Water (Reference 18b).
Weeds	Brassica weeds can serve as alternate hosts especially field pepperweed, Virginia pepperweed, and field pennycress. See Appendix 1 for other brassica weeds.
Harvest	Infected leaves should be trimmed before storing. See Section 9: *Harvesting*.

Management Option	Recommendation for Alternaria
Postharvest	Remove or destroy affected crop debris by disking or plowing as soon as possible to reduce inoculum for future crops and to initiate decomposition.

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 Alternaria Leaf Spot

Class of Compounds 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	Actinovate not effective in 1 recent cauliflower trial. Label recommends use of a spreader sticker.
Agricure (potassium bicarbonate)	2-5 lb/acre	0	1	?	
Badge X2 (copper hydroxide, copper oxychloride)	0.5-1.8 lb/acre	-	48	3	Copper based products effective in 0/2 trials.
Basic Copper 53 (basic copper sulfate)	1 lb/acre	up to day	48	3	See comment for Badge X2.
Champ WG (copper hydroxide)	1.06 lb/acre	-	48	3	See comment for Badge X2.
CS 2005 (copper sulfate pentahydrate)	19.2-25.6 oz/acre	-	48	3	See comment for Badge X2.
Cueva Fungicide Concentrate (copper octanoate)	0.5-2 gal/acre	up to day	4	3	See comment for Badge X2. Cueva not effective in 1 recent cauliflower trial.
Double Nickel 55 (Bacillus amyloliquefaciens strain D747)	0.25-3 lb/acre	0	4	?	
Double Nickel LC (Bacillus amyloliquefaciens strain D747)	0.5-6 qt/acre	0	4	?	
Milstop (Potassium bicarbonate)	2-5 lb/acre	0	1	?	Not labeled for Brussels sprouts.
Nordox 75 WG (cuprous oxide)	0.66-2 lb/acre	-	12	3	See comment for Badge X2.
Nu Cop 50 WP (copper hydroxide)	2 lb/acre	1	24	3	See comment for Badge X2. Only labeled for cabbage.
Nu-Cop 50DF (copper hydroxide)	1 lb/acre	1	48	3	See comment for Badge X2.
Nu-Cop HB (copper hydroxide)	0.5-1 lb/acre	-	48	3	See comment for Badge X2. Apply at 7-10 day intervals. Reddening of older leaves may occur on broccoli and a flecking of wrapper leaves may occur on cabbage.
Optiva (Bacillus subtilis str. QST 713)	14-24 oz/acre	0	4	?	Begin application soon after emergence and when conditions are conducive to disease development. Repeat at 3-10 day interval or as needed.
Organic JMS Stylet-Oil (paraffinic oil)	3-6 qt/100 gal water	0	4	?	Labeled for cabbage and cauliflower only. See label for sulfur and other incompatibility information.
Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid)	128 fl oz/100 gal water curative	0	until dry	?	Apply first three treatments using curative rate at 5 day intervals. Reduce to 32 fl oz/100 gal water

Table 11.1 Pesticides for Management of Alternaria Leaf Spot					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
	32 fl oz/100 gal water preventative				preventative rate and maintain 5-day spray interval until harvest. Bee Hazard. This product is toxic to bees exposed to direct contact
PERpose Plus (hydrogen peroxide)	1 fl oz/ gal initial/curative 0.25-0.33 fl oz/ gal weekly preventative	-	until dry	3	Effective in 0/1 trial on cabbage. For initial or curative use, apply higher rate for 1 to 3 consecutive days. Then follow with weekly/preventative treatment. 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)	0.5-4 qt/acre	0	4	1	Regalia effective in 1/1 recent cauliflower trial. See label for application instructions. Repeat applications at 7-14 day intervals.
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	1	Serenade Max effective in 1/1 recent cauliflower trial.
Serenade Opti[1] (Bacillus subtilis str. QST 713)	14-20 oz/acre	0	4	?	
Trilogy (neem oil)	0.5-1% solution in 25-100 gals water/A	up to day	4	3	Neem oil products effective in 0/1 trial in cabbage. Maximum 2 gal/acre/application. Bee Hazard. This product is toxic to bees exposed to direct contact

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label. 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. [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 Black Rot, Xanthomonas campestris pv. campestris

Time for concern: Planting through harvest. Warm, wet conditions favor black rot. Rain and heavy fogs or dews and day temperatures of 75° to 95°F are most favorable. Under cool, wet conditions infection can occur without development of symptoms, consequently, transplants grown at low temperatures may be infected but symptomless. The bacteria do not spread below 50°F or during dry weather.

Key characteristics: Black rot is caused by a seed-borne and systemic bacterium. The classic systemic symptoms are wilted, pale green tissue becoming yellow then brown. Lesions from leaf margin infections are usually wedge- or V-shaped, enlarging as the disease progresses. Severely affected leaves may drop off. Bacteria can spread by wind-driven rain and enter leaves through leaf margins, wounds, and insect damage. Infected veins become black and are visible in leaf lesions and can be seen in infected leaf petioles, stems, and roots by cutting crosswise through affected tissue. Infected cabbage heads are more susceptible to secondary infections in storage. This disease is also known as blight, black stem, black vein, stem rot, stump rot, and leaf spot. See Cornell fact sheet (Reference 63); University of Connecticut fact sheet Reference 64), and references 2, and 3.

Relative risk: This disease is seen annually in scattered locations and can be very serious when warm and wet weather conditions favor its development. Yield can be reduced from infected plants dying prematurely, heads remaining small, or marketability problems due to visible lesions.

Management Option	Recommendation for Black Rot
Scouting/thresholds	Examine lower leaves of transplants and field plants weekly for black rot especially when warm, wet conditions exist. Remove diseased plants from the field and/or initiate spray program. Removing diseased leaves will serve to spread disease rather than control it. Record the occurrence and severity of black rot in the field. Avoid scouting when foliage is wet to prevent spreading bacteria.
Site selection	Plant late season brassicas upwind from early season crops. Select a well drained field. Avoid fields near hedgerows or woods where air movement is restricted. Plant rows in the direction of the prevailing winds to promote quick drying of plants and soil.
Crop rotation	Use a 3-year minimum rotation out of cruciferous plants including crops, and cover crops (e.g. mustard, canola). During rotation, manage cruciferous weeds (see Appendix 1). Avoid fields where brassica plant waste was disposed.
Resistant varieties	The best way to reduce damaging infestations is to plant cabbage varieties resistant to black rot. Most broccoli and cauliflower varieties tend to be susceptible to black rot. See Section 6: *Varieties*.
Seed and transplants	**Seed:** This pathogen is seed-borne therefore planting pathogen-free seed and preventing infection during transplant production are the most effective means of controlling black rot. Some seed companies offer hot water treated seeds and guarantee the percentage of viable seeds, although some desired cultivars are not available in seed treated condition. Seed can be tested for pathogens at private laboratories such as STA Laboratories (reference 57). If seed is from an unknown source or from known infested plants, hot water treatment may reduce the inoculum in and on the seed. Soak broccoli and cauliflower seed for 20 minutes in 122°F water, 25 minutes for Brussels sprouts and cabbage. This treatment may reduce germination and vigor and may not eradicate the pathogen from heavily infested lots. For instructions see Managing Pathogens Inside Seed With Hot Water (Reference 18b). To test seed vigor, send samples to the New York State Seed Testing Laboratory (reference 58). (See Section 7: *Planting* Methods) **Transplants**: To avoid spread of the bacteria, do not clip oversized transplants. Use certified disease-free plants if available. Examine plants carefully before planting. **Do not plant transplants with evidence of black rot.**
Weed control	Do not enter the field to cultivate while foliage is wet if black rot is present. Clean equipment thoroughly after using in fields infected with this disease. Eliminate brassica weeds in and around the field. Weeds known to be susceptible to black rot include birdsrape mustard, Indian mustard, black mustard, shortpod mustard, Virginia pepperweed and other pepper grasses, shepherds purse, radish, wild radish, hedge mustard, swinecress, and hairy whitetop (See Appendix 1 and reference 5 and 64).

Management Option	Recommendation for Black Rot
Cultural practices	Bacteria are spread within a crop primarily by workers, machinery, wind-blown or splashing water, and occasionally insects. Do not enter fields when foliage is wet. This pathogen is systemic so infected plants should be removed from the farm or burned. Avoid use of overhead irrigation to prevent extended periods of leaf wetness. If watering is necessary, do so in the morning to allow plants to dry during the day. Drip irrigation is preferred.
Postharvest	Crop debris should be destroyed by deep plowing if possible or disking as soon as possible to remove this source of the pathogen for subsequent plantings and to initiate decomposition. Cabbage harvested with black rot should not be placed into storage since they are prone to secondary pathogens.
Chemical controls	Copper applications are recommended to protect uninfected plants at the first sign of disease. It will not cure plants that are already infected since the disease is systemic, but will help to prevent secondary spread to clean plants.

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 Black Rot

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Badge X2 (copper hydroxide, copper oxychloride)[3]	0.5-1.8 lb/acre	0	48	1	Copper compounds are unable to control disease when wet weather is persistent.
Basic Copper 53 (basic copper sulfate)[3]	1 lb/acre	up to day	48	1	See note for Badge X2
Champ WG (copper hydroxide)[3]	1.06 lb/acre	-	48	1	See note for Badge X2.
ChampION++ (copper hydroxide)[3]	0.5-0.75 lb/acre	0	48	?	See note for Badge X2.
CS 2005 (copper sulfate pentahydrate)[3]	19.2-25.6 oz/acre	-	48	1	See note for Badge X2
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	?	
Nordox 75 WG (cuprous oxide)[3]	0.66-2 lb/acre	-	12	1	See note for Badge X2
Nu Cop 50 WP (copper hydroxide)[3]	2 lb/acre	1	24	1	Only labeled for cabbage. Copper compounds are unable to control disease when wet weather is persistent.
Nu-Cop 50DF (copper hydroxide)[3]	1 lb/acre	1	48	1	See note for Badge X2
Nu-Cop HB (copper hydroxide)[3]	0.5-1 lb/acre	-	48	1	Apply at 7-10 day intervals. Reddening of older leaves may occur on broccoli and a flecking of wrapper leaves may occur on cabbage. Copper compounds are unable to control disease when wet weather is persistent.

Table 11.2 Pesticides for Management of Black Rot					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
PERpose Plus (hydrogen peroxide)	1 fl.oz./ gal initial/curative 0.25-0.33 fl.oz./ gal weekly preventative	-	until dry	3	For initial or curative use, apply higher rate for 1 to 3 consecutive days. Then follow with weekly/preventative treatment. Effective in 0/3 trials on cabbage. 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*)	0.5-4 qt/acre	0	4	?	Repeat applications at 7-14 day intervals.
Serenade ASO[1] (*Bacillus subtilis* str . QST 713)	2-6 qt/acre	0	4	3	Serenade effective in 0/1 trial.
Serenade MAX[1] (*Bacillus subtilis* str . QST 713)	1-3 lb/acre	0	4	3	Serenade effective in 0/1 trial.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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. [3]Copper can slow spread of disease to uninfected plants but can't cure plants already infected.

11.3 Clubroot, *Plasmodiophora brassicae*

Time for concern: Seedling through harvest especially when soils are cool and wet.

Key characteristics: Clubroot attacks all brassicas. The fungus overwinters in the soil and causes large spindle-shaped galls to appear on roots; yellowing and wilting occurs on the aboveground portion. Surviving plants are stunted due to impaired root function. Although other pests cause similar symptoms (e.g. root maggot), abnormally large roots are diagnostic. Low pH favors this disease. See Cornell fact sheet (reference 65) and University of Massachusetts fact sheet (reference 66) for photos and more information and references 2 and 3.

Relative risk: Clubroot can be a devastating problem. It is very difficult to manage once on a farm, therefore preventing introduction is extremely important.

Management Option	Recommendation for Clubroot
Scouting/thresholds	Examine transplants for symptoms; do not plant any if symptoms are seen. Examine fields weekly, especially during cool, wet conditions. Examine the roots for symptoms on cruciferous plants and weeds seen wilting in the heat of the day including weeds along field edges. Thresholds are not available for organic production, but record occurrence for field records.
Site selection	Avoid fields where crucifer plant waste has been discarded. Avoid fields with potential for pathogen movement from an infested field in runoff or irrigation water or on animal feet.
Crop rotation	Since resting clubroot spores can contaminate the soil for 7 to 10 years or longer, a minimum crop rotation of 7 years is recommended if clubroot has been observed. Rotate away from all cruciferous plants (see Appendix 1) including cover crops. During rotation, manage weeds (see specific weeds below). The high pH required to control this fungus may adversely affect other crops in the rotation. Clubroot has declined more quickly where tomato, cucumber, snap bean and buckwheat are grown. Growing aromatic perennial herbs such as summer savory, peppermint, or garden thyme has provided effective control of clubroot when grown for 2 to 3 consecutive years.

Management Option	Recommendation for Clubroot
Seeds and transplants	This pathogen is not seed-borne. Affected transplants produced off farm are the main source of the pathogen. Purchase transplants certified to be free of clubroot.
Resistant varieties	Resistant varieties are not known.
Weeds	Several weeds are hosts including wild mustard, common lambsquarters, field pennycress, Virginia pepperweed, shepherd's purse, yellow woodsorrel, field pepperweed, and wild radish. See Appendix 1 for other cruciferous weeds.
Postharvest	Destroy crop debris as soon as possible to reduce disease potential for future plantings and to initiate decomposition. Discard any infected crop waste in the field in which it was grown.
Other	Clean and disinfect equipment used in a field suspected of having clubroot. Some preliminary work indicates that incorporation of meadowfoam seedmeal can reduce incidence of clubroot while also suppressing some weeds (reference 67). Once present on a farm, clubroot can be managed by adjusting the soil pH to 7.2 with ground limestone prior to the production season. Add limestone annually unless the soil pH exceeds 7.5. This high pH may adversely affect other crops in the rotation.

