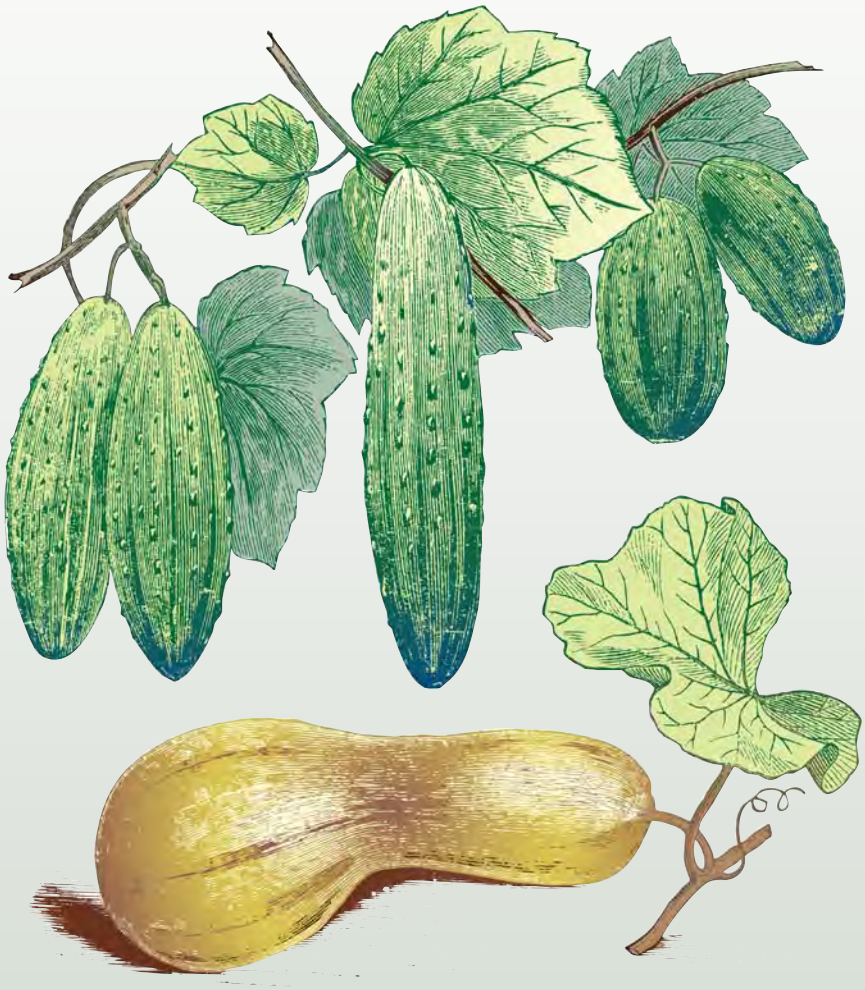
2011

Production Guide for Organic Cucumbers and Squash



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2011 Production Guide for Organic Cucumber & Butternut Squash for Processing

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INTRODUCTION

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

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

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

1. General Organic Management Practices

1.1 Organic Certification

To use a certified organic label, farming operations that gross more than $5,000 per year in organic products must be certified by a U.S. Department of Agriculture National Organic Program (NOP) accredited certifying agency. The choice of certifier may be dictated by the processor or by the target market. A list of accredited certifiers (Link 6) operating in New York can be found on the New York State Department of Agriculture and Markets Organic Farming Resource Center web page (Link 7). See more certification and regulatory details under Section 4.1 *Certification Requirements* and Section 10: *Using Organic Pesticides*.

1.2 Organic Farm Plan

An organic farm plan is central to the certification process. The farm plan 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 farm plan is from the NOP web site:

The Organic Food Production Act of 1990 (OFPA or Act) requires that all crop, wild crop, livestock, and handling operations requiring certification submit an organic system plan to their certifying agent and, where applicable, the State Organic Program (SOP). The organic system plan is a detailed description of how an operation will achieve, document, and sustain compliance with all applicable provisions in the OFPA and these regulations. The certifying agent must concur that the proposed organic system plan fulfills the requirements of subpart C, and any subsequent modification of the organic plan by the producer or handler must receive the approval of the certifying agent.

More details may be found at: the Agricultural Marketing Service's National Organic Program website (Link 8). The National Sustainable Agriculture Information Service, (formerly ATTRA), has produced a guide to organic certification that includes templates for developing an organic farm plan (Link 10). The Rodale Institute has also developed resources for transitioning to organic and developing an organic farm plan (Link 11).

2. Soil Health

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

Rotating between crop families can help prevent the buildup of diseases that overwinter in the soil. Rotation with a grain crop, preferably a sod that will be in place for one or more seasons, deprives disease-causing organisms of a host, and also contributes to a healthy soil structure that promotes vigorous plant growth. The same practices are effective for preventing the buildup of root damaging nematodes in the soil, but keep in mind that certain grain crops are also hosts for some nematode species. Rotating between crops with late and early season planting dates can help prevent the buildup of weed populations. Organic growers must attend to the connection between soil, nutrients, pests, and weeds to succeed. An excellent resource for additional information on soils and soil health is Building Soils for Better Crops by Fred Magdoff and Harold Van Es, 2000 (Link 13). For more

information, refer to the Cornell Soil Health website (Link 14).

3. COVER CROPS

Unlike cash crops, which are grown for immediate economic benefit, cover crops are grown for their valuable effect on soil properties and on subsequent cash crops. Cover crops help maintain soil organic matter, improve soil tilth, prevent erosion and assist in nutrient management. They can also contribute to weed management, increase water infiltration, maintain populations of beneficial fungi, and may help control insects, diseases and nematodes. To be effective, cover crops should be treated as any other valuable crop on the farm, with their cultural requirements carefully considered including their cultural requirements, life span, mowing recommendations, incorporation methods, and susceptibility, tolerance, or antagonism to root pathogens and other pests. Some cover crops and cash crops share susceptibility to certain pathogens and nematodes. Careful planning and monitoring is required when choosing a cover crop sequence to avoid increasing pest problems in subsequent cash crops. See Tables 3.1 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 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, to add nitrogen, smother weeds, or break a pest cycle. The cover crop might best achieve some of these goals if it is in place for the entire growing season. If this is impractical, a compromise might be to grow the cover crop between summer cash crops. Allow two or more weeks between cover crop incorporation and cash crop seeding to permit decomposition of the cover crop, which will improve the seedbed and help avoid any unwanted allelopathic effects on the next cash crop. Another option is to overlap the cover crop and the cash crop life cycles by overseeding, interseeding or intercropping the cover crop between cash crop rows at final cultivation. An excellent resource for determining the best cover crop for your situation is Northeast Cover Crop Handbook, by Marianne Sarrantonio (Reference 23) or the Cornell online decision tool to match goals, season, and cover crop (Link 12).

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

3.2 Legume Cover Crops

Legumes are the best cover crop for increasing available soil nitrogen. Legumes have symbiotic bacteria called rhizobia, which live in their roots and 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 fixed nitrogen will be available for the crop to use in the first season, but this may 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.

Interseeding Red Clover into Cucurbits

Red clover may be interseeded into vining type winter squash at a rate of 10-15 lbs/acre at last cultivation, just before the plants start to run. The seed may be spun on while cultivating, or in a separate pass immediately after. The clover will germinate and establish under the plant canopy and continue to grow after frost kills the vines. Left to grow for the next season, it can provide enough nitrogen to meet the requirement for heavy nitrogen feeders the following season. Alternately, the clover can be cut for hay, but this will result in less nitrogen returned to the soil.

3.3 Non-Legume Cover Crops

Barley, rye grain, rye grass, Sudangrass, wheat, oats, and other grain crops left on the surface or plowed under as green manures or dry residue in the spring are beneficial because they capture nitrogen that otherwise might be leached from the soils. If incorporated, allow two weeks or more for decomposition prior to planting to avoid the

negative impact on stand establishment from actively decomposing material. Three weeks might not be enough if soils are very cold.. In wet years, the presence of cover crop residues may increase slug damage.

3.4 Biofumigant Cover Crops

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

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

Cover Crops for Vegetable Growers: Decision Tool (Link 12).

Northeast Cover Crops Handbook (Reference 23).

Cover Crops for Vegetable Production in the Northeast (Reference 29).

Crop Rotation on Organic Farms: A Planning Manual (Link 14a).

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

Species	Planting Dates	Life Cycle	Cold Hardiness Zone	Tolerances: Heat	Tolerances: Drought	Tolerances: Shade	pH Preference	Soil Type Preference	Seeding (lb/A)	Nitrogen Fixed (lb/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**	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**	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**	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**	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**	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**	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. * Nitrogen fixed but not total available nitrogen. * Nitrogen fixed but not total available nitrogen. See Section 8 for more information. ** Winter killed.
Reprinted with permission from Rodale Institute®, www.rodateinstitute.org, M. Sarrantonio. 1994. Northeast Cover Crop Handbook. (Reference 23).

Table 3.2 Non-leguminous Cover Crops: Cultural Requirements and Crop Benefits

Species	Planting Dates	Life Cycle	Cold Hardiness Zone	--Tolerances-- Heat	Drought	Shade	pH Preference	Soil Type Preference	Seeding (Lb/A)	Comments
Brassicas e.g. mustards, rapeseed	April or late August-early Sept.	Annual / Biennial **	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 **	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**	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 **	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. Drought, Heat, Shade Tolerance Ratings: 1-2=low, 3-5=moderate, 6-8=high, 9-10=very high. AR=Annual Rye, PR=Perennial Rye. **Winter killed.
Reprinted with permission from Rodale Institute®, www.rodateinstitute.org, M. Sarrantonio. 1994. Northeast Cover Crop Handbook. (Reference 23).

4. Field Selection

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

4.1 Certifying Requirements

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

4.2 Crop Rotation Plan

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

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

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

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

Table 4.2.1 Crops Nutrient Requirements

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

From NRAES publication *Crop Rotation on Organic Farms: A Planning Manual.* Charles L. Mohler and Sue Ellen Johnson, editors, (Reference 14a).

Crop Information Specific to Cucurbits

Plan at least three years between cucurbit family plantings and peppers, eggplants, tomatoes or other cucurbits. Crucifers would be an especially good crop to precede cucurbits.

Table 4.2.2 Potential Interactions of Crops Grown in Rotation with Cucurbits

Crops in Rotation	Potential Rotation Effects	Comments
Many crops	*Decrease* weeds	**Mulched** vine crops help reduce weed populations for subsequent crops. Mulched cucurbits are a good choice prior to growing crops where weed control is challenging.
Carrot, lettuce, spinach and other direct seeded crops.	*Increase* weeds in direct seeded crops	**Unmulched** vine crops are often very weedy. Do not follow with direct seeded crops such as carrot, parsnip, lettuce, or spinach.
Eggplant, pepper	*Increase Phytophthora capsici*	*Phytophthora capsici* causes collar rot of eggplant and Phytophthora blight in cucurbits and peppers. Use a rotation of more than 3 years between these crops. Also found on weeds: common purslane, eastern black nightshade, horsenettle, velvetleaf, field pepperweed, field pennycress, Virginia pepperweed.
Broccoli, cauliflower, Brussels sprouts, kale, cabbage, collards, radish, rutabaga, turnip, daikon	*Decrease* clubroot	Clubroot declines more quickly when grown in rotation with cucurbits, tomato, snap bean or buckwheat.
Corn	*Increase* corn rootworm	Corn rootworm adults are attracted to cucurbits. They lay their eggs at the base of the plants and the larvae attack corn roots the following year.
Lettuce, spinach, brassica greens	Possible double cropping	Cucurbits can be double cropped when planted after early salad crops or brassica greens.
Hairy vetch	Early seeding of cover crop	Hairy vetch can be overseeded into winter squash in July to provide a winter cover crop after harvest.

Excerpt from Appendix 2 of Crop Rotation on Organic Farms: A Planning Manual. Charles L. Mohler and Sue Ellen Johnson, editors. (Reference 14a)

4.3 Pest History

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

All cultivated cucurbits are hosts for both root-knot nematode, *Meloidogyne hapla*, and root-lesion nematode, *Pratylenchus penetrans*. It is important to know whether or not these nematodes are present in the field in order to develop long-term crop rotations and cropping sequences that either reduce the populations in heavily infested fields or minimize their increase in fields that have no to low infestation levels. Refer to Section 12 for more information on nematodes.

4.4 Soil and Air Drainage

Cucurbits need well drained soil types to reduce the risk of *Phytophthora blight*.

With the exception of powdery mildew, most fungal and bacterial pathogens need free water on the plant tissue or high humidity for several hours in order to infect. Any practice that promotes leaf drying or drainage of excess water from the root zone will minimize favorable conditions for infection and disease development. Fields with poor air movement, such as those surrounded by hedgerows or woods, result in leaves staying wet. Plant rows parallel to the prevailing winds, which is typically 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.

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 (References 24-25).

5.2 Weed Management Methods

Planting and cultivation equipment should be set up on the same number of rows to minimize crop losses and damage to crop roots during cultivation. It may be necessary to purchase specialized equipment to successfully control weeds in some crops. See resources at the end of this section to help fine-tune your weed management system. Weed fact sheets provide a good color reference for common weed identification. See Cornell weed ecology and Rutgers weed gallery websites (Links 24-25).

Weeds in cucurbits are difficult to control after the crop vines out in the row, because tractor cultivation becomes impossible. A high percentage of weeds will then go to seed and carry over the weed problem to the following year. Transplanting cucurbits rather than direct seeding allows the canopy to close quicker and can reduce in-row weed development.