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 Clubroot in Broccoli

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Serenade Soil[1](*Bacillus subtilis* str. QST 713)	2-6 qt/acre soil treatment	0	4	?	Soil drench or in-furrow.
Zonix (Rhamnolipid Biosurfactant)	0.5-0.8 fl.oz./ gal water: soil treatment	-	4	?	

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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.

11.4 Downy Mildew, *Peronospora parasitica*

Time for concern: The fungus overwinters in New York and is favored by cool, wet conditions making it a potential problem from seedling to harvest. It is most prevalent in the fall.

Key characteristics: Small, yellow leaf spots turn brown with blue or black lace-like markings. Vascular tissue is discolored. In moist weather, look on the underside of leaves for white downy mold. Irregular black spots develop on broccoli. Spores are wind blown. See University of Massachusetts fact sheet (reference 68), and references 2 and 3.

Relative Risk: Downy mildew is rarely a problem in New York.

Management Option	Recommendation for Downy Mildew
Scouting/thresholds	Examine transplants and production fields weekly especially when conditions have been cool and wet. Check lower leaves for symptoms. Record first occurrence and weather conditions for farm history records. If downy mildew begins to develop early in the crop development in a few plants, remove diseased plants from the field and/or initiate a spray program at first sign of disease. It is not necessary to spray preventatively.
Site selection	Select a well drained field away from hedgerows or woods that impede air flow and prevent leaves from drying quickly. Avoid fields where brassica plant waste was discarded.
Crop rotation	Maintain a minimum of 3 years without cruciferous cover crops, weeds, or crops (see Appendix 1).
Resistant varieties	No resistant varieties are available although some varieties may be more susceptible.
Seed treatment	Seed treatments are not generally recommended although the pathogen can be seed-borne, this is not thought to be an important source of the pathogen.
Weeds	Suspected weed hosts of downy mildew include wild mustard, yellow rocket, hedge mustard, shepherd's purse, marsh yellowcress, and field pennycress, but the specific strain of downy mildew may vary and some do not affect cabbage.
Harvest	Trim outer infected leaves to avoid problems in storage. See Section 9: *Harvesting*.
Postharvest	Crop debris should be destroyed as soon as possible to remove this source of disease for future plantings and to initiate decomposition.
Other	Avoid use of overhead irrigation to prevent extended periods of leaf wetness. If watering is necessary, do so in the morning to allow plants to dry during the day. Drip irrigation is recommended.

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 Downy Mildew

Class of Compounds 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	?	Label recommends use of a spreader sticker.
Agricure (potassium bicarbonate)	2-5 lb/acre	0	1	?	
Badge X2 (copper hydroxide, copper oxychloride)	0.5-1.8 lb/acre	0	48	1	
Basic Copper 53 (basic copper sulfate)	1 lb/acre	up to day	48	1	
Champ WG (copper hydroxide)	1.06 lb/acre for cauliflower, broccoli, Brussels sprouts	-	48	1	
Champ WG (copper hydroxide)	0.5-1 lb/acre for cabbage	-	48	1	
ChampION++ (copper hydroxide)	0.5-0.75 lb/acre	0	48	1	
CS 2005 (copper sulfate pentahydrate)	19.2-25.6 oz/acre	-	48	1	

Table 11.4 Pesticides for Management of Downy Mildew					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
Cueva Fungicide Concentrate (copper octanoate)	0.5-2 gal/acre	up to day	4	1	
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	?	
Milstop (potassium bicarbonate)	2-5 lb/acre	0	1	?	Not labeled for Brussels sprouts.
Nordox 75 WG (cuprous oxide)	0.66-2 lb/acre	-	12	1	
Nu Cop 50 WP (copper hydroxide)	0.5-1 lb/acre	1	24	1	
Nu-Cop 50DF (copper hydroxide)	0.5-1 lb/acre	1	48	1	
Nu-Cop HB (copper hydroxide)	0.5-1 lb/acre	-	48	1	Apply at 7-10 day intervals. Reddening of older leaves may occur on broccoli and a flecking of wrapper leaves may occur on cabbage.
Organocide (sesame oil)	1-2 gal/100 gal water	0	-	?	25(b) pesticide
Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid)	128 fl oz/100 gal water curative	0	until dry	?	Apply first three treatments using curative rate at 5 day intervals. Bee Hazard. This product is toxic to bees exposed to direct contact
Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid)	32 fl oz/100 gal water preventative	0	until dry	?	Reduce to 32 fl oz/100 gal water preventative rate and maintain 5-day spray interval until harvest. Bee Hazard. This product is toxic to bees exposed to direct contact
PERpose Plus (hydrogen peroxide)	1 fl oz/ gal initial/curative	-	until dry	?	For initial or curative use, apply higher rate for 1 to 3 consecutive days. Then follow with weekly/preventative treatment.
PERpose Plus (hydrogen peroxide)	0.25-0.33 fl oz/ gal weekly preventative	-	until dry	?	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*)	0.5-4 qt/acre	0	4	?	See label for application instructions. Repeat applications at 7-14 day intervals.
Serenade ASO[1] (*Bacillus subtilis* str. QST 713)	2-6 qt/acre	0	4	3	Serenade effective in 0/1 trial.
Serenade MAX [1](*Bacillus subtilis* str. QST 713)	1-3 lb/acre	0	4	3	Serenade effective in 0/1 trial.

Table 11.4 Pesticides for Management of Downy Mildew					
Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Trilogy (neem oil)	0.5-1% solution in 25-100 gals water/A	Up to day	4	3	Maximum 2 gal/acre/application. Neem oil products effective in 0/2 trials in broccoli. Bee Hazard. This product is toxic to bees exposed to direct contact.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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

11.5 Fusarium Yellows, *Fusarium oxysporum*

Time for concern: Seedling through harvest but especially when temperatures are above 60o.

Key characteristics: Fusarium yellows can attack all brassicas. The causal fungus enters mainly through the roots causing a sickly, dwarfed, yellow appearance and leaf drop, with vascular tissue browning the affected sides of leaves and plants. Leaves are often twisted, with one-sided yellowing. Oldest leaves are usually affected first. The disease is favored by hot and moist conditions and spread primarily by contaminated transplants, soil, or equipment moving from field to field. Fusarium oxysporum has many strains, each of which specializes on a single crop or crop group. Fields with a history of Fusarium on non-crucifer crops will not necessarily be a risk to crucifer crops. See Cornell fact sheet(reference 69) and references 2 and 3.

Relative risk: Fusarium yellows was a severe problem in the past but is now largely controlled through the use of resistant varieties. This disease can be severe in susceptible varieties when the pathogen is present in the soil.

Management Option	Recommendation for Fusarium Yellows
Scouting/thresholds	Look for symptoms of *Fusarium yellows* when scouting for other pests. If present, record occurrence, and plant resistant varieties in the future (See Section 6. *Varieties*). Symptoms normally appear 2 to 4 weeks after transplanting. For a definitive diagnosis, submit a sample to a diagnostic lab (reference 59). No thresholds have been established for organic production.
Seed treatment	The fungus in not seed-borne therefore seed treatments are unnecessary.
Site selection	Avoid fields where cruciferous plant waste was discarded (see brassicas in Appendix 1).
Crop rotation	Maintain a minimum of 3 years without cruciferous crops, cover crops (mustard, radish, rapeseed) or weeds (see *Weeds* below and Appendix 1). If *Fusarium* yellows is severe in the field, increase the rotation to 7 years.
Resistant varieties	Resistant varieties are the most effective means of controlling this disease. See Section 6: *Varieties*.
Weeds	Many common cruciferous weeds host the pathogen including annual wild radish, wild mustard.
Postharvest	Crop debris should be destroyed as soon as possible to initiate decomposition

11.6 Head Rot of Broccoli, *Pseudomonas spp, Erwinia carotovora.*

Time for concern: During wet conditions from heading to harvest.

Key characteristics: Head rot begins as water-soaked florets that become malodorous and soft-rotted if head maturation coincides with periods of prolonged wet weather. The bacterium is most serious in broccoli but can affect other brassica crops. Soft rot will continue to develop in the low temperatures of storage facilities. See Cornell fact sheet (reference 70).

Relative risk: A sporadic problem in wet weather.

Management Option	Recommendation for Head Rot of Broccoli
Scouting/thresholds	Monitor for presence of head rot at harvest to prevent marketing of infected broccoli.
Site selection	Select fields away from hedgerows or woods that impede air flow and prevent leaves from drying quickly.
Crop rotation	Maintain a minimum of 2 years without cruciferous crops, cover crops (e.g. mustard, radish, rapeseed) or weeds (e.g. wild radish, wild mustard, shepherds purse).
Seeds	The bacteria are not seed-borne therefore seed treatments are not useful.
Resistant varieties	Varieties like Shogun, Green Defender, and Pirate that have tight, dome-shaped heads with very small beads are less susceptible to head rot than other varieties.
Harvest	Clean all tools used during harvest. Avoid entering fields when plants are wet. Harvest when heads are tight. Cut stalks at an angel to minimize the chance the stump will provide a place for the pathogen to invade and produce inoculum for near-by healthy heads.
Postharvest	Crop debris should be destroyed as soon as possible to reduce future inoculum and initiate decomposition.

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Table 11.6 Pesticides for Management of Head Rot in Broccoli

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
PERpose Plus (hydrogen peroxide)	1 fl oz/ gal initial/curative 0.25-0.33 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. 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.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label. 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. [2] Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

11.7 Damping Off and Wire Stem

Caused primarily by *Pythium ultimum* and Wire stem caused by *Rhizoctonia solani*

Time for concern: Most often at planting and early growth stages especially when conditions are wet.

Key characteristics: Pythium can cause damping-off and seedling death in young plants.

Depending on the time of onset, infection by Rhizoctonia most often is expressed as damping-off in seedlings, but can cause wirestem in young plants, bottom rot in midseason, and head rot as the heads mature. Wirestem is characterized by water-soaked or darkened constrictions on the stem near the soil line in young plants. It can also provide entry points along the soil line for secondary bacterial rot which ultimately rot the head. If plants survive, growth is stunted and the stem is black or brown. Bottom rot causes leaf margins to discolor. Plants may wilt, and gray-brown lesions may appear on the stem and lower side of leaves at the soil surface. Head rot causes a dark decay of the stem and base of heads, as well as spotted and wilted leaves at the center of the head. See reference 2 and Virginia Cooperative Extension description and photo (reference 71).

Relative risk: This disease is most often seen in transplant production especially in cold greenhouses and wet soil.

Management Option	Recommendation for Damping off and Wirestem
Scouting/thresholds	Remove flats with signs of damping off. Disease spread will slow when the flats are allowed to dry out. Field scouting and threshold information has not been established for organic production.
Site selection/treatment	Plant on well-drained and light-textured soils. Greenhouse sanitation is critical (See Section 7.2 *Transplant Production*).
Crop rotation	Both *Pythium* and *Rhizoctonia* are common soil pathogens with a wide host range. For severe outbreaks, a minimum rotation of 3 years out of all vegetables may be necessary. A rotation with grain crops can reduce inoculum. Potatoes, beans, lettuce, and cabbage are the most important host crops but other hosts include broccoli, kale, radish, turnip, carrot, cress, cucumber, eggplant, pepper, and tomato (reference 5).
Resistant varieties	No resistant varieties are available.
Seed selection	These pathogens are generally not seed-borne; however hot water treatment could reduce the risk of pathogens present on the outside of the seed. For instructions see Managing Pathogens Inside Seed With Hot Water (Reference 18b). See more on hot water treatment in Section 7.1: *Direct Seeding and Seed Treatment*).
Weeds	Several common weeds host *Pythium* species including wild-proso millet, shattercane, barnyardgrass, and quackgrass. Weeds hosting *Rhizoctonia* include annual bluegrass, barnyardgrass, common lambsquarters, common milkweed, common purslane, common ragweed, corn chamomile, eastern black medic, black nightshade, field bindweed, field horsetail, goosegrass, green foxtail, Italian ryegrass, kochia, large crabgrass, mouseear chickweed, perennial sowthistle, prickly lettuce, prostrate pigweed, redroot pigweed, shepherd's-purse, tumble pigweed, Venice mallow, wild buckwheat, wild mustard, and witchgrass (reference 5).
Transplants	Avoid overwatering in the greenhouse. Sanitize greenhouses and equipment where transplants are produced. Use the optimal seed planting depth, plant density, nutrition, growing medium, and watering methods (See Section 7.2: *Transplant Production*). Do not plant transplants too deep.
Postharvest	Crop debris should be destroyed as soon as possible to remove inoculum for future plantings and to initiate decomposition.

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Table 11.7 Pesticides for Management of Damping Off and Wirestem

Class of Compounds 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 2-18 oz/cwt seed in hopper or slurry seed treatment	0	1 or until dry	3	*Streptomyces lydicus* products effective on broccoli in 0/1 trial.
Actinovate STP (*Streptomyces lydicus*)	4-32 oz/ cwt seed seed treatment	-	1 or until dry	?	
BIO-TAM (*Trichoderma asperellum, Trichoderma gamsii*)	1.5-3 oz/ 1000 row feet in-furrow treatment	-	1	?	