Planting cucurbits into black plastic mulch is another strategy to improve weed control, since the mulch prevents weed germination in the area immediately near the crop. Cultivate the aisles between plastic covered beds with sweeps. To avoid weed problems along the edges of the plastic, either use vegetable knives to under cut the margin of the plastic or use hilling discs or spider gangs to throw additional soil onto the edge of the plastic to bury weeds. These cultivations will be most effective when weeds are small.

Straw mulch is an alternative to black plastic, but will cool the soil and slow crop development. Straw can also be used for weed suppression between plastic covered beds. Rodents may nest in the straw, however, and then feed on the fruit. Also, belly rot may be more prevalent in straw mulch. If using straw without plastic, tine weed and cultivate direct seeded crops as indicated below, then lay straw shortly before vines run out. For effective weed control lay 3 inches of baled compressed material or 6 inches of loose straw, which can be blown through a hydro-seeding cannon or bale chopper.

If direct seeding without black plastic, tine weed just before emergence and again 5 to 7 days after emergence. A third tine weeding may be possible a week later. Set the weeder to work about 2/3 of the seeding depth. When tine weeding cucurbits, avoid using weeders with > 45 degree bends in the tines.

Alternatively, cucurbits can be direct seeded or transplanted in a grid pattern, with equal spacing in and between rows. This allows cultivation in both directions. See Section 7: Planting Methods for spacing recommendations. In either case, cultivate at 10 to 14-day intervals for as long as possible. Once winter squash is well established, throw soil around the base of the plants to bury small weeds. Hand hoe before the vines run out of the row. Do the last cultivation with vegetable knives pointed *toward* the crop, which will allow you to reach in under the leaves and cultivate later and closer to the row.

Butternut squash is reasonably tolerant of weed competition.

Resources

Steel in the Field by Greg Bowman:
http://www.sare.org/publications/steel/index.htm (Link 23).
Cornell Weed Ecology website:
http://www.css.cornell.edu/weedeco/ (Link 24).
Rutgers University, New Jersey Weed Gallery:
http://njaes.rutgers.edu/weeds/ (Link 25).
University of Vermont videos on cultivation and cover cropping:
http://www.uvm.edu/vtvegandberry/Videos/videos.html (Link 26).
ATTRA Principles of Sustainable Weed Management for Croplands:
http://attra.ncat.org/attra-pub/weed.html (Link 27).
New Cultivation Tools for Mechanical Weed Control in Vegetables
http://www.vegetables.cornell.edu/pubs/newcultivationmech.pdf (Link 28)

6. RECOMMENDED VARIETIES

Variety selection is important both for the horticultural characteristics specified by the processor and the pest resistance profile that will be the foundation of a pest management program. If disease pressures are known, tables 6.1 and 6.2 can help to determine which varieties will be more successful in reducing disease problems. Collaborate with processors on varieties, choosing 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 Resistance of Pickling Cucumber Varieties for Processing

	Angular Leaf Spot	Anthracnose	Bacterial Wilt	Downy Mildew	Powdery Mildew	Scab	Cucumber Mosaic Virus	Papaya Ringspot Virus	Watermelon Mosaic Virus	Zucchini Yellow Mosaic Virus
Alibi				X	X					
Amour					X					
Ballerina					X	X	X			
Bush Pickle						X	X			
Calypso F1	X	X		X	X	X	X			
Carolina F1	X	X		X	X	X	X	X	X	
Classy	H				X					
Cross Country	X	X		X	X	X	X			
County Fair	X		X							
Earlipik 14						M	M			
Eclipse	X	X		X	X	X	X			
Eureka	H	H		H	H	H	H	X	X	X
Fancy Pak M	X	X		X	X	X	X			
Fiesty					X					
FM 5020					X					
Jackson Classic F1	X	X		X	X	X	X			
Jackson Supreme	X	X		M	X	X	X			
H-19 Little Leaf					X					
Lafayette Classic F1	X	X		X	X	X	X			
Moxie					X					
Napoleon classic F1	X	X		X	X	X	X			
Patton					X					
Pioneer	X	X		X	X		X			
Salty				X	X	X	X			
Sassy	X	X		H	X	X	X	X		
SMR58					X	X				
Spear It					X					
Spunky					X					
Timor					X					
Vlasstar F1	X	X		X	X	X	X			
Wellingon F1	X	X		X			X			
Wisconsin SMR						X				
Zapata	X	X		H	X	X	X	X	X	X

L-low resistance, M-medium resistance, H-high resistance X- variety has some level of resistance based on seed catalog information.

Table 6.2 Powdery Mildew Resistance in Butternut-type Winter Squash Varieties

Variety	Relative Maturity	Plant Type	Fruit Color	Fruit Size	Disease Resistance
Achieve	90 days	Large Bush	Lt Tan	4-6 lbs	PMR
Argonaut	140 days	Vigorous Vine	Orange	30 lbs	None
Atlas	90 days	Short Vine	Lt Tan	10-12"	None
Avalon	88 days	Vigorous Vine	Buff	5"x11"	None
Betternut 401	80 days	Semi-Bush	Lt Tan	8-9"; 3 lb	PMR
Bugle	80 days	Semi-Bush	Lt Tan	10"	PMR
Butternut Supreme	80 days	Semi-Bush	Lt Tan	10-12"	None
Casius	110 days	Vine	Lt Tan	14-15"	None
Early Butternut	85 days	Semi-Bush	Tan	8"	None
JWS 6823	100 day	Vine	Orange	3-4 lbs	PMR
Metro	105 days	Vine	Orange	2.5-3.5 lbs	PMR
Matilda	110 days	Vine	Lt Tan	7-9 lbs	None
Neck Pumpkin	120 days	Vine	Lt Brown	18-24"	None
Pilgrim	80 days	Semi-Bush	Lt Tan	8-10"	None
Provider	100 day	Large Bush	Lt Tan	6-12 lbs	PMR
Ultra	90 days	Vine	Lt Tan	15"	None
Waltham*	97 days	Vine	Lt Tan	10-12"	None

PMR = Powdery Mildew Resistance; Waltham is resistant to Plectosporium.

Table 6.3 Ranking of Butternut Varieties by Cucumber Beetle Preference

Variety	Ranking
Zenith	13
Butternut Supreme	16
Early Butternut	25
Waltham	28

Ranking 1-14- non-preferred, > 45 – highly preferred.

7. PLANTING METHODS

7.1 Cucumber

Direct seeded cucumbers are planted May 25th to July 15th. Wait 2 to 3 weeks depending on soil temperature and moisture between plowing down a cover crop and planting direct seeded cucurbits so that the cover crop has sufficient time to decompose to avoid allelopathy and seedcorn maggot.

If a processing grower wanted to experiment with transplants, in upstate New York, they are typically set in the field between June 1st and 10th for harvest in mid-August to early September. Using transplants requires careful timing to avoid allowing the plants to become root-bound in the transplant flats.

Wind, combined with low air temperatures (32° to 50°F), can severely damage vine crops, retarding maturity and reducing yields. Soil temperatures below 50°F also slow growth and impair water uptake by roots. For these reasons, plastic mulch and row covers are often used. Black, clear, or infrared-transmitting (IRT) mulches can be used.

Another means of wind protection is to plant rye strips between every second or third row of the crop. Site selection is also important for wind protection and optimal soil temperature. Light-textured soils that warm quickly in the spring are preferable to heavier soils that remain cool. Good drainage, fertility, and high organic matter are other soil features that will improve the potential for good yield and quality.

7.2 Winter squash

These are normally direct seeded after all danger of frost is past, between May 25th and June 15th. Winter squash also can be planted on a grid, with equal distance in and between rows, to allow cultivation both ways.

Table 7.1 Recommended spacing

Crop	Row	In-row
Cucumber-Pickles	2-5′	3-8″
Squash-Butternut	6-8′	24-48″

8. CROP & SOIL NUTRIENT MANAGEMENT

To produce a healthy crop, soluble nutrients must be available from the soil in amounts that 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. 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. Restrictions in any one of the needed nutrients will slow growth and can reduce crop quality and yields.

Organic growers often speak of feeding the soil rather than feeding the plant. A more accurate statement is that organic growers focus their fertility program on feeding soil microorganisms rather than the plant. 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.

The primary challenge in organic systems is synchronizing nutrient release from organic sources, particularly nitrogen, with the crop requirements. 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 Program rules that no more than 20% of nitrogen can be applied as Chilean nitrate. Confirm the practice with your organic certifier prior to field application.

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.

Table 8.0.1 Nutrient Testing Laboratories

TESTING LABORATORY	SOIL	COMPOST/ MANURE	FORAGE	LINK
Cornell Soil Health Lab	x			14
Agri Analysis, Inc.		x		16
A&L Eastern Ag Laboratories, Inc.	x	x		17
Penn State Ag Analytical Services Lab.	x	x		18
University of Massachusetts	x	x		20
The Agro One Lab			x	19

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.* .

8.1 Fertility

Recommendations from the Cornell Integrated Crop and Pest Management Guidelines indicate a cucurbit crop requires 100 lb. of available nitrogen (N), 120 lb. of phosphorus (P), and 120 lb of potassium (K) per acre. These levels are based on the total needs of the whole plant and assume the use of synthetic fertilizers. Farmer and research experience suggests that lower levels may be adequate in organic systems. See Table 8.2.2 for the recommended rates of P and K based on soil test results. Nitrogen is not included because levels of available N change in response to soil temperature and moisture, N mineralization

potential, and leaching. . As many of the nutrients as possible should come from cover crop, manure, and compost additions in previous seasons.

If the crop is grown with plastic mulch, the nitrogen level can be reduced to 70 lb. of available N. The more uniform moisture and warmer temperatures under plastic mulch increase the decomposition rate of soil organic matter, which increases available N.

The source of these nutrients depends on soil type and historic soil management. Some soils are naturally high in P and K, or have a history of manure applications that have resulted in elevated levels. Additional plant available nutrients are supplied by decomposed soil organic matter or through specific soluble nutrient amendments applied during the growing season in organically managed systems. Many types of organic fertilizers are available to supplement the nutrients supplied by the soil. **ALWAYS check with your certifier before using any product to be sure it is approved**.

8.2 Preparing an Organic Nutrient Budget

Insuring an adequate supply of nutrients when the crop needs them requires careful planning. Developing an organic nitrogen budget can help estimate the amount of nutrients released by various organic amendments as well as native soil organic matter. 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.

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. Consider submitting soil samples for a Cornell Soil Health Test (Reference 13). This test includes an estimate of nitrogen mineralization rate, which indicates the potential for release of N from soil organic matter. Testing soils over time can be useful for monitoring changes in nitrogen mineralization rate during the transition, and over time, in organic production.

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 8.2.1 Calculating Nutrient Credits and Needs.

	Nitrogen (N) lbs/acre	Phosphate (P_2O_5) lbs/acre	Potash (K_2O) lbs/A
1. Total crop nutrient needs			
2. Recommendations based on soil test			
3. Credits			
a. Soil organic matter		---	---
b. Manure			
b. Compost			
c. Prior cover crop			
4. Total credits:			
5. Additional needed (2-4) =			

Line 1. Total Crop Nutrient Needs: Research indicates that an average cucurbit crop requires 100 lbs. of available nitrogen (N), 120 lbs. of phosphorus (P), and 120 lbs. of 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 Cucurbits Based on Soil Tests

	Soil Phosphorus Level			**Soil Potassium Level**		
Level shown in soil test	low	med	high	low	med	high
	P_2O_5 lbs/A			**K_2O lbs/A**		
Total nutrient recommendation	120	80	40	120	80	40

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.

Line 3b. Manure: Assume that manure will release N for 3 years. Based on the test of total N in the manure applied, estimate that 50% is available in the first year, and then 50% of the remaining is released in each of the next two years. For an application rate of 100 lbs. of N as manure, 50 lbs. would be available the first year, 25 lbs. in year 2, and 12.5 lbs. in year 3. Remember, any raw manure applications must occur at least 120 days before harvest of a vegetable crop.

Line 3c, Compost: Estimate that 10 to 25% of the N contained in compost will be available the first year. Compost maturity will influence how much N is available. If the material is immature, more of the N may be

available to the crop in the first year. A word of caution: Using compost to provide for a crop's nutrient needs is not generally a financially viable strategy. The total volume neededcan be very expensive for the units of N available to the crop esoecuakkt uf trycjubg us reqyured. Most stable composts should be considered as soil conditioners, improving soil health, microbial diversity, tilth, and nutrient retaining capacity. Any compost applied on organic farms must be approved for use by your farm certifier. Compost generated on the farm must follow an approved process outlined by your certifier.

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

Line 4. Total Credits: Add together the various N values from the organic matter, compost and cover crops to estimate the N 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 (~90 lbs/acre), a sidedress application of organic N may be needed. There are several sources for N for organic sidedressing (see Table 8.2.4) as well as pelleted composts. If early in the organic transition, a grower may consider increasing the N budget supply by 30%, to help reduce some of the risk of N being limiting to the crop.

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

Table 8.2.3 Nutrient Content of Common Animal Manures and Manure Composts

	TOTAL N	P_2O_5	K_2O	N1 [1]	N2 [2]	P_2O_5	K_2O
	NUTRIENT CONTENT LB/TON			*AVAILABLE NUTRIENTS LB/TON IN FIRST SEASON*			
Dairy (with bedding)	9	4	10	6	2	3	9
Horse (with bedding)	14	4	14	6	3	3	13
Poultry (with litter)	56	45	34	45	16	36	31
Composted dairy manure	12	12	26	3	2	10	23
Composted poultry manure	17	39	23	6	5	31	21
Pelleted poultry manure [3]	80	104	48	40	40	83	43
Swine (no bedding)	10	9	8	8	3	7	7
	NUTRIENT CONTENT LB/1000 GAL.			*AVAILABLE NUTRIENTS LB/1000 GAL FIRST SEASON*			
Swine finishing (liquid)	50	55	25	25*	20+	44	23
Dairy (liquid)	28	13	25	14*	11+	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.)
* injected, + incorporated.
Adapted from *"Using Manure and Compost as Nutrient Sources for Fruit and Vegetable Crops"* by Carl Rosen and Peter Bierman (Reference 22) and Penn State Agronomy Guide 2007-8 (Reference 22a).