Table 11.7 Pesticides for Management of Damping Off and Wirestem					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
BIO-TAM (*Trichoderma asperellum, Trichoderma gamsii*)	2-3 lb/acre band	-	1	?	
BIO-TAM 2.0 (*Trichoderma asperellum, Trichoderma gamsii*)	1.5-3 oz/ 1000 ft row	-	4	?	
Double Nickel 55 (*Bacillus amyloliquefaciens* str D747)	0.125-1 lb/acre soil treatment	0	4	?	
Double Nickel LC (*Bacillus amyloliquefaciens* str D747)	0.5-4.5 pts/acre soil treatment	0	4	?	
MycoStop (*Streptomyces grieoviridis* str K61)	0.176 oz/ 1.5 lbs of seed seed treatment 0.07 oz/100-200 sq ft soil drench	-	4	?	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)	0.05-0.08 oz/lb of seed seed treatment	-	4	?	Use at planting. 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)	.0175-.07 oz/100 sq ft soil treatment	-	4	?	Use at planting. Irrigate within 6 hours after soil spray or drench with enough water to move Mycostop into the root zone. Soil spray or drench.
PERpose Plus (hydrogen peroxide)	1 fl.oz./ gal soil drench	-	until dry	?	Soil drench at time of seeding or transplanting
Prestop (*Gliocladium catenulatum*)	1.4-3.5 pt/ 2.5 gal water Soil treatment	-	0	?	Soil application only; do not use as foliar spray
RootShield Granules (*Trichoderma harzianum*)	2.5-6 lbs./ half acre in-furrow treatment	-	0	?	
RootShield PLUS+ Granules (*Trichoderma harzianum, Trichoderma virens*)	2.5-6 lbs./ half acre in-furrow treatment	-	0	?	
RootShield PLUS+ WP (*Trichoderma harzianum, Trichoderma virens*)	16-32 oz/acre in-furrow treatment	0	4	?	Do not apply product when above-ground harvestable food commodities are present.
RootShield WP (*Trichoderma harzianum*)	16-32 oz/acre	-	until dry	?	Applied in greenhouse as a soil drench. In-furrow or transplant starter solution.
Serenade Soil[1] (*Bacillus subtilis* str. QST 713)	2-6 qt/acre soil treatment	0	4	?	Labeled only for Rhizoctonia spp. Soil drench or in-furrow.
Soilgard (*Gliocladium virens*)	2-10 lb/acre	-	0	?	Repeated applications can be made as needed. Used as a directed spray or drench at the base of the plant after transplanting.
Taegro (*Bacillus subtilis*)	2.6 oz/100 gal water in-furrow treatment	-	24	?	Soil drench or over furrow at time of planting.
Taegro (*Bacillus subtilis*)	3 tsp/gal water seed treatment	-	24	?	
TerraClean 5.0 (hydrogen	128 fl.oz./100 gal water	up to	0	?	Soil treatment prior to seeding/

Table 11.7 Pesticides for Management of Damping Off and Wirestem					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
dioxide, peroxyacetic acid)	soil treatment	day			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	up to day	0	?	Soil drench with established plants.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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.

11.8 Sclerotinia White Mold, *Sclerotinia sclerotiorum*

Time for concern: Head formation through harvest under cool, moist conditions.

Key characteristics: Sclerotinia white mold causes bleached, water-soaked spots that enlarge to irregular-shaped areas followed by rot on stems or entire head. Tissue becomes covered with fluffy, white fungal growth often producing black seed-like sclerotia the size of pea seeds, which remain in the soil and serve as inoculum for future years. See Cornell fact sheet (reference 72) and references 2 and 3.

Relative risk: White mold occurs annually on cabbage and Brussels sprouts but is uncommon on broccoli and cauliflower.

Management Option	Recommendation for Sclerotinia White Mold
Scouting/thresholds	Scout field prior to harvest to determine if a post-harvest treatment of Contans is necessary to reduce overwintering inoculum. Record white mold incidence and severity in all fields.
Site selection	Select a well-drained field with good air flow to dry leaves and soil quickly. Growing on raised beds enhances air movement and soil drying for better disease control. Avoid fields with previous populations of alternate host weeds (see *Weed* section below). White mold spores are locally airborne. Plant upwind from previously infected fields. Avoid fields where brassica plant waste has been discarded.
Crop rotation	The long list of alternate hosts makes the use of crop rotation a difficult method to control this long-lived fungus. Work to prevent inoculum buildup by maintaining a minimum of 3 years without brassica crops. In severe cases 5 years may be necessary. See *Weeds* below and Appendix 1 for a listing of brassicas. Other susceptible host crops include soybeans, beans, peas, tomatoes, eggplants, peppers, lettuce, carrots, and cucurbits. Rotations with non-hosts such as grains, sweet corn and sorghum are effective as long as brassica weed hosts are controlled.
Resistant varieties	Research has not been conducted, but it appears that some varieties may be more susceptible than others.
Seed	The fungus is not seed-borne therefore seed treatments are not useful.
Planting	Avoid overcrowding and orient rows with the prevailing winds to quickly dry leaves and soil.
Weeds	Maintain fields free of the many weeds that serve as an alternate host to Sclerotinia such as wild mustard, wild radish, shepherd’s purse, ragweed, velvetleaf, dandelion, common lambsquarters, prickly lettuce, eastern black nightshade, field pennycress, redroot pigweed, common ragweed, shattercane, annual sowthistle, common sunflower, common chickweed, green foxtail, and Canada thistle (reference 5).

Management Option	Recommendation for Sclerotinia White Mold
Harvest	Bruises and other mechanical injuries provide avenues of infection in storage. See more information about harvest and storage in Section 9.
Postharvest	Destroy crop debris by plowing or disking as soon as possible after harvest to manage this source of inoculum for future plantings and to initiate decomposition. If practical, dispose of infected debris off the farm. Composting waste will not effectively reduce inoculum, which even survives animal digestive tracts. If fields are badly infested, rotate to grains and treat with Contans® immediately after harvest. Correct application of Contans® is critical; see application details below.

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Table 11.8 Pesticides for Management of White Mold

Class of Compounds 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	?	
BIO-TAM (*Trichoderma asperellum, Trichoderma gamsii)*	1.5-3 oz/ 1000 row feet in-furrow treatment	-	1	?	
BIO-TAM (*Trichoderma asperellum, Trichoderma gamsii*)	2-3 lb/acre band	-	1	?	
BIO-TAM 2.0 (*Trichoderma asperellum, Trichoderma gamsii*)	2.5-5 lb/acre	-	4	?	
Contans WG (*Coniothyrium minitans*)	1-4 lb/acre	-	4	1	Contans effective at reducing sclerotia in the soil in 1/1 trial. Read label for details of soil application and incorporation which is critical for performance. See more details about effective application below.[1]
Cueva Fungicide Concentrate (copper octanoate)	0.5-2 gal/acre	up to day	4	?	
PERpose Plus (hydrogen peroxide)	1 fl.oz./ gal (curative)	-	until dry	?	Foliar treatment or soil drench at time of seeding or transplanting.
PERpose Plus (hydrogen peroxide)	1/3 fl.oz./ gal (preventative)	-	until dry	?	
Trilogy (neem oil)	0.5-1% solution in 25-100 gals water/A	up to day	4	?	Maximum of 2 gal/acre/application. Bee Hazard. This product is toxic to bees exposed to direct contact

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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.
[1]Apply Contans® to a Sclerotinia-infected crop immediately following harvest at 1 lb/A and incorporate the debris into the soil and/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®. This will avoid bringing untreated soil that contains viable sclerotia near the surface. The seller recommends applying Contans® for at least 3 to 4 years to reduce levels in the soil, or every year a susceptible crop is grown in that field. Since the active ingredient is a living organism, storage life is enhanced by keeping the product at 39^0F. [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. NEMATODES

12.1 Sugar-beet Cyst Nematode, *Heterodera schachtii*

Time for concern: Before planting to seedling.

Key characteristics: Symptoms include stunted plants and small, loose heads. Roots branch excessively. The appearance of pearly-white, tan, or reddish bodies of female nematodes is common on the root surface. The leathery, lemon-shaped cysts are approximately 0.7 mm in length and can survive up to 7 to 8 years in soil in the absence of host plants. See Cornell fact sheet (reference 74).

Relative Risk: This is not a highly destructive pest of brassicas.

Management Option	Recommendation for Sugar-beet Cyst Nematodes
Scouting/thresholds	Look for the presence of swollen immature females attached to the surface of roots about 4 to 6 weeks after planting. Dig the plants carefully to prevent jarring the females loose from the roots. Threshold: 6 to 9 eggs per cubic centimeter. Contact the Cornell Plant Disease Diagnostic Clinic reference 59) or the Michigan State University Diagnostic Services (reference 75) to determine egg numbers and reference 3.
Resistant varieties	No resistant varieties are available.
Crop rotation	Maintain a minimum of 3 years without brassica crops (especially beet), brassica cover crops, or weeds listed in the weed section below. Also see Appendix 1. Rotations with non-hosts such as alfalfa and sweet corn are better than rotations with soybean or wheat.
Site selection	Choose soil with good tilth and no recent history of beet or cabbage production. Analyze for the presence of the nematode by collecting a representative soil sample.
Weed control	Control alternate weed hosts in the cabbage and beet families such as lambsquarters, shepherds purse, wild radish, mustard and dock. See Appendix 1 for more cruciferous weeds.
Cultural practices	Nematodes only move a few inches per year on their own and are spread primarily by equipment and transplants moved from contaminated soils. Cyst nematodes can be present for several seasons at numbers low enough to not cause symptoms, thus spread may occur from a field before infestations are noticed.
Postharvest	Destroy crop debris as soon as possible after harvest to stop further development on remaining roots and to initiate decomposition.

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Table 11.8.1 Pesticides for Management of Sugar Beet Cyst Nematodes

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
DiTera DF (*Myrothecium verrucaria*)	13-100 lb/acre soil treatment	-	4	?	
Ecozin Plus 1.2% ME (azadirachtin)	25-56 oz/acre	0	4	?	
MeloCon (*Paecilomyces lilacinus* str. 251)	2-4 lb/acre soil treatment	-	4	?	

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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

12.2 Lesion Nematodes, *Pratylenchus penetrans*

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

Key characteristics: Lesion nematode populations can build on crops in the brassica family causing significant destruction of the root cortical tissues. Lesion nematode is more prevalent where grain cover crops are used in rotations with susceptible cash crops.

Relative Risk: Lesion nematode populations can be damaging if populations are high.

Management Option	Recommendation for Lesion Nematodes
Scouting/thresholds	Use a soil bioassay with soybean to assess soil lesion nematode infestation levels. Or, submit the soil sample(s) for nematode analysis at a public or private nematology lab (reference 59). See Section 4: *Field Selection* and Section 2: *Soil Health* for more information as well as the following Cornell publications for instructions: Soil Sampling for Plant-Parasitic Nematode Assessment (reference 74a). A Soil Bioassay for the Visual Assessment of Soil Infestations of Lesion Nematode (reference 74b).
Resistant varieties	Resistant varieties are not known.
Crop rotation	Root-lesion nematode has over 400 hosts including many vegetable and grain crops that are planted in rotation with cole crops 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 and weed hosts are managed.
Site selection	Assay soil for nematode infestation, if needed.
Biofumigant cover crops	Cover crops with a biofumigant effect, 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 11.8.1 Pesticides for Management of Lesion Nematodes

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
DiTera DF (Myrothecium verrucaria)	13-100 lb/acre soil treatment	-	4	?	

Ecozin Plus 1.2% ME (azadirachtin)	25-56 oz/acre	0	4	?	
MeloCon (Paecilomyces lilacinus str. 251)	2-4 lb/acre soil treatment	-	4	?	

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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. NONPATHOGENIC DISORDERS

Environmental factors can cause symptoms that appear to be diseases but are actually not caused by a pathogen or insect. Table 13.1 provides a list of disorders that may be confused with diseases. See Cornell fact sheet (reference 73).

Table 13.1 Nonpathogenic Disorders

Affected Crop(s)	Disorder	Management	Recommendation
Cabbage	Tipburn	Variety selection Irrigation	Maintain uniform soil moisture to encourage a constant growth rate. Varieties vary in susceptibility, check with seed dealer. Note that tipburn symptoms occur in the center of the head when causal conditions occur later in the season. There the lesions look different from classic tipburn: they are black with a pearly surface and do not dry out.
Cabbage	Black petiole or black midrib	Variety selection Fertility	On fields that test high or very high in phosphorus, apply potassium sulfate or other OMRI-approved potassium source that contains no phosphorus. Varieties vary in susceptibility, check with seed dealer. Note the symptoms can occur on leaf veins without affecting the midrib.
Cabbage	Pepperspot or black speck	Variety selection	Spot or speck may be caused by high rates of fertility, temperature fluctuations, and cultural conditions promoting vigorous growth.
Cauliflower	Hollowheart	Boron	If soil tests low in boron, supplement with OMRI-approved borax product
Broccoli	Rough head, leafy head, and premature flowering	Harvest date	High temperature causes all three disorders, dependent on head maturity when the excessive temperature occurs. Eastern-adapted varieties tend to do well if they mature after September 1 in much of New York. Some varieties produce acceptable heads for August harvest as well. Cooler nights in Northern New York and on Long Island reduce the risk of this disorder.
Cauliflower Cabbage	Bolting	Variety selection	Bolting can occur if the early planted crop is subjected to ten or more continuous days of temperatures between 35° and 50°F. The sensitivity to bolting is variety dependent.
Broccoli Cauliflower	Buttoning	Transplant maturity, sudden drop in growth rate at transplanting.	Use small transplants with no more than four to five true leaves. Harden by reducing fertilizer before transplanting, and apply a starter fertilizer at transplanting, to avoid transplant shock.