Tables 8.2.4 to 8.2.6 lists some commonly available fertilizers, their nutrient content.

Table 8.2.4 Available Nitrogen in Organic Fertilizer

	Pounds of Fertilizer/Acre to Provide X Pounds of N per Acre				
Sources	**20**	**40**	**60**	**80**	**100**
Blood meal, 13% N	150	310	460	620	770
Soy meal 6% N (x 1.5)* 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)*	200	400	600	800	1000
Chilean nitrate 16% N cannot exceed 20% of crop's need.	125	250	375	500	625

* 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 21).

Table 8.2.5 Available Phosphorous in Organic Fertilizers.

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

* 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 21).

Table 8.6 Available Potassium in Organic Fertilizers.

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

* Application rates for some materials are multiplied to adjust for their slow to very slow release rates. Tables 8.4 to 8.6 adapted by Vern Grubinger from the University of Maine soil testing lab (Link 21).

An example of how to determine nutrient needs for cucurbits. You will be growing an acre of winter squash. The Cornell Integrated Crop and Pest Management Guidelines suggests a total nutrient need for a cucurbit crop is 100 lb. N, 120 lb. P, and 120 lb K per acre for a high yielding crop. Soil tests show a pH of 6.5, with medium P and low K levels and recommends 80 lbs P_2O_5/acre and 120 lbs K_2O/acre (see Table 8.2.3). The field you'll be planting has 2% organic matter and there is a stand of red clover that will be turned in a week or so prior to planting (see Table 3.1). Last season you injected 1000 gallons of liquid hog manure into the red clover stubble after taking the last cutting of hay.

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

	Nitrogen (N) lbs/A	Phosphate (P_2O_5) lbs/A	Potash (K_2O) lbs/acre
1. Total crop nutrient needs:	100	120	120
2. Recommendations based on soil test	# not provided	80	120
3. Credits			
a. Soil organic matter 2%	40	---	---
b. Manure – 1000 gal hog	25	44	23
c. Compost - none	0	0	0
d. Cover crop – red clover	50	0	0
4. Total credits:	115	44	23
5. Additional needed (2-4) =	0	36	97

Table 8.2.3 indicates about 25 lbs. N will be released in the first season from 1000 gallons of hog manure injected. Estimate that each percent organic matter will release about 20 lbs. of N, so the 2% soil organic matter will supply 40 lbs. N (line 3a). Looking at Table 3.1, the red clover cover crop will release about half its fixed N, or 50 lbs. as it decomposes (line 3d), for a total estimated N released and available for plant uptake of 115 lbs. per acre. The 44 lbs. of P released from the injected manure will need to be supplemented by an additional 40 lbs P through applying ~250 lbs/A of bonemeal to meet the soil test recommendation of 80 lbs per acre. Potassium will also need to be supplemented in this example. The manure supplies 23 of the 120 lbs. needed. The remaining ~100 lbs. K_2O/acre, can be incorporated through broadcasting 200 lbs. of potassium sulfate from an organically approved product, if soil tests indicate sufficient magnesium. If magnesium is needed, then apply ~450 lbs. of Sul-Po-Mag.

9. HARVESTING

9.1 Cucumber

Pickling cucumbers in smaller plantings are picked by hand on four to five day intervals depending on temperature and moisture. A field can be picked 7 or 8 times, although 3 to 5 times is more typical.

Populations of 40,000 plants or more per acre concentrate yields sufficiently for mechanical harvesting of pickles. Success of machine harvest depends on establishing a uniform stand, harvesting when ten percent of the fruit are two inches in diameter or larger, and moving the fruit quickly from the field to the processing plant. Not all processors allow machine harvesting.

9.2 Winter Squash

Store only mature fruit that is free of disease. Harvest and place the fruit under shelter before chilling or freezing can damage it. Fruits subjected to temperatures below 50°F for two weeks or more may break down and rot.

Desirable storage conditions are 50° to 55°F at a relative humidity of 50 to 75 percent with good air circulation to maintain uniform temperature and humidity throughout the storage period. During a long storage period, fruit will lose less moisture if humidity is maintained near 70 to 75 percent.

10. USING ORGANIC PESTICIDES

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

10.1 Sprayer Calibration and Application

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

RESOURCES:

Cornell Integrated Crop and Pest Management Guidelines: Pesticide Information and Safety (Reference 65).
Calibrating Backpack Sprayers (Reference 66).
Agricultural Pocket Pesticide Calibration Guide (Reference 67).
Knapsack Sprayers – General Guidelines for Use (Reference 68)
Herbicide Application Using a Knapsack Sprayer (Reference 69) this publication is relevant for non-herbicide applications).

10.2 Regulatory Considerations

Organic production focuses on cultural, biological, and mechanical techniques to manage pests on the farm, but in some cases organically approved pesticides, which include repellents, are a necessary option. Pesticides mentioned in this organic production guide must be registered and labeled at the federal level for use, like any other pesticide, by the Environmental Protection Agency (EPA), or meet the EPA requirements for a "minimum risk" pesticide, making it exempt from normal registration requirements as described in FIFRA regulation 40 CFR Part 152.25(b) (Reference 18).

"Minimum risk" pesticides, also referred to as 25(b) pesticides, must meet specific criteria to achieve the "minimum risk" designation. The active ingredients of a minimum-risk pesticide must be on the list of exempted active ingredients found in the federal regulations (40 CFR 152.25). Minimum-risk pesticides must also contain inert ingredients listed on the most current List 4A published in the Federal Register (Reference 18a).

In addition to meeting the active and inert ingredient requirements above, a minimum-risk pesticide must also meet the following:

- Each product must bear a label identifying the name and percentage (by weight) of each active ingredient and the name of each inert ingredient.
- The product must not bear claims to either control or mitigate microorganisms that pose a threat to human health, including, but not limited to, disease-transmitting bacteria or viruses, or claim to control insects or rodents carrying specific diseases, including, but not limited to, ticks that carry Lyme disease.
- The product must not include any false or misleading labeling statements.

Besides registration with the EPA, pesticides sold and/or used in New York State must also be registered with the New York State Department of Environmental Conservation (NYS DEC). However, pesticides meeting the EPA "minimum risk"

criteria described above do not require registration with the NYS DEC.

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 15). The Organic Materials Review Institute (OMRI) (Reference 9) is one organization that reviews and publishes products they find compliant with the NOP regulations, 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 potential pesticides.

Finally, each farm must be certified by an accredited certifier who must approve any material applied for pest management. ALWAYS check with the certifier before applying any pest control products.

Some organic certifiers may allow "home remedies" to be used to manage pests. These materials are not labeled as pesticides, but may have properties that reduce the impact of pests on production. 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. Home remedies are not mentioned in these guides, but in some cases, may be allowed by organic certifying agencies. Maintaining good communication with your certifying agent cannot be overemphasized in order to operate within the organic rules.

10.3 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. Pesticide manufacturers are not required to demonstrate efficacy to list a pest on the label. The Resource Guide for Organic Insect and Disease Management (Reference 3) 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. 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 under *Crop Management Tools and Production Aids* (Reference 10). 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. Thoroughly cover plant surfaces, especially in the case of insecticides, since many must be ingested to be effective. 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.

11. Disease Management

In organic systems, cultural practices form the basis of a disease management program. Promote plant health by maintaining a biologically active, well-structured, adequately drained and aerated soil that supplies the requisite amount and balance of nutrients. Choose varieties resistant to one or more important diseases whenever possible (see Section 6: *Varieties*). Plant only clean, disease-free seed and transplants and maintain the best growing conditions possible.

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

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

Scouting fields weekly is key to early detection and evaluating control measures. The earlier a disease is detected, the more likely it can be suppressed with organic fungicides. When available, scouting protocols can be found in the sections

listed below for each individual disease. The same scouting protocol may be used for angular leaf spot, anthracnose, scab, Septoria, and Ulocladium. While following a systematic scouting plan, keep watch for other disease problems. Removing infected plants during scouting is possible on a small operation. Accurate identification of disease problems, especially recognizing whether they are caused by a bacterium or fungus, is essential for choosing an effective control strategy. Anticipate which diseases are likely to be problems that could affect yield and be ready to take control action as soon as symptoms are seen. Allowing pathogen populations to build can quickly lead to a situation where there are few or no options for control.

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

Contact your local cooperative extension office to see if newsletters and pest management updates are available for your region. For example, the Cornell Cooperative Extension Regional Vegetable Program in Western New York offers subscriptions to *Pestminder*, a report that gives timely information regarding crop development, pest activity and control, and *VegEdge*, a monthly newsletter with articles on pest management. In the Albany area, information is available through the weekly *Vegetable Pest Status Report*. 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**.

Use weather-based disease forecasting programs when available to help time applications to periods of favorable weather or the arrival of inoculum. The movement of some pathogens that do not overwinter in the Northeast may be tracked online to help determine when control measures are needed. Track downy mildew at the North American Plant Disease Forecast Center (Link 30).

Resources:

Cornell Vegetable MD online (Link 31).
Resource Guide for Organic Insect and Disease Management (Reference 24)

Table 11.1 Relative Susceptibility to Diseases in Cucurbit Crops.

Disease	Pickling Cucumber	Butternut Squash
Angular leaf spot	L, R	M
Bacterial leaf spot	L	M
Bacterial wilt	H	L
Alternaria leaf blight	L	L
Anthracnose	L, R	L
Choanephora blight	-	L
Fusarium crown and fruit rot	L	M
Fusarium wilt	-	-
Damping-off	M	L
Downy mildew	H, R	H
Gummy stem blight (Black rot)	L	M
Phytophthora blight	H	H
Powdery mildew	M, R	M, R
Plectosporium blight	L	L/M
Scab	L, R	L
Septoria leaf spot	-	L
Ulocladium leaf spot	M,R	-
Viruses	L, R	M

R = resistant varieties exist (plants are less susceptible); L = low (occurs, but rarely in damaging levels); M = moderate, H = high level of susceptibility to pest; - disease tolerance for a particular crop is unknown.

Table 11.2 Calendar of When to Expect Diseases in the Northeast USA

Month	May	June	July	August	September	October
Weather Factors	Cool & wet Higher rainfall	Cool & wet Higher rainfall	Warm to hot Moderate rainfall	Warm & dry Moderate rainfall Morning dews	Warm to cool Moderate rainfall Long dews	Cool & wet
Septoria leaf spot						
Bacterial wilt						
Scab						
Powdery mildew						
Viruses						
Phytophthora blight						
Gummy stem/ Black rot						
Alternaria leaf blight						
Anthracnose						
Downy mildew						
Fusarium						

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 10.1.3 Pesticides Labeled for Organic Cucurbit Disease Management.

CLASS OF COMPOUNDS Product Name (*active ingredient*)	ALTERNARIA	ANGULAR LEAFSPOT	ANTHRACNOSE	BACTERIAL WILT	BELLY ROT	COTTONY LEAK	DAMPING OFF	DOWNY MILDEW	FUSARIUM	GUMMY STEM BLIGHT	PHYTOPHTHORA BLIGHT	POWDERY MILDEW	SCAB	SCLEROTINIA	SEED DECAY	SEPTORIA LEAF SPOT	ULOCLADIUM LEAF SPOT	VIRUSES
BIOLOGICALS																		
Actinovate AG (*Streptomyces lydicus*)	4		4	4	4	4	4	4	4		3	2		4	4			
Actino-Iron (Streptomyces lydicus WYEC108)					4	4	4		4		4			4	4			
Contans WG (Coniothyrium minitans)														2				
Mycostop Mix (Streptomyces griseoviridis)	4						4		4		4							
Mycostop (Streptomyces griseoviridis)	4						4		4									
Organocide (Sesame and fish oil)												1						
PlantShield HC (Trichoderma harzianum)							4				4							
Regalia SC (Reynoutria sachalinensis)										4								
RootShield WP (Trichoderma harzianum Str. T-22 (KRL-AG2))							4		4						4			
RootShield Granule (Trichoderma harzianum str. T-22 (KRL-AG2))							4											
Serenade MAX (Bacillus subtilis)										4								
Serenade ASO (Bacillus subtilis)								1		4								
Serenade Soil (Bacillus subtilis str. QST 713)					4	4	4		4		4				4			
Sonata (Bacillus pumilus)								2										
T-22 HC or Plant Shield (Trichoderma harzianum)							3		4									
COPPER PRODUCTS[a]																		
Basic Copper 53 (Copper sulfate)	1	1	1	4				1		1		2	1			1		
Champ WG (Copper hydroxide)	4	4	4					4		4		4	4					
Cueva Fungicide Concentrate (Copper octanoate)	4	4	4					4				4					4	
Nu Cop 50WP (Copper hydroxide)		1[b]						1[b]				2[c]						
BOTANICAL OILS																		
Mildew cure, GC-3 organic fungicide (Cottonseed, corn, and garlic oil)												1						
Organocide (Sesame and fish oil)												1						
Sporan EC (Rosemary, thyme and clove oils)	4							4				3						
Trilogy (Neem extract)	4	4	4					4				1	4					
MINERAL (Paraffinic) OIL																		
Glacial Spray Fluid																		4
Organic JMS Sylet Oil										4		1						4
POTASSIUM BICARBONATE																		
Kaligreen												2						
Milstop	4		4					4				1						
SULFUR[d]																		
Kumulus DF												1						
Microthiol Disperss												4						
Micro Sulf												1						
OTHER																		
Surround WP (kaolin)												4						
Oxidate (hydrogen dioxide)	4		4		4		1	1	4	4	4	3						

a-fixed copper fungicides include basic/tribasic copper sulfate, copper oxychloride sulfate, as well as copper hydroxide; b-cucumber only; c-squash only; d-sulfur can be phototoxic at temperatures above 90F therefore read the label carefully.
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.1 MANAGEMENT OF COMMON DISEASES

11.1.1 Bacterial Wilt, *Erwinia tracheiphila.*

Affected crop(s): Most common for cucumber. Some varieties of squash are very susceptible. The bacterium is spread by the striped cucumber beetle and the spotted cucumber beetle.