Edited by Thomas Björkman July 9, 2009

14. 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, a familiarity with allowable control practices and their effectiveness, 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 or 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 insects are highly mobile, it is better to leave a greater distance between past and present plantings.

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 avoiding broad-spectrum insecticides. 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 an 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 pest buildup 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 A , Guide to Natural Enemies in North America (reference 76), and Natural Enemies of Vegetable Insect Pests (reference 77) and

Regulatory

Organic farms must comply with all 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:

Resource Guide for Organic Insect and Disease Management (Reference 6).
Biological Control: A Guide to Natural Enemies in North America (Reference 76)
Natural Enemies of Vegetable Insect Pests (Reference 77).

Table 14.0 Pesticides for Organic Cole Crop Insect and Slug Management.

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.

CLASS OF COMPOUNDS **Product Name** ***(active ingredient)***	**Aphids**	**Cabbage Looper**	**Cabbage Root Maggot**	**Diamondback Moth**	**Flea Beetle**	**Imported Cabbageworm**	**Swede Midge**	**Thrips**	**Slugs**
MICROBIAL									
Agree WG (*Bacillus thuringiensis,* var. *aizawai*)		X		X		X			
XenTari (*Bacillus thuringiensis,* var. *aizawai*)		X		X		X			
Biobit HP (*Bacillus thuringiensis var. kurstaki*)		X		X		X			

ORGANIC COLE CROP PRODUCTION

CLASS OF COMPOUNDS **Product Name** **(*active ingredient*)**	**Aphids**	**Cabbage Looper**	**Cabbage Root Maggot**	**Diamondback Moth**	**Flea Beetle**	**Imported Cabbageworm**	**Swede Midge**	**Thrips**	**Slugs**
Deliver (*Bacillus thuringiensis var. kurstaki*)		X		X		X			
Dipel DF (*Bacillus thuringiensis var. kurstaki*)		X		X		X			
Grandevo (*Chromobacterium subtsugae str. PRAA4-1*)	X	X		X		X		X	
Javelin WG (*Bacillus thuringiensis var. kurstaki*)		X		X		X			
Entrust (*spinosad*)		X		X	X	X		X	
Entrust SC (*spinosad*)		X		X	X	X		X	
PFR-97™ 20% WDG *(Isaria fumosorosea Apopka Strain 97)*	X	X		X	X	X		X	
BOTANICAL									
azadirachtin									
Aza-Direct (*azadirachtin*)	X	X	X	X	X	X	X	X	
AzaGuard (*azadirachtin*)	X	X	X	X	X	X	X	X	
AzaMax (*azadirachtin*)	X	X	X	X	X	X		X	
AzaSol (*azadirachtin*)	X	X	X	X	X	X	X	X	
Azatrol EC (*azadirachtin*)	X	X	X	X	X	X	X	X	
Azera (*azadirachtin, pyrethrins*)	X	X	X	X	X	X	X		
Ecozin Plus 1.2% ME (*azadirachtin*)	X	X		X	X	X		X	
Molt-X (*azadirachtin*)	X	X	X	X	X	X	X	X	
Neemix 4.5 (*azadirachtin*)	X	X	X	X	X	X			
Pyrethrin									
Pyganic EC 1.4$_{II}$ (*pyrethrin*)	X	X	X	X	X	X	X	X	
Pyganic EC 5.0$_{II}$ (*pyrethrin*)	X	X	X	X	X	X	X	X	
Other									
Safer® Brand #567 Pyrethrin & Insecticidal Soap Concentrate II (*pyrethrin, potassium salts of fatty acids*)	X	X		X	X	X			
BioLink (*garlic juice*)	X	X	X	X	X	X	X	X	X
BioLink Insect & Bird Repellant (*garlic juice*)	X	X	X	X	X	X	X	X	X
Envirepel 20 (*garlic juice*)	X	X	X	X	X	X			
Garlic Barrier AG (*garlic juice*)	X	X	X	X	X	X			
OILS									
BioRepel (*garlic oil*)	X							X	
Cedar Gard *(cedar oil)*					X				
Ecotec *(rosemary and peppermint oils)*	X	X	X	X	X	X		X	
GC-Mite *(cottonseed, clove and garlic oils)*	X							X	
Glacial Spray Fluid *(mineral oil)*	X				X			X	
GrasRoots (*cinnamon oil*)	X							X	
Oleotrol-I (*soybean oil*)	X							X	
Omni Supreme Spray *(mineral oil)*	X	X						X	
Organocide 3-in-1 *(sesame oil)*	X							X	
PureSpray Green (*petroleum oil*)	X	X				X		X	
SuffOil-X *(petroleum oil)*	X	X						X	
Trilogy (*neem oil*)	X							X	
TriTek *(mineral oil)*	X	X						X	
SOAPS (Potassium salts of fatty acids)									
DES-X *(insecticidal soap)*	X								
M-Pede (*potassium salts of fatty acids)*	X							X	
OTHER									
Bug-N-Sluggo *(iron phosphate and spinosad)*									X

CLASS OF COMPOUNDS Product Name (*active ingredient*)	Aphids	Cabbage Looper	Cabbage Root Maggot	Diamondback Moth	Flea Beetle	Imported Cabbageworm	Swede Midge	Thrips	Slugs
Sil-Matrix (*potassium silicate*)	X								
Surround WP (*kaolin clay*)					X				
Sluggo Slug & Snail Bait (*iron phosphate*)									X
Sluggo-AG (*iron phosphate*)									X

X= May be used against pest on cole crops in New York State and OMRI listed.

Active ingredient meets EPA criteria for acute toxicity to bees

14.1 Cabbage Root Maggot, *Delia radicum*

Time for concern: April through July when conditions are cool and moist. See pest forecasting details in the scouting section below. Cabbage maggot populations tend to decline in the heat of the summer unless the season is particularly rainy, leaving soils cooler than normal. The first generation can cause extensive damage to small, slow-growing young plants.

Key characteristics: Cabbage root maggots overwinter as pupae and become active adults at about the same time as yellow rocket and forsythia are in bloom. Larvae are small (1/4 inch), white, legless, blunt-ended maggots. Larvae burrow into roots creating brown tunnels in roots and stems near the soil line, causing plants to wilt especially during high temperatures. The rarely seen adult looks similar to a house fly. Eggs are laid at the base of the plant in the soil. There are 3 to 4 generations per year. See Cornell photos of life stages (reference 79) and fact sheets from Penn State (reference 80), Maine (reference 81), and Cornell (reference 82)

Relative risk: Cabbage maggot is a sporadic and sometimes very serious pest but can generally be controlled by the cultural methods recommended below.

Management Option	Recommendation for Cabbage Root Maggot
Scouting/thresholds	A degree-day model to predict the flight periods of cabbage root maggot adults can help growers target the management of this pest. A forecast and history of the flight periods (reference 83) can be obtained through the NYS IPM program's Network for Environment and Weather Awareness (reference 15). In Central New York, adult emergence loosely correlates to the blossoming stage of common plants: overwintering generation -about May 1: yellow rocket bloom; second generation - mid to late June: day lily; third generation- mid-August: Canada thistle; final generation- early September: New England aster. No thresholds have been established for organic production.
Site selection	Soils with high organic matter content are more conducive to cabbage maggot infestations.
Crop rotation	Rotating away from cole crops will help reduce root maggot populations. However, new plantings of cole crops located in nearby fields could still be at risk.
Cover crops	Decomposing organic matter seems to attract egg laying adults. Leave at least 2 to 3 weeks after plowing under a cover crop before planting any brassica crops.
Resistant varieties	No resistant varieties of any cole crops are available, but all varieties become more tolerant of injury after the seedling stage of growth.
Planting and transplants	Newly emerged plants in direct-seeded fields may incur more damage than larger transplanted crops. Delaying planting until soils are warm can reduce damage.
Weeds	Cabbage maggot populations can build on brassica weeds, especially wild mustards in and around the field. Control these weeds to reduce cabbage maggot incidence in subsequent plantings.

Management Option	Recommendation for Cabbage Root Maggot
Barriers	**Spunbonded row covers** can control cabbage maggots through exclusion. After planting seed, install row cover and seal edges. Yields of late plantings may be reduced by row covers. This method is only effective in fields where brassicas were not recently grown since row covers can act to trap emerging flies from the previous crop. **Soil barriers** prevent larvae from entering the soil. Place 5” to 6” circular barriers, made from dark colored felt or similar material, at the base of the stem. Adults lay eggs on the barriers where they dehydrate and die. Eggs can be monitored on dark colored barriers which contrast with the white eggs. For more detail see the Resource Guide for Organic Insect and Disease Management (page 19, reference 6). Straw mulch also acts as a barrier to egg laying, but monitoring eggs is difficult (reference 9).
Natural enemies	Cabbage maggot eggs and small larvae are subject to predation by rove beetles and other ground dwelling predators. Use Cornell’s Guide to Natural Enemies in North America (reference 76) or Natural Enemies of Vegetable Insect Pests (reference 77) for identification of natural enemies. Some experiments have demonstrated that entomopathogenic nematodes can reduce populations of cabbage maggot if applied at high concentrations.
Postharvest	To minimize spread of cabbage maggot, destroy crop debris and bury the pupae by plowing or disking as soon as possible after harvest.
Chemical options	While several organic pesticides are available, none are reported to work well.
Notes	Cabbage maggot eggs often die when soil temperatures are above 95°F for several days as can happen in May and June if soil moisture is low.

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 14.1.1 Pesticides for Management of Cabbage Root Maggot

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre soil drench	0	4	?	Up to 3.5 pts per acre can be used under extreme pest pressure.
AzaGuard (azadirachtin)	10-16 oz/acre soil drench	0	4	?	Use with an OMRI approved spray oil.
AzaSol (azadirachtin)	6 oz/acre	-	4	?	Foliar spray or soil drench.
PyGanic EC 1.4 II (pyrethrins)	16-64 fl.oz./acre	until dry	12	?	

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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

14.2 Flea Beetle, *Phyllotreta striolata* and *P. cruciferae*

Time for concern: Can damage cotyledon, seedling, and mature head. Heavy spring activity normally declines in June.

Key characteristics: Flea beetles are shiny, black, about 1/16 inch long, and jump when disturbed. Flea beetles overwinter as adults in brassica and non-brassica leaf litter and vegetation. Being excellent fliers, they can infest fields quickly from vegetation surrounding fields. In brassicas, the most common flea beetles are *P. cruciferae,* which feeds only on brassicas, and *P. striolata* which has a wider host range. Eggs are laid in the soil near the plants. A second generation of adults emerges in late July or early August. See Cornell fact sheet (reference 84) and the ATTRA publication on flea beetle control (reference 85).

Relative risk: Flea beetles are a consistent annual problem for organic growers in the early spring and again in the fall. Beetles can damage the cosmetic quality and, with high populations, can stunt or kill small plants by chewing holes in the leaves especially during cool springs when plants cannot outgrow damage.

Management Option	Recommendation for Flea Beetle
Scouting/thresholds	**Scout** fields at least weekly in the early season especially on direct-seeded fields. Flea beetles are most active in sunny weather. Reinfestations can occur rapidly. Treatment of cabbage is not usually necessary between six leaves and early headfill unless beetles begin to chew on heads bound for fresh market. **Thresholds** are not established for organic production.
Field selection	Rotate to a non-cole crop after harvest to reduce the buildup of damaging flea beetle populations. Hedgerows and woods can harbor overwintering flea beetles in fields with a history of infestation.
Resistant varieties	While no resistant varieties are available, varieties with shiny, dark green foliage are generally more attractive to flea beetle.
Planting	Waiting until early July to plant brassicas will help break the reproductive cycle and avoid the heavy early season flea beetle activity allowing young plants to outgrow the damage.
Natural enemies	The effect of most natural enemies is not well known. *Microcotonus vittage Muesebeck*, a native braconid wasp, parasitizes and kills the adult flea beetle. Commercially available entomopathogenic nematodes have shown promise in reducing flea beetle larvae in some cases. For sources of commercial producers, see Biological Control: A Guide to Natural Enemies in North America: Nematodes (reference 86).
Barriers	Spunbonded row covers can control flea beetles during the early seedling stage. Install row cover immediately after planting, and seal the edges to keep flea beetles out. This method is only effective in fields where brassicas were not recently grown since row covers can act to trap emerging flies from the previous crop. Yields may be reduced in cole crops grown under row covers.
Trap crops & trapping	Surrounding cole crop fields with Chinese giant mustard or glossy leaf collards, one to 2 weeks before planting, may help reduce migration into the field. It may be necessary to treat the trap crop to prevent movement of flea beetles to the cash crop.
Mulching	Mulching with straw or other organic mulch appears to reduce flea beetle incidence.
Postharvest	Crop debris should be destroyed as soon as possible after harvest to kill larvae feeding on roots.