Key characteristics: Dull, green, wilted patches appear on damaged leaves. Petioles and leaves initially wilt and eventually, the entire plant. Fruit may be small, poorly shaped, and wilted (Reference 1). See Cornell bacterial wilt symptoms (Link 29).

Management Options: See the Striped and Spotted Cucumber Beetles in Section 12.2.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.1.1. Pesticides Labeled for Management of Bacterial Wilt.

Class of Compounds Products (*active ingredient*)	Crop	Rate/A	PHI (days)	REI (hours)	Efficacy	Comments
Actinovate AG *(Streptomyces lydicus)*	C, WS	3-12 oz	0	1 or until dry	?	
Basic Copper 53 (*Basic copper sulfate)*	C, WS	2 lbs	Up to day of harvest	24	?	

Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.
PHI = pre-harvest interval, REI = restricted-entry interval.

11.1.2 Downy Mildew, *Pseudoperonospora cubensis*

Time for concern: Mid-July to the end of the season. Refer to the North American Plant Disease Forecast Center for cucurbit downy mildew forecast (Link 30)

Affected crop(s): All cucurbits

Key characteristics: Upper surfaces of leaves show angular, pale green areas bounded by leaf veins that give the impression of mosaic. See Cornell photo and initial symptoms (Links 32 and 33). These areas turn into yellow, and later necrotic angular spots. Under wet and humid conditions, sporulation occurs on the lower leaf surface (Reference 1).

Management Option	Recommendations for Downy Mildew
Scouting/thresholds	In general, follow the scouting guidelines used for Alternaria leaf blight. In areas of the state prone to infection, this disease has the potential for rapid spread with short incubation periods, so growers should be aware of disease occurrence within the area and the neighboring states. Refer to county agent newsletters, and monitor the Downy Mildew national forecast website (Link 30). Windblown sporangia from infected cucurbits in other areas are the primary inoculum source, followed by secondary spore production within the field (Reference 3).
Resistant varieties	Plant resistant varieties of cucumbers whenever possible (see Section 6: Varieties). Some newly developed varieties have resistance to the pathogen strain that dominated before 2005 and also exhibit some suppression of the current strain.
Site selection	If possible, select sites with good air movement that encourages leaf drying.
Cultural	Fresh market growers have had success controlling downy mildew by trellising cucumbers, although this is probably cost prohibitive for process cucumber growers.

Notes	Avoid overhead irrigation to prevent moist conditions that favor disease. See Cornell Organic Resource Guide for information on efficacy (Reference 24). Also see the ATTRA publication Downy Mildew Control in Cucurbits at (Link 34).

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.1.2 Pesticides Labeled for Management of Downy Mildew

Class of Compounds Products (*active ingredient*)	Crop	Rate/A	PHI (days)	REI (hours)	Efficacy	Comments
BIOLOGICALS						
Actinovate AG (Streptomyces lydicus)	C, WS	3-12 oz	0	1 or until dry	4	Effective in 1 trial
Sonata *(Bacillus pumilis)*	C, WS	2-4 qts	0	4	2	Effective in 1 of 3 trials. Sonata may be more effective when used with an adjuvant according to a trial using a non-OMRI approved product. Reapply every 7-14 days. Use spreader-sticker.
Serenade ASO (Bacillus subtilis)	C, WS	2-6 qts	0	4	1	
BOTANICALS						
Sporan EC *(herbal oils)*	C, WS	1-3 pints	0	0	4	
COPPER						
Basic Copper 53 (*basic copper sulfate)*	C, WS	2 lbs	Up to day of harvest	24	1	Rated ++ out of ++++ in Cornell Guidelines.
Champ WG (*Copper hydroxide*)	C, WS	1½ -3 lbs	-	24	?	
Cueva Fungicide Concentrate (*copper octanoate*)	C, WS	0.5-2.0 gal/100gal water	Up to day of harvest-	4	?	Note that mixed material is applied at 50-100 gallons of diluted spray per acre.
Nu Cop 50WP (*copper hydroxide*)	C	1.5-3 lbs	1	24	1	Rated ++ out of ++++ in Cornell Guidelines. Cucumber only.
OTHER						
Milstop *(potassium bicarbonate)*	C, WS	2-5 lbs	-	1	4	
OxiDate *(hydrogen dioxide)*	C, WS	1/3-1 gal per 100 gal water	0	Until dry	1	Effective in 1 trial. Do not spray OxiDate during conditions of intense heat, drought or poor vine canopy.
Trilogy *(neem extract)*	C, WS	0.5-1% in 25-100 gal water	-	4	4	Maximum labeled rate of 2 gal/acre/application.

C = cucumber, WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval.
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.
+ = May be ineffective under high disease pressure; ++++=highly effective.

11.1.3 Phytophthora Blight, *Phytophthora capsici*

Time for concern: Seedling stage through harvest.

Affected crop(s): All cucurbits

Key characteristics: All aboveground plant parts can be affected. Occurrence varies with crop type. Initial symptoms include a sudden, permanent wilt of infected plants (crown blight phase) and/or white yeast-like fungal growth on affected fruit. See Cornell photo and fact sheet (Link 35 and 36). Crown blight often starts with the growing tip collapsing and turning brown. Fruit rot is the most common symptom for cucumber and winter squash. Asymptomatic winter squash in an infected field should be harvested as soon as possible, then watched for several days for disease development before selling (References 1, 7, & 9).