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 14.2.1 Pesticides for Management of Flea Beetles

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	2	Up to 3.5 pts per acre can be used under extreme pest pressure. Azadirachtin based products effective in 1/3 trials. Foliar spray or soil drench.
AzaGuard (azadirachtin)	8-16 oz/acre	0	4	2	Use with an OMRI approved spray oil. Azadirachtin based products effective in 1/3 trials. Foliar spray or soil drench.
AzaMax (azadirachtin)	1.33 fl oz/ 1000 ft^2	0	4	2	Azadirachtin based products effective in 1/3 trials.
AzaSol (azadirachtin)	6 oz/acre	-	4	2	See comment for AzaMax. Foliar spray or soil drench.
Azatrol-EC (azadirachtin)	0.24-0.96 fl oz/ 1000 ft^2	0	4	2	See comment for AzaMax.
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	-	12	2	See comment for AzaMax. Azera effective in 0/1 trial.
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
Cedar Gard (cedar oil)	1 qt/acre	-	-	?	25(b) pesticide
Ecotec (rosemary oil, peppermint oil)	1-4 pts/100 gal water	-	-	3	25(b) pesticide. Ecotec effective in 0/1 trial.
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	2	See comment for AzaMax. Foliar spray or soil drench.
Entrust (spinosad)	1.25-2.5 oz/acre	1	4	1	Spinosad based products effective in 5/8 trials. For flea beetle suppression.
Entrust SC (spinosad)	4-8 fl.oz./acre	1	4	1	Spinosad based products effective in 5/8 trials. For flea beetle suppression.
Envirepel 20 (garlic juice)	10-32 oz/acre	-	-	?	25(b) pesticide
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	?	Only kills larval stage of insect. See label for specific application volumes.
Molt-X (azadirachtin)	8 oz/acre	0	4	2	See comment for AzaMax.
Neemix 4.5 (azadirachtin)	7-16 fl.oz./acre	0	12	2	See comment for AzaMax. Only kills larval stage of insect.
PFR-97 20% WDG (*Isaria fumosorosea* Apopka str. 97)	1-2 lb/acre Soil treatment	-	4	?	To control grubs and larvae in soil.

Table 14.2.1 Pesticides for Management of Flea Beetles					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
PureSpray Green (white mineral oil)	0.75-1.5 gal/acre	up to day	4	?	Larvae only.
PyGanic EC 1.4 II (pyrethrins)	16-64 fl.oz./acre	until dry	12	1	Pyrethrin based products effective in 4/5 trials.
PyGanic EC 5.0 II (pyrethrins)	4.5-17 fl. oz./acre	-	12	1	Pyrethrin based products effective in 4/5 trials.
Safer Brand #567 II (potassium laurate, pyrethrins)	6.4 oz/ gal water applied at 1 gal mix/700 sq ft	until dry	12	?	Larvae only.
Surround WP (kaolin clay)	25-50 lb/acre	up to day	4	3	Surround effective in 0/4 trials. Suppresses and repels but does not kill.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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

14.3 Diamondback Moth (DBM), *Plutella xylostella*

Time for concern: Early May through harvest. Cold, wet weather conditions will reduce diamondback moth populations. Weather fronts arriving from the south may suddenly increase populations.

Key characteristics: The diamondback moth does not overwinter in upstate New York, but it may on Long Island in warm years. Small, round, yellowish-white eggs are laid singly or in groups of two or three on the underside of leaves or lower stalks. The yellow-green larvae are smaller than those of the cabbage looper or imported cabbage worm, ranging in size from about 1/16 to 1/4 inch, and are distinguished by active wriggling or dropping from the leaf on silk thread when disturbed. Larvae first mine into foliage and when older, feed on the undersides of leaves. Adult moths are small, dark gray/brown with distinguishing light colored triangular markings on the back. They are most active at dusk. See the two Cornell fact sheets (reference 87 and reference 89), Pennsylvania's fact sheet (reference 91) and reference 2.

Relative risk: Diamondback moths damage foliage and cause contamination in the marketable products. While sometimes a serious pest, its damage is variable on a yearly basis. Much of the problem originates from transplants grown in warmer areas.

Management Option	Recommendation for Diamondback Moth
Scouting/thresholds	**Scouting:** Scout weekly. Use the same method and sample simultaneously for imported cabbageworm, cabbage looper, aphids, and thrips. Examine the underside of leaves on plants from at least 10 randomly selected sites throughout the field. For five acres or less, examine two plants per site (20 plants total); for five to 25 acres, examine four plants per site (40 plants total); for each additional five acres, examine four plants at an additional site. **Thresholds:** are in Table 14.5.1 for products footnoted with a "5" in the pesticides table below. These thresholds were developed with conventional insecticides and may need to be adjusted for organic insecticides.
Site selection	Do not plant near previously infested fields
Trap cropping and crop barriers	Success in using trap crops to reduce larval damage has been variable. Yellow rocket has shown promise as a trap crop for diamondback moth in plantings of an acre or less. It attracts moths

Management Option	Recommendation for Diamondback Moth
	to lay eggs, but inhibits larval development. Research suggests planting at least 20% of the field to the trap crop. Yellow rocket is not effective for other caterpillars. Research on trap cropping, especially using collards, has shown mixed results. See Trap Cropping Appendix in the Resource Guide For Organic Insect and Disease Management(reference 6) for more information about trap cropping. Isolating the crop through growing tall barriers of a non-host crop such as sorghum Sudan or sweet corn, can reduce infestations from these low flying pests in small, isolated plantings.
Resistant varieties	No resistant varieties are available. However, varieties do have different levels of susceptibility and should be scouted separately.
Transplants	To prevent DBM from being introduced on transplants, inspect 100 transplants per shipment for the presence of DBM eggs, larvae, or pupae. If more than five percent of the transplants are infested, consider rejecting the load or applying a cleanup insecticide application using an insecticide from a different class than that used by the transplant grower.
Row covers	Floating row covers provide a barrier between the crop and pest, but can be expensive and may reduce crop yields.
Natural enemies	Natural enemies, particularly Diadegma insulare , can reduce DBM populations by >80%. Use Cornell's Guide to Natural Enemies in North America (reference 76) or Natural Enemies of Vegetable Insect Pests (reference 77) for identification of natural enemies. Longevity and effectiveness of the *Diadegma insulare* adult female is increased when nectar is available from sources such as wildflowers. Provide a variety of wildflowers nearby the field since the nectar quality can vary between species. *D. insulare* can be purchased from suppliers of natural enemies.
Weeds	Weeds in the brassica family, such as wild mustard, yellow rocket, and shepherds purse serve as alternate hosts for DBM and can contribute to a quick buildup of populations. See Appendix 1.
Postharvest	Plow down crop residues after harvest to destroy existing eggs and larvae which could build populations over the season.

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 14.3.1 Pesticides for Management of Diamondback Moth

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Agree WG (*Bacillus thuringiensis*)	0.5-2 lb/acre	up to day	4	1	Bt products effective in 6/8 trials. Most effective under warm weather conditions. In locations where the DBM has been documented to be resistant to Bt var. kurstaki, Bt var. aizawai is recommended.

Table 14.3.1 Pesticides for Management of Diamondback Moth					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	1	Up to 3.5 pts per acre can be used under extreme pest pressure. Larvae must ingest azadirachtin, therefore thorough coverage is required. Azadirachtin does not control adults. Azadirachtin based products effective in 5/9 trials. Foliar spray or soil drench.
AzaGuard (azadirachtin)	8-16 oz/acre	0	4	1	Use with an OMRI approved spray oil. Larvae must ingest azadirachtin, therefore thorough coverage is required. Azadirachtin does not control adults. Azadirachtin based products effective in 5/9 trials. Foliar spray or soil drench.
AzaMax (azadirachtin)	1.33 fl oz/ 1000 ft²	0	4	1	Larvae must ingest azadirachtin, therefore thorough coverage is required. Azadirachtin does not control adults. Azadirachtin based products effective in 5/9 trials.
AzaSol (azadirachtin)	6 oz/acre	-	4	1	See comment for AzaMax. Foliar spray or soil drench.
Azatrol-EC (azadirachtin)	0.19-0.96 fl oz/ 1000 ft²	0	4	1	See comment for AzaMax.
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	-	12	1	Azera effective in 1/1 recent trial.
Biobit HP (*Bacillus thuringinensis* subsp. Kurstaki)	0.5-1 lb/acre	0	4	1	See comment for Agree WG.
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
Deliver (*Bacillus thuringinensis* subsp. Kurstaki)	0.25-1.5 lb/acre	0	4	1	See comment for Agree WG.
Dipel DF (*Bacillus thuringinensis* subsp. Kurstaki)	0.5-2 lb/acre	0	4	1	See comment for Agree WG.
Ecotec (rosemary oil, peppermint oil)	1-4 pts/100 gal water	-	-	?	25(b) pesticide
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	1	See comment for AzaMax. Foliar spray or soil drench.
Entrust (spinosad)	0.5-1.25 oz/acre	1	4	1	Spinosad products effective in 41/47 trials against caterpillars including diamondback moth. Resistance to Entrust has been documented in some areas. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house or field plot.
Entrust SC (spinosad)	1.5-4 fl.oz./acre	1	4	1	Spinosad products effective in 41/47 trials against caterpillars including diamondback moth.
Envirepel 20 (garlic juice)	10-32 oz/acre	-	-	?	25(b) pesticide

Table 14.3.1 Pesticides for Management of Diamondback Moth					
Class of Compounds 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.
Grandevo (*Chromobacterium subtsugae* str. PRAA4-1)	1-3 lb/acre	0	4	3	Grandevo effective in 0/1 recent trial.
Javelin WG (*Bacillus thuringinensis* subsp. Kurstaki)	0.12-1.5 lb/acre	0	4	1	See comment for Agree WG.
Molt-X (azadirachtin)	8 oz/acre	0	4	1	See comment for AzaMax.
Neemix 4.5 (azadirachtin)	4-10 fl.oz./acre	0	12	1	See comment for AzaMax.
PFR-97 20% WDG (*Isaria fumosorosea* Apopka str. 97)	1-2 lb/acre soil treatment	-	4	?	Aimed at caterpillars and larvae.
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)	6.4 oz/ gal water applied at 1 gal mix/700 sq ft	until dry	12	?	Larvae only.
XenTari (*Bacillus thuringiensis*, var. aizawai)	0.5-1.5 lb/acre	0	4	1	See comment for Agree WG.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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

14.4 Imported Cabbageworm (ICW), *Pieris rapae*

Time for concern: June 1 through September 30.

Key characteristics: ICW overwinters in New York and is the most common *Lepidoptera* on cole crops in New York. ICW eggs are yellow, bullet-shaped, and are laid perpendicular to the underside of the leaf. Larvae grow to a length of 1 ¼ inch, are velvety green with a light yellow stripe running down their backs, and unlike the DBM, are sluggish if disturbed. Larvae begin feeding on the underside of leaves and then move to the marketable portions of the crop. The conspicuous white butterflies with 1 or 2 black spots on the wings fly from plant to plant during sunny days. Three generations per season are possible in the Northeast. See Cornell fact sheets (references 92 and 93), and photos of larva and adult (page 84 reference 94) or reference 2.

Relative risk: This is the most consistent insect pest of cabbage in New York and can cause considerable damage through chewing on the leaves and head and causing contamination in the marketable product.

Management Option	Recommendations for Imported Cabbageworm
Scouting/thresholds	Watch for adult moths to help indicate the initiation of another generation. Use the same method and scout simultaneously with diamondback moth, cabbage looper, aphids and thrips. Scout weekly throughout the season. Examine plants from at least 10 randomly selected sites throughout the field. For five acres or less, examine two plants per site (20 plants total); for five to 25 acres, examine four plants per site (40 plants total); for each additional five acres, examine four plants at an additional site. **Thresholds** are in Table 14.5.1 for products footnoted with a "5" in the pesticides table below. These thresholds were developed with conventional insecticides and may need to be adjusted for organic insecticides.
Resistant varieties	No resistant varieties are available. However, varieties do differ in susceptibility and should be scouted separately.
Natural enemies	Natural enemies can reduce ICW populations by >40%. *Coleomegilla maculata* is a lady beetle noted to eat ICW eggs and two species of *Apanteles* wasps parasitize ICW larvae. Use Cornell's Guide to Natural Enemies in North America (reference 76) or Natural Enemies of Vegetable Insect Pests (reference 77) for identification of natural enemies.
Weeds	Brassica weeds such as yellow rocket and mustards, serve as alternate hosts allowing populations to build more quickly (see Appendix 1).
Crop barriers	Isolating the crop by growing tall barriers of a non-host crop such as sorghum Sudan or sweet corn, can reduce infestations from these low flying insects in small, isolated plantings.
Postharvest	Crop debris should be destroyed as soon as possible after harvest to minimize the spread of imported cabbageworms to other plantings.

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 14.4.1 Pesticides for Management of Imported Cabbageworm

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Agree WG (*Bacillus thuringiensis*)	0.5-2 lb/acre	up to day	4	1	Most effective under warm weather conditions. Bt products effective in 5/5 trials. Bt works well on imported cabbage worm.
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	3	Up to 3.5 pts per acre can be used under extreme pest pressure. Will not control adults. Azadirachtin based products effective in 0/1 trial. Foliar spray or soil drench.
AzaGuard (azadirachtin)	8-16 oz/acre	0	4	3	Use with an OMRI approved spray oil.Will not control adults. Azadirachtin based products effective in 0/1 trial.Foliar spray or soil drench.
AzaMax (azadirachtin)	1.33 1000 sq ft	0	4	3	Will not control adults. Azadirachtin based products effective in 0/1 trial.

Table 14.4.1 Pesticides for Management of Imported Cabbageworm

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
AzaSol (azadirachtin)	6 oz/acre	-	4	3	See comment for AzaMax. Foliar spray or soil drench.
Azatrol-EC (azadirachtin)	0.19-0.96 1000 sq ft	0	4	3	See comment for AzaMax.
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	-	12	1	Azera effective in 1/1 recent trial.
Biobit HP (*Bacillus thuringinensis* subsp. Kurstaki)	0.5-1 lb/acre	0	4	1	See comment for Agree WG.
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
Deliver (*Bacillus thuringinensis* subsp. Kurstaki)	0.25-1.5 lb/acre	0	4	1	See comment for Agree WG.
Dipel DF (*Bacillus thuringinensis* subsp. Kurstaki)	0.5-2 lb/acre	0	4	1	See comment for Agree WG.
Ecotec (rosemary oil, peppermint oil)	1-4 pts/100 gal water	-	-	?	25(b) pesticide
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	3	See comment for AzaMax. Foliar spray or soil drench.
Entrust (spinosad)	1-2 oz/acre	1	4	1	Resistance to Entrust has been documented in some areas. Do not apply to seedling cole crops grown for transplant within a greenhouse, shade house or field plot. Spinosad products effective in 41/47 trials against caterpillars including imported cabbageworm.
Entrust SC (spinosad)	3-6 fl.oz./acre	1	4	1	Spinosad products effective in 41/47 trials against caterpillars including imported cabbageworm.
Envirepel 20 (garlic juice)	10-32 oz/acre	-	-	?	25(b) pesticide
Garlic Barrier AG (garlic juice)	See comments	-	-	?	25(b) pesticide. See label for specific information.
Grandevo (*Chromobacterium subtsugae* str. PRAA4-1)	1-3 lb/acre	0	4	3	Grandevo effective in 0/1 recent trial.
Javelin WG (*Bacillus thuringinensis* subsp. Kurstaki)	0.12-1.5 lb/acre	0	4	1	See comment for Agree WG.
Molt-X (azadirachtin)	8 oz/acre	0	4	3	See comment for AzaMax.
Neemix 4.5 (azadirachtin)	4-10 fl.oz./acre	0	12	3	See comment for AzaMax.
PFR-97 20% WDG (*Isaria fumosorosea* Apopka str. 97)	1-2 lb/acre soil drench	-	4	?	
PureSpray Green (white mineral oil)	0.75-1.5 gal/acre	up to day	4	?	

Table 14.4.1 Pesticides for Management of Imported Cabbageworm

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
PyGanic EC 1.4 II (pyrethrins)	16-64 fl.oz./acre	until dry	12	1	Pyrethrum based products effective.
PyGanic EC 5.0 II (pyrethrins)	4.5-17 fl. oz./acre	-	12	1	Pyrethrum based products effective.
Safer Brand #567 II (potassium laurate, pyrethrins)	6.4 oz/ gal water applied at 1 gal mix/700 sq ft	until dry	12	?	
XenTari (*Bacillus thuringiensis, var.* aizawai)	0.5-1.5 lb/acre	0	4	1	See comment for Agree WG.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label. 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. [2] Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

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14.5 Cabbage Looper, Trichoplusia ni

Time for concern: August 1 through harvest. Cold, wet weather conditions will reduce cabbage looper populations. Favorable weather fronts from the south may suddenly increase populations.

Key characteristics: Because adults are nocturnal, the gray, non-descript moths are seldom seen. White, round eggs, the size of a pinhead, are laid on the undersides of leaves. Larvae are up to 1 ½ inches long, light green with white strips along each side of the body and can be distinguished by the looping movement they use to travel. See Cornell's description of life stages (reference 95), photo of larvae (page 84 reference 96) and fact sheet (98), or references 2 and 97.

Relative risk: Because cabbage looper does not overwinter in New York, infestations are variable and depend on weather fronts to move them in from areas further south. Larvae feed on leaves and heads causing plant stress and contamination at harvest.

Management Option	Recommendation for Cabbage Looper
Scouting/thresholds	**Scouting:** Use the same method and frequency as for diamondback moth, imported cabbageworm, thrips and aphids. Examine plants for eggs and larvae from at least 10 randomly selected sites throughout the field. For fields less than five acres, examine two plants per site (20 plants total); for five to 25 acres, examine four plants per site (40 plants total); for each additional five acres, examine four plants at an additional site. **Thresholds:** are in Table 14.5.1 for products footnoted with a "5" in the pesticides table below. These thresholds were developed with conventional insecticides and may need to be adjusted for organic insecticides.
Transplants	Watch for CL if transplants were grown in southern states.
Resistant varieties	No resistant varieties are available. However, varieties do differ in susceptibility and should be scouted separately.
Barrier crop	Isolating the crop through growing tall barriers of a non-host crop such as sorghum Sudan or sweet corn, can reduce infestations from these low flying pests in small isolated plantings.
Natural enemies	Natural enemies may help to control CL populations. Use Cornell's Guide to Natural Enemies in North America (reference 76) or Natural Enemies of Vegetable Insect Pests (reference 77) to identify natural enemies.

Management Option	Recommendation for Cabbage Looper
Weeds	Cabbage looper feeds on many different weed species which may support the buildup of populations.
Postharvest	Plow down crop residues after harvest to destroy existing eggs and larvae which could build populations over the season.

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 14.5.1 Pesticides for Management of Cabbage Looper

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Agree WG (Bacillus thuringiensis)	0.5-2 lb/acre	up to day	4	1	Most effective under warm weather conditions. Bt products effective in 6/7 trials.
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	1	Up to 3.5 pts per acre can be used under extreme pest pressure. Azadirachtin will not control adults. Azadirachtin based products effective in 2/4 trials. Foliar spray or soil drench.
AzaGuard (azadirachtin)	8-16 oz/acre	0	4	1	Use with an OMRI approved spray oil. Azadirachtin will not control adults. Azadirachtin based products effective in 2/4 trials. Foliar spray or soil drench.
AzaMax (azadirachtin)	1.33 fl. oz./ 1000 sq ft	0	4	1	Azadirachtin will not control adults. Azadirachtin based products effective in 2/4 trials.
AzaSol (azadirachtin)	6 oz/acre	-	4	1	See comment for AzaMax. Foliar spray or soil drench.
Azatrol-EC (azadirachtin)	0.19-0.96 1000 sq ft	0	4	1	See comment for AzaMax.
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	-	12	1	See comment for AzaMax.
Biobit HP (Bacillus thuringinensis subsp. Kurstaki)	0.5-1 lb/acre	0	4	1	Most effective under warm weather conditions. Bt products effective in 6/7 trials.
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
Deliver (Bacillus thuringinensis subsp. Kurstaki)	0.25-1.5 lb/acre	0	4	1	See comment for Agree WG.
Dipel DF (Bacillus thuringinensis subsp. kurstaki)	0.5-1.5 lb/acre	0	4	1	See comment for Agree WG.
Ecotec (rosemary oil, peppermint oil)	1-4 pts/100 gal water	-	-	?	25(b) pesticide
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	1	See comment for AzaMax. Foliar spray or soil drench.

Table 14.5.1 Pesticides for Management of Cabbage Looper

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Entrust (spinosad)	1-2 oz/acre	1	4	1	Resistance to Entrust has been documented in some areas. Spinosad products effective in 41/47 trials against caterpillars including cabbage looper.
Entrust SC (spinosad)	3-6 fl.oz./acre	1	4	1	Spinosad products effective in 41/47 trials against caterpillars including cabbage looper.
Envirepel 20 (garlic juice)	10-32 oz/acre	-	-	?	25(b) pesticide
Garlic Barrier AG (garlic juice)	See comments	-	-	?	25(b) pesticide. See label for specific information.
Grandevo (*Chromobacterium subtsugae* str. PRAA4-1)	1-3 lb/acre	0	4	?	
Javelin WG (Bacillus thuringinensis subsp. Kurstaki)	0.12-1.5 lb/acre	0	4	1	See comment for Agree WG.
Molt-X (azadirachtin)	8 oz/acre	0	4	1	See comment for AzaMax.
Neemix 4.5 (azadirachtin)	7-16 fl.oz./acre	0	12	1	See comment for AzaMax.
Omni Supreme Spray (mineral oil)	1-2 gal/acre	-	12	?	Use in combination with other insecticides registered for use on these crops.
PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97)	1-2 lb/acre soil drench	-	4	?	
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	Pyrethrum based products effective in older trials.
PyGanic EC 5.0 II (pyrethrins)	4.5-17 fl. oz./acre	-	12	1	Pyrethrum based products effective in older trials.
Safer Brand #567 II (potassium laurate, pyrethrins)	6.4 oz/ gal water applied at 1 gal mix/ 700 sq ft	until dry	12	?	
SuffOil-X (aliphatic petroleum solvent)	1-2 gal/100 gal water	up to day	4	?	Do not mix with sulfur products.
TriTek (mineral oil)	1-2 gal/100 gal water	up to day	4	?	Apply as needed.
XenTari (*Bacillus thuringiensis*, var. aizawai)	0.5-1.5 lb/acre	0	4	1	See comment for Agree WG.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label. 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. [2] Note that when the REI is longer than the PHI, Worker Protection Standard requirements may necessitate waiting until after REI to harvest.

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Table 14.5.1 Thresholds for Diamondback Moth, Imported Cabbageworm, and Cabbage Looper on Cabbage, Cauliflower, Broccoli, and Brussels Sprouts.
These thresholds were developed with conventional insecticides and may need to be adjusted for organic insecticides. See notations in each pest section.

	% Cabbage Plants Infested			% Cauliflower, Broccoli, & Brussels Sprouts Infested
	Kraut	Storage	Fresh	Fresh
Seedling (cotyledon)	20	20	20	20
Early vegetative to cupping	30	30	30	30
Early head to harvest	30	15	5	—
Curd initiation	—	—	—	10
Curd development and maturation	—	—	—	2.5

14.6 Aphids: Cabbage Aphid, *Brevicoryne brassicae*, and Green Peach Aphid, *Myzus persicae*

Time for concern: June 15 through harvest but most prevalent later in the season. Aphid populations can increase rapidly during hot weather or decline during periods of heavy rainfall.

Key characteristics: Cabbage aphids are grayish green, but often appear bluish white because of their waxy coating. Green peach aphids can be green, pink, red, or dark brown with wings. Both aphids are between 1/32 and 1/16 inch long. Plant growth may be stunted by aphid feeding. See reference 4 or Cornell fact sheet (reference 99), Minnesota fact sheet (reference 100), photo of the cabbage aphid (page 84,reference 101),and fact sheet for the Green Peach Aphid (reference 102).

Relative risk: Aphids are rarely a problem in organic systems, where broad-spectrum insecticides are rarely used. Cabbage aphids can be a problem in late fall, when cool temperatures and short days reduce the activity of natural enemies. Heavy infestations can stunt growth and cause leaves to yellow, curl, and die. Contamination from aphids can make the harvested crop unmarketable depending on market tolerance.

Management Option	Recommendation for Aphids
Scouting/thresholds	**Scouting:** Use the same method and sample each week simultaneously with diamondback moth, imported cabbageworm, cabbage looper, and thrips. Examine plants at a minimum of ten randomly selected sites throughout the field. For fields less than 5 acres, examine two plants per site (20 plants total); for five to 25 acres, examine four plants per site (40 plants total); for each additional five acres, examine four plants at an additional site. **Thresholds**: treat when a localized infestation is found.
Resistant varieties	Resistance information is not available although some varieties are known to be more susceptible. Aphids are a particular problem on savoy cabbage.
Natural enemies	Naturally occurring predators, parasitoids, and pathogens help suppress aphid populations. *Coleomegilla maculate*, a lady beetle, *Chrysoperla carnea*, the green lacewing, and *Aphidoletes aphidimyza*, the aphid midge are particularly helpful in reducing aphid populations although usually more effective for green peach aphid. Predators tend to come in later in the season, after aphid populations are established making early control sometimes necessary. Increases in aphid infestations are often associated with applications of broad spectrum insecticides like pyrethrins that also kill natural enemies. Use Cornell's Guide to Natural Enemies in North America (reference 76) or Natural Enemies of Vegetable Insect Pests (reference 77) to identify natural enemies.

Management Option	Recommendation for Aphids
Weeds	Destroy weeds around the field.
Barrier crops	Isolating the cole crop through growing tall barriers of a non-host crop such as sorghum Sudan or sweet corn, can reduce infestations from aphids in small, isolated plantings but will not protect from aphids arriving on storm fronts.
Mulches	Reflective foil mulches may slow down colonization of plants by winged aphids.
Postharvest	Crop debris should be destroyed as soon as possible 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 14.6 Pesticides for Management of Aphids

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	1	Up to 3.5 pts per acre can be used under extreme pest pressure. These products must be ingested, therefore thorough coverage is required. Efficacy depends on formulation and type of aphid. Azadirachtin based products effective in 4/7 trials against green peach aphid and 3/4 trials against other aphids.
AzaGuard (azadirachtin)	10-16 oz/acre	0	4	1	Use with an OMRI approved spray oil. These products must be ingested, therefore thorough coverage is required. Efficacy depends on formulation and type of aphid. Azadirachtin based products effective in 4/7 trials against green peach aphid and 3/4 trials against other aphids.
AzaMax (azadirachtin)	1.33 fl oz/ 1000 ft^2	0	4	1	These products must be ingested, therefore thorough coverage is required. Efficacy depends on formulation and type of aphid. Azadirachtin based products effective in 4/7 trials against green peach aphid and 3/4 trials against other aphids.
AzaSol (azadirachtin)	6 oz/ acre	-	4	1	See comment for AzaMax.
Azatrol-EC (azadirachtin)	0.24-0.96 fl oz/ 1000 ft^2	0	4	1	See comment for AzaMax.
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	-	12	1	See comment for AzaMax.
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
BioRepel (garlic oil)	1 part BioRepel: 100 parts water	-	-	2	25(b) pesticide. Plant and petroleum based oils effective in 2/5 trials.
DES-X (insecticidal soap)	2% solution sprayed at 75-200 gals/acre	0	12	?	

Table 14.6 Pesticides for Management of Aphids					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
Ecotec (rosemary oil, peppermint oil)	1-4 pts/100 gal water	-	-	?	25(b) pesticide
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	1	See comment for AzaMax.
Envirepel 20 (garlic juice)	10-32 oz/acre	-	-	?	25(b) pesticide
Garlic Barrier AG (garlic juice)	See comments	-	-	?	25(b) pesticide. See label for specific information.
GC-Mite (garlic oil, clove oil, cottonseed oil)	1 gal/100 gal water	-	-	2	25(b) pesticide. Plant and petroleum based oils effective in 2/5 trials. Check compatibility by spraying a small number of plants.
Glacial Spray Fluid (mineral oil)	0.75-1 gal/100 gal water	up to day	4	?	See label for specific application volumes. Plant and petroleum based oils effective in 2/5 trials.
Grandevo (*Chromobacterium subtsugae* str. PRAA4-1)	2-3 lb/acre	0	4	?	
GrasRoots (cinnamon oil)	1 part GrasRoots to 9 parts water	-	-	?	25(b) pesticide.
Molt-X (azadirachtin)	10 oz/acre	0	4	1	See comment for AzaMax.
M-Pede (insecticidal soap)	1-2% volume to volume	0	12	2	Soap products effective in 0/9 trials against green peach aphid. Soap products effective in 6/8 trials against other aphids. Apply when aphid populations are low. For green peach aphid control, must tank mix M-Pede with a labeled companion insecticide. For other aphid control, use M-Pede in combination with another labeled product.
Neemix 4.5 (azadirachtin)	5-7 fl.oz./acre	0	12	1	See comment for AzaMax. Only labeled for green peach aphid.
Oleotrol-I Bio-Insecticide Concentrate (soybean oil)	43-45 fl.oz./100 gal water	-	-	2	25(b) pesticide. Plant and petroleum based oils effective in 2/5 trials.
Omni Supreme Spray (mineral oil)	1-2 gal/acre	-	12	2	Use in combination with other insecticides registered for use on these crops. Plant and petroleum based oils effective in 2/5 trials.
Organocide (sesame oil)	1-2 gal/100 gal water	0	-	2	25(b) pesticide. Plant and petroleum based oils effective in 2/5 trials.
PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97)	1-2 lb/acre soil drench	-	4	?	
PureSpray Green (white mineral oil)	0.75-1.5 gal/acre	up to day	4	2	Plant and petroleum based oils effective in 2/5 trials.
PyGanic EC 1.4 II (pyrethrins)	16-64 fl.oz./acre	until dry	12	2	Effective in older trials against cabbage aphid. Effective in 1/3 trials against green peach aphid
PyGanic EC 5.0 II (pyrethrins)	4.5-17 fl.oz./acre	-	12	2	See comment for PyGanic EC 1.4 II.

Table 14.6 Pesticides for Management of Aphids					
Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Safer Brand #567 II (potassium laurate, 🐝pyrethrins)	6.4 oz/ gal water applied at 1 gal mix/ 700 sq ft	until dry	12	?	
Sil-Matrix (potassium silicate)	0.5-1% solution	up to day	4	?	
SuffOil-X (aliphatic petroleum solvent)	1-2 gal/100 gal water	up to day	4	2	Do not mix with sulfur products. Plant and petroleum based oils effective in 2/5 trials.
Trilogy (🐝neem oil)	0.5-1% solution in 25-100 gals water/A	up to day	4	1	Maximum of 2 gal/acre/application. Bee Hazard. This product is toxic to bees exposed to direct contact
TriTek (mineral oil)	1-2 gal/100 gal water	up to day	4	2	Apply as needed. See comment for PureSpray Green.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label. 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. [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

14.7 Onion Thrips, Thrips tabaci

Time for concern: As cabbage heads begin to form through harvest. Populations are favored by hot dry weather and decrease with heavy rain or overhead irrigation.

Key characteristics: Onion thrips vary in color but typically larvae are yellow and adults brown, are 1/16 inch in length, and move rapidly. They cause rough, bronzed areas on leaves, especially the light-colored inner leaves. Adults survive on overwintering clover, alfalfa, and wheat rather than in onion or cabbage plant residues. See Cornell fact sheets (references 103 and 104) or reference 2.

Relative risk: Infestations from onion thrips cause cosmetic damage to the leaves within mature heads of cabbage. Serious infestations make cabbage unmarketable. They are a consistent problem if growing susceptible cabbage varieties but are not normally a pest of broccoli, Brussels sprouts or cauliflower.

Management Option	Recommendation for Onion Thrips
Scouting/thresholds	**Scout** fields weekly. Use this same method and sample simultaneously for diamondback moth, imported cabbageworm, cabbage looper, and aphids. Examine plants from at least 10 randomly selected sites throughout the field. For fields less than 5 acres, examine two plants per site (20 total plants); for five to 25 acres, examine four plants per site (40 plants total); for each additional five acres, examine four plants at an additional site. Varieties have different susceptibilities and should be scouted and treated separately. **Thresholds** for organic production have not been established.
Site selection	Onion thrips will move into cabbage fields from onion plantings or harvested fields of small grains, alfalfa and clover. Do not plant sensitive varieties near these fields.
Cover crops	Cover crops are likely to harbor thrips populations, therefore use resistant varieties if cover crops are overwintered in the field.

Management Option	Recommendation for Onion Thrips
Resistant varieties	The primary method of controlling thrips is through use of tolerant cabbage varieties. See Section 6: *Varieties* for more information on resistance. Even tolerant varieties may be injured during hot, dry summers, but their injury will be far less than on more susceptible varieties.
Natural enemies	The effects of natural enemies on thrips populations are not well understood.
Planting	In general, thrips damage is less in fields planted in late June or early July. Expect more damage in earlier plantings especially those with longer growing requirements.
Harvest	Harvesting highly susceptible cabbage varieties prior to full maturity will decrease the injury that would normally occur.
Postharvest	Plow under plant debris after harvest and choose a winter-killed cover crop to deprive thrips of overwintering sites.
Chemical control	Use an NOP compliant surfactant to ensure good coverage.

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 14.7.1 Pesticides for Management of Onion Thrips

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	2	Up to 3.5 pts per acre can be used under extreme pest pressure. Azadirachtin based products effective in 0/11 trials against thrips spp. and effective in 1/1 trial against onion thrips.
AzaGuard (azadirachtin)	10-16 oz/acre soil drench	0	4	2	Use with an OMRI approved spray oil. Azadirachtin based products effective in 0/11 trials against thrips spp. and effective in 1/1 trial against onion thrips.
AzaMax (azadirachtin)	1.33 fl. oz./ 1000 sq ft	0	4	2	Azadirachtin based products effective in 0/11 trials against thrips spp. and effective in 1/1 trial against onion thrips.
AzaSol (azadirachtin)	6 oz/acre	-	4	2	See comment for AzaMax.
Azatrol-EC (azadirachtin)	0.24-0.96 1000 sq ft	0	4	2	See comment for AzaMax.
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
BioRepel (garlic oil)	1 part BioRepel with 100 parts water	-	-	3	25(b) pesticide. Plant and petroleum oil products effective in 0/2 trials.
Ecotec (rosemary oil, peppermint oil)	1-4 pts/100 gal water	-	-	3	25(b) pesticide. Plant and petroleum oil products effective in 0/2 trials.

Table 14.7.1 Pesticides for Management of Onion Thrips

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	2	See comment for AzaMax.
Entrust (spinosad)	1.25-3 oz/acre	1	4	1	Spinosad based products effective in 12/17 trials against onion thrips. Efficacy better with adjuvant.
Entrust SC (spinosad)	4-10 fl.oz./acre	1	4	1	Spinosad based products effective in 12/17 trials against onion thrips.
GC-Mite (garlic oil, clove oil, cottonseed oil)	1 gal/100 gal water	-	-	3	25(b) pesticide. Plant and petroleum oil products effective in 0/2 trials.
Glacial Spray Fluid (mineral oil)	0.75-1 gal/100 gal water	up to day	4	3	See label for specific application volumes. Plant and petroleum oil products effective in 0/2 trials.
Grandevo (Chromobacterium subtsugae str. PRAA4-1)	2-3 lb/acre	0	4	?	
GrasRoots (cinnamon oil)	1 part GrasRoots to 9 parts water	-	-	?	25(b) pesticide.
Molt-X (azadirachtin)	10 oz/acre	0	4	2	See comment for AzaMax.
M-Pede (insecticidal soap)	1-2% volume to volume	0	12	3	Effective in 0/6 trials against thrips spp.
Oleotrol-I Bio-Insecticide Concentrate (soybean oil)	43-45 fl.oz./100 gal water	-	-	3	25(b) pesticide. Plant and petroleum oil products effective in 0/2 trials.
Omni Supreme Spray (mineral oil)	1-2 gal/acre	-	12	3	Use in combination with other insecticides registered for use on these crops. Plant and petroleum oil products effective in 0/2 trials.
Organocide (sesame oil)	1-2 gal/100 gal water	0	-	3	25(b) pesticide. Plant and petroleum oil products effective in 0/2 trials.
PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97)	1-2 lb/acre soil drench	-	4	?	
PureSpray Green (white mineral oil)	0.75-1.5 gal/acre	up to day	4	3	Plant and petroleum oil products effective in 0/2 trials.
PyGanic EC 1.4 II (pyrethrins)	16-64 fl.oz./acre	Until Dry	12	1	
PyGanic EC 5.0 II (pyrethrins)	4.5-17 fl. oz./acre	-	12	1	
SuffOil-X (aliphatic petroleum solvent)	1-2 gal/100 gal water	up to day	4	3	Plant and petroleum oil products effective in 0/2 trials.
Trilogy (neem oil)	0.5% solution in 25-100 gals water/A	Up to day of harvest	4	3	Maximum of 2 gal/acre/application.Neem oil effective in 0/1 trial. Suppression only.Bee Hazard. This product is toxic to bees exposed to direct contact

Table 14.7.1 Pesticides for Management of Onion Thrips					
Class of Compounds 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	3	Plant and petroleum oil products effective in 0/2 trials.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label. 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. [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

14.8 Swede Midge, Contarinia nasturtii

Time of concern: May 15 through September 30

Key characteristics: Swede midge feeds on cabbage, broccoli, cauliflower, and Brussels sprouts as well as many other brassicas. Adults emerge from pupae in the spring and are tiny (1.5-2 mm) light brown flies identifiable only with special training. These weak fliers can be blown from field to field on light winds. During their short lives (3 to 4 days), females lay clusters of microscopic eggs in the growing tip of young plants or shoots. Larvae are small maggots initially about 0.3 mm in length before reaching their final size of 3 to 4 mm. They are lemon yellow at maturity. Up to 4 to 5 generations can occur annually. Pupae have survived in soils for over a year. See Cornell fact sheet (reference 105) and swede midge information center (reference 106)

Relative Risk: Swede midge is a new and increasing threat to brassicas in New York. It will be especially problematic on farms where rotation out of brassicas is not practiced and on organic farms since extensive laboratory tests have not identified any effective organic products. Brassicas can tolerate low populations, but if allowed to build, damage can be serious enough to result in areas where they can no longer be grown as seen in parts of Ontario, Canada. Growing tips may become distorted by larval feeding and produce several growing tips or none at all. Young leaves may become swollen, crinkled or crumpled. Brown scarring may be seen on the leaf petioles or stems and galls may form on flowers and leaves. Damage is most severe on broccoli but Brussels sprouts, cauliflower and red cabbage are also prone to Swede Midge.

Management Option	Recommendation for Swede Midge
Scouting/thresholds	**Scouting:** Swede midge injury is difficult to diagnose and can be confused with mechanical injury, other insect feeding, nutrient deficiencies, wildlife feeding, herbicide injury or stress from heat or cold. Confirm swede midge larval feeding by dissecting the growing points of plants exhibiting unusual growth habits. Using a hand lens, look for larvae or evidence of their feeding expressed as brown, corky scarring in growing tips. Larvae can be forced from the growing tips for easier identification by placing the tissue in a vial of alcohol or in a clear plastic bag in the sun. Scout cabbage prior to head development. Populations are typically higher in sheltered areas of the field near hedgerows. Pheromone traps are available to detect early populations but identification of the adult midge is difficult and requires training. **Threshold:** none has been established for organic production.
Site selection	Damage tends to be most severe in sheltered areas such as near hedges or in fields surrounded by brassica weeds where midges overwinter. The swede midge prefers moist soils.
Crop rotation	Due to the short life cycle of SM, populations can build quickly making crop rotation one of the most important management tools for growers. Because SM may survive in the soil for 2 or more years, avoid cole crops in a rotation or in nearby fields for 3 years. Planting in isolated locations or upwind from fields previously in brassicas can decrease the chance of infestations arriving by wind.

Management Option	Recommendation for Swede Midge
Resistant varieties	Broccoli is the most susceptible crop. The broccoli variety, Paragon, consistently sustains high levels of swede midge damage. Eureka and Packman are also susceptible. Cauliflower and Brussels sprouts appear to be more susceptible than cabbage, with red cabbage being more susceptible than green cabbage although heavy infestations can cause damage in all cole crops.
Barrier crops	Isolating the crop through growing tall barriers of a non-host crop such as sorghum Sudan or sweet corn, may reduce infestations from these low flying insects in small, isolated plantings.
Planting	Planting brassica crops early in the season can reduce damage levels and population growth provided the field was not planted to cole crops the previous fall. The first generation of SM emerges in mid to late May in New York. Planting brassicas early allows young plants to grow past the most susceptible early stages of growth before SM populations begin to build. Target a mid-July harvest date when SM populations are highest. Avoid late season plantings to help to reduce the overwintering population of pupae in the soil. This strategy will not work for long season cole crops like Brussels sprouts. Infested transplants can provide an avenue of contamination for the farm. Use transplants grown in the Northeast or other cool season areas.
Weeds	Brassica weeds such as shepherds purse, mustard, pennycress, wild radish, and yellow rocket are alternate hosts although swede midge prefers brassica crops to weeds. See Appendix 1 for more brassica weeds.
Exclusion	Install polamide insect netting over pvc hoops to exclude swede midge from the crop. Use 25 grams/m^2 weight netting such as ProtekNet Insect Netting
Post Harvest	Immediate destruction of crop residue after harvest is one of the most important management strategies. Deep plowing of infested crop residue will bury overwintering pupae.

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 14.8.1 Pesticides for Management of Swede Midge

Class of Compounds Product Name (Active Ingredient)	Product Rate	PHI[2] (Days)	REI (Hours)	Efficacy	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	Up to 3.5 pts per acre can be used under extreme pest pressure. Foliar spray or soil drench.
AzaGuard (azadirachtin)	8-16 oz/acre	0	4	?	Use with an OMRI approved spray oil. Foliar spray or soil drench.
Azatrol-EC (azadirachtin)	0.24-0.96 1000 sq ft	0	4	?	
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	-	12	2	Azera effective in 1/2 recent trials.
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	?	
Molt-X (azadirachtin)	10 oz/acre	0	4	?	
PyGanic EC 1.4 II (pyrethrins)	16-64 fl.oz./acre	until dry	12	?	

Table 14.8.1 Pesticides for Management of Swede Midge					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
PyGanic EC 5.0 II (pyrethrins)	4.5-17 fl.oz./acre	-	12	?	

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label. 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. [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. SLUGS

Time of concern: Early spring and fall or if conditions are damp.

Key characteristics: Adult slugs are between one and two inches in length. 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 them protection. 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, extensive feeding may persist in damp areas. See Cornell fact sheet (reference 107).

Relative Risk: Slugs are a particular problem in wet periods during the spring and fall. Their feeding can kill seedlings in the spring. During the season, they feed on mature leaves and heads. Slugs and their droppings can cause contamination at harvest.

Management Option	Recommendation for Slugs
Scouting/thresholds	Record the occurrence and severity of slug damage. No thresholds have been established.
Resistant varieties	No resistant varieties are available.
Note	Practices that help dry the soil surface (e.g. conventional tillage and good weed control) will reduce slug populations.

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 15.1 Pesticides for Management of Slugs					
Class of Compounds Product Name (Active Ingredient)	**Product Rate**	**PHI[2] (Days)**	**REI (Hours)**	**Efficacy**	**Comments**
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
Bug-N-Sluggo (spinosad, iron phosphate)	20-44 lb/acre soil treatment	1	4	?	

Sluggo AG (iron phosphate)	20-44 lb/acre soil treatment	0	0	?	Apply in the evening to moist soil. Scattering the bait around the perimeter of the vegetable plantings to provide a protective "barrier". If slugs are inside the barrier, scatter bait on the soil around the plants and between rows. Do not place in piles.
Sluggo Slug and Snail Bait (iron phosphate)	20-44 lb/acre soil treatment	0	0	?	Scatter bait around perimeter of vegetable planting.

PHI = pre-harvest interval, REI = restricted entry interval. - = pre-harvest interval isn't specified on label.
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. [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

16. Pesticides and Abbreviations Mentioned in this Publication

Table 16.1 Insecticides and Slug Control Products

TRADE NAME	ACTIVE INGREDIENT	EPA REG. NO.
Agree WG	*Bacillus thuringiensis*, var. *aizawai*	70051-47
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
Biobit HP	*Bacillus thuringiensis,* var. *kurstaki*	73049-54
BioLink	*garlic juice*	Exempt - 25(b) pesticide
BioLink Insect & Bird Repellant	*garlic juice*	Exempt - 25(b) pesticide
BioRepel	*garlic oil*	Exempt - 25(b) pesticide
Bug-N-Sluggo	*iron phosphate and spinosad*	67702-24-70051
Cedar Gard	*cedar oil*	Exempt 25(b) pesticide
Deliver	*Bacillus thuringiensis* var. *kurstaki*	70051-69
DES-X	*insecticidal soap*	67702-22-70051
Dipel DF	*Bacillus thuringiensis,* var. *kurstaki*	73049-39
Ecotec	*rosemary and peppermint oil*	Exempt - 25(b) pesticide
Ecozin Plus	*azadirachtin*	5481-559
Entrust	*spinosad*	62719-282
Entrust SC	*spinosad*	62719-621
Envirepel 20	*garlic juice*	Exempt - 25(b) pesticide
Garlic Barrier AG	*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,* var. *kurstaki*	70051-66
M-Pede	*potassium salts of fatty acids*	10163-324
MeloCon WG	*Paecilomyces lilacinus str. 251*	72444-2
Molt-X	*azadirachtin*	68539-11

Table 16.1 Insecticides and Slug Control Products

TRADE NAME	ACTIVE INGREDIENT	EPA REG. NO.
Neemix 4.5	*azadirachtin*	70051-9
Oleotrol-I	*soybean oil*	Exempt - 25(b) pesticide
Omni Supreme Spray	*mineral oil*	5905-368
Organocide 3-in-1	*sesame oil*	Exempt - 25(b) pesticide
PFR-97™ 20% WDG	*Isaria fumosorosea Apopka Strain 97*	70051-19
PyGanic EC 1.4$_{II}$	*pyrethrin*	1021-1771
PyGanic EC 5.0$_{II}$	*pyrethrin*	1021-1772
PureSpray Green	*petroleum oil*	69526-9
Safer Brand #567 Pyrethrin & Insecticidal Soap Concentrate II	*pyrethrin, potassium salts of fatty acids*	59913-9
Sil-Matrix	*potassium silicate*	82100-1
Sluggo-AG	*iron phosphate*	67702-3-54705
Sluggo Slug & Snail Bait	*iron phosphate*	67702-3-70051
SuffOil-X	*aliphatic petroleum solvent*	48813-1-68539
Surround WP	*kaolin clay*	61842-18
Trilogy	*neem oil*	70051-2
TriTek	*mineral oil*	48813-1
XenTari	*Bacillus thuringiensis*, var. aizawai	73049-40

Active ingredient meets EPA criteria for acute toxicity to bees

Table 16.2 Fungicides and Nematicides

TRADE NAME	ACTIVE INGREDIENT	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	*copper sulfate*	45002-8
BIO-TAM	*Trichoderma asperellum, Trichoderma gamsii)*	80289-9-69592
BIO-TAM 2.0	*Trichoderma asperellum, Trichoderma gamsii*)	80289-9
Champ WG	*copper hydroxide*	55146-1
ChampION++	*copper hydroxide*	55146-115
Contans WG	*Coniothyrium minitans*	72444-1
CS 2005	*copper sulfate pentahydrate*	66675-3
Cueva Fungicide Concentrate	*copper octanoate*	67702-2-70051
DiTera DF	*Myrothecium verrucaria str.AARC-0255*	73049-67
Double Nickel 55 Biofungicide	Bacillus amyloliquefaciens str. D747	70051-108
Double Nickel LC Biofungicide	Bacillus amyloliquefaciens str. D747	70051-107
Milstop	*potassium bicarbonate*	70870-1-68539
Mycostop Biofungicide	*Streptomyces griseoviridis K61*	64137-5
Mycostop Mix	*Streptomyces griseoviridis K61*	64137-9
Nordox 75 WG	*cuprous oxide*	48142-4
Nu Cop 50WP	*copper hydroxide*	45002-7
Nu-Cop 50DF	*copper hydroxide*	45002-4
Nu-Cop HB	*cupric hydroxide*	42750-132
Optiva	*Bacillus subtilis str. QST 713*	69592-26
Organic JMS Stylet Oil	*paraffinic oil*	65564-1
Organocide 3-in-1	*sesame oil*	Exempt - 25(b) pesticide

Table 16.2 Fungicides and Nematicides

TRADE NAME	ACTIVE INGREDIENT	EPA REG. NO.
OxiDate 2.0	*hydrogen dioxide, peroxyacetic acid*	70299-12
PERpose Plus	*hydrogen peroxide/dioxide*	86729-1
Prestop Biofungicide	*Gliocladium catenulatum str. J1446*	64137-11
PureSpray Green	*petroleum oil*	69526-9
Regalia Biofungicide	*Reynoutria sachalinensis*	84059-3
RootShield Granules	*Trichoderma harzianum str. T-22*	68539-3
RootShield PLUS+ Granules	*Trichoderma harzinanum str. T-22* *Trichoderma virens str. G-41*	68539-10
RootShield PLUS+ WP	*Trichoderma harzianum Rifai str. T-22** *T. virens strain G-41*	68539-9
RootShield WP	*(Trichoderma harzianum Rifai strain KRL-AG2)*	68539-7
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	*Gliocladium virens str. GL-21*	70051-3
Taegro Biofungicide	*Bacillus subtilis var. amyloliquefaciens strain FZB24*	70127-5
Terraclean 5.0	*hydrogen dioxide, peroxyacetic acid*	70299-13
Trilogy	*neem oil*	70051-2
Zonix	*Rhamnolipid Biosurfactant*	72431-1

*Restricted-use pesticide in New York State

Active ingredient meets EPA criteria for acute toxicity to bees

Table 16.3 Sanitizers

TRADE NAME	ACTIVE INGREDIENT	EPA REG. NO.
CDG Solution 3000	*chlorine dioxide*	75757-2
Enviroguard Sanitizer	*hydrogen peroxide/peroxyacetic acid*	63838-1-527
*GreenClean PRO	*sodium carbonate peroxyhydrate*	70299-15
Oxine	*chlorine dioxide*	9804-1
Oxonia Active	*hydrogen peroxide/peroxyacetic acid*	1677-129
Peraclean 5	*hydrogen peroxide/peroxyacetic acid*	54289-3
Peraclean 15	*hydrogen peroxide/peroxyacetic acid*	54289-4
Perasan 'A'	*hydrogen peroxide/peroxyacetic acid*	63838-1
Per-Ox	*hydrogen peroxide/peroxyacetic acid*	833-4
Pro Oxine	*chlorine dioxide*	9804-9
*SaniDate 5.0	*hydrogen peroxide/peroxyacetic acid*	70299-19
SaniDate 12.0	*hydrogen peroxide/peroxyacetic acid*	70299-18
San-I-King No. 451	*sodium hypochlorite*	2686-20001
Shield-Brite PAA 5.0	*hydrogen peroxide/peroxyacetic acid*	70299-19-64864
Shield-Brite PAA 12.0	*hydrogen peroxide/peroxyacetic acid*	70299-18-64864
StorOx 2.0	*hydrogen peroxide/peroxyacetic acid*	70299-7
Tsunami 100	*hydrogen peroxide/peroxyacetic acid*	1677-164
Victory	*hydrogen peroxide/peroxyacetic acid*	1677-186
VigorOx 15 F & V	*hydrogen peroxide/peroxyacetic acid*	65402-3
VigorOx LS-15	*hydrogen peroxide/peroxyacetic acid*	65402-3

* Restricted-use pesticide. Only certified applicators can purchase and use restricted-use pesticides.

Abbreviations Used in this Publication

A	acre	N	nitrogen
AS	aqueous suspension	NOP	national organic program
DF	dry flowable	OMRI	organic materials review institute
EC	emulsifiable concentrate	P	phosphorus
G	granular	PHI	pre-harvest interval
K	potassium	REI	restricted-entry interval
HC	high concentrate	WG	water dispersible granular
		WP	wettable powder
		WPS	Worker Protection Standard

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APPENDIX 1: CASH CROPS, COVER CROPS, AND WEEDS IN THE FAMILY BRASSICACEAE

The more common plants within the Brassicaceae family are listed below, but this is not a comprehensive list.

Cash Crops		Weeds	Cover Crops
Arugula	Horseradish	Yellow rocket	Radish - oilseed and forage
Broccoli	Kale	Wild mustard	Mustard - spring and fall
Brussels sprouts	Kohlrabi	Shepherd's purse	Kale - forage
Cabbages	Mustards	Hairy bittercress	Turnip - forage
Canola	Pak choi	Field pepperweed	Canola/Rapeseed/summer turnip
Cauliflower	Radish	Virginia pepperweed	
Collards	Rutabagas	Wild radish	
Cress	Turnip	Marsh yellowcress	
Daikon	Wasabi	Hedge mustard	
		Field peppercress	

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This guide is published by the New York State Integrated Pest Management Program, which is funded through Cornell University, Cornell Cooperative Extension, the New York State Department of Agriculture and Markets, the New York State Department of Environmental Conservation, and USDA-NIFA. Cornell Cooperative Extension provides equal program and employment opportunities. NYS IPM Publication number 134. June 2016 www.nysipm.cornell.edu.