Management Option	Recommendation for Phytophthora Blight
Scouting/thresholds	Record the occurrence and severity of this disease. This is important for future rotational strategies. Include any areas where water does not drain well when scouting (Reference 3). Prevention is very important because Phytophthora blight is very difficult to suppress once it starts to develop in a field.
Resistant varieties	No resistant varieties are available.
Crop rotation	Phytophthora has a wide range of hosts. Use a three-year minimum rotation with other susceptible crops such as peppers, eggplants, tomatoes, snap and lima beans and other cucurbits; longer if possible.
Site selection	Select well-drained fields. Avoid planting next to other susceptible crops. Do not plant in low areas of a field. Grow bush types on raised, dome-shaped beds with plastic mulch. Vining cucurbits grown on raised beds may show more fruit infection due to a more favorable environment within the furrow. Subsoiling before planting and between rows before vining improves drainage.
Sanitation	Movement of the fungus in water and on soiled equipment can be an important means of spread between fields. Thoroughly clean equipment and boots after working in affected fields.
Cultural	Break up plantings with grass strips and non-susceptible crops. One study (Reference 28) indicated that calcium (soil and foliar applications) contributed significantly to reduced foliar infections, however copper applications were needed for significant reduction in fruit infections.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.1.3 Pesticides Labeled for Management of Phytophthora

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BIOLOGICALS						
Actino-Iron (*Streptomyces lydicus WYEC 108*)	C, WS	10-15 lb	-	4	?	Water in after application.
Actinovate AG (*Streptomyces lydicus)*	C, WS	3-12 oz (soil treatment)	0	1 or until dry	3	Not effective in 1 trial done on pumpkin. Soil drench at planting,

Table 11.1.3 Pesticides Labeled for Management of Phytophthora						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
						seedling, or transplanting.
Mycostop Mix *(Streptomyces griseoviridis)*	C, WS	1-4 g/ cu. yd.	0	4	?	Only labeled for greenhouse use.
PlantShield HC (*Trichoderma harzianum*)	C, WS	3-5 oz	0	When spray is dry	?	
Serenade Soil (*Bacillus subtilis str. QST 713*)	C, WS	2.2-13.2 fl oz/1000 row feet	0	4	?	Used as in furrow application.
OTHER						
OxiDate (*Hydrogen dioxide)*	C, WS	½ to 1 gal	0	Until dry	?	In-furrow applications at planting as a drench or as a foliar spray. See label.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.1.4 Powdery Mildew, *Podosphaera xanthii*

Time for concern: July, after fruit initiation until the end of the season. Dry leaf surfaces and humidities above 50% favor this disease.

Affected crop(s): All cucurbits

Key characteristics: Symptoms begin as circular, powdery white spots first on crown leaves and shaded lower leaves, especially on leaf undersurfaces. Eventually, leaves yellow, turn brown, and die. Fruits may be poorly colored and/or sunburned because of loss of foliage. See Cornell fact sheet (Link 37) and References 1, 4, and 10.

Management Option	Recommendation for Powdery Mildew
Scouting/thresholds	When first fruit start to enlarge, begin scouting weekly by examining both the upper and lower leaf surfaces of 5 old, crown leaves in at least 10 locations throughout the field. It is critical that treatments begin as soon as powdery mildew is found on at least 1 of the 50 leaves. See Reference 3 for more scouting information.
Indicator crop	A spring planting of summer squash will become infected before a main season crop and thus can be used as an indicator of when powdery mildew is present in an area and it is time to begin scouting winter squash.
Resistant varieties	Plant resistant varieties whenever possible (See Section 6: Varieties, Table 6.1 and 6.2). Cucumber varieties have a very high level of resistance
Crop rotation	The exact source of primary inoculum for powdery mildew in New York is not known. It has long been suspected that airborne conidia originating in southern states where cucurbit crops are grown earlier in the year could be the primary source.
Fungicide Use	A seven-day interval is recommended. It is important to begin early when disease is just starting. To obtain adequate control, fungicide is needed on the undersides of leaves.
Site selection, & Sanitation	Do not plant sequential plantings next to each other.
Notes	See Organic Resource Guide for information on efficacy (Reference 24).

At the time this guide was produced, the following materials were labeled 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. Those pesticides

meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.1.4 Pesticides Labeled for Management of Powdery Mildew

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BIOLOGICALS						
Actinovate AG (*Streptomyces lydicus*)	C, WS	3-12 oz	0	1 or until dry	2	Effective in 1 of 2 pumpkin trials.
BOTANICALS						
Mildew Cure GC-3 (*Cottonseed, corn, and garlic oils*)	C, WS	1%	0	4	1	Effective in 1 pumpkin trial.
Organocide (*Sesame and fish oil*)	C, WS	2 oz/gal	0	4	1	Effective in 2 of 2 trials.
Sporan EC (*Herbal Oils*)	C, WS	1-3 pt	0	0	3	Not effective in 1 trial.
Trilogy (*Neem Extract*)	C, WS	0.5%-1% in 25-100 gal	None listed	4	1	Effective in 1 trial. May reapply every 7-14 days. Label specifies a 2 gal/A maximum/application.
COPPER						
Basic Copper 53 (*Basic copper sulfate)*	C, WS	2 lbs	Up to day of harvest	24	2	+ of ++++ in Cornell Guidelines. Effective in 2 of 7 trials.
Champ WG (*Copper hydroxide*)	C, WS	1½ -3 lbs	-	24	?	
Cueva Fungicide Concentrate (*copper octanoate*)	C, WS	0.5-2.0 gal/100gal water	Up to day of harvest	4	?	Note that mixed material is applied at 50-100 gallons of diluted spray per acre.
Nu Cop 50wp (*Copper hydroxide)*	WS	1.5-3 lbs	1	24	2	+ of ++++ in Cornell Guidelines. Effective in 2 of 7 trials. Labeled for PM in squash, not cucumbers
KAOLIN CLAY						
Surround WP	C, WS	12.5-25 lbs	Up to day of harvest	4	?	
OIL						
Organic JMS Stylet-oil	C, WS	3-6 qt/100 gal water	0	4	1	Effective in 5 of 6 trials. Protectant. Use at least 200 psi spray pressure. See label for sulfur and other incompatibility information.
POTASSIUM BICARBONATE						
Kaligreen	C, WS	2.5-5 lb	1	4	2	Effective in 3 of 7 trials
MilStop	C, WS	2-5 lb	-	1	1	Effective in 2 of 2 trials.
SULFUR						
Kumulus DF	C WS	2-6 lbs cucumber 5-10 lbs squash	not listed	24	1	Effective in 2 of 2 trials. +++ of ++++ in Cornell Guidelines.
Micro Sulf	C, WS	2-4 lbs	-	24	1	Effective in 2 of 2 trials. +++ of

Table 11.1.4 Pesticides Labeled for Management of Powdery Mildew						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
		cucumber 5-10 lbs squash				++++ in Cornell Guidelines. Limit 2 lbs if temps exceed 95^0 F
Microthiol Disperss (*Sulfur*)	WS C	3-10 lbs 2-4 lbs	-	24	?	Do not apply within 2 weeks of an oil application nor at temperatures over 90 degrees.
OTHER						
OxiDate (hydrogen dioxide)	C, WS	½ to 1 gal	0	Until dry	3	Not effective in 1 trial. In-furrow applications at planting as a drench or as a foliar spray. See label.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.
+ = May be ineffective under high disease pressure; ++++ = very effective.

11.1.5 Storage and Fruit Rots

Time for concern: Initial infection occurs in the field, with further development and spread in storage

Affected crop(s): Winter squash

Key characteristics: This section is meant to highlight the exceptionally long list of bacterial and fungal pathogens that cause fruit loss in the field, at roadside stands, or much later while in storage, primarily due to fruit rots. The list includes Bacterial diseases - angular and bacterial leaf spot and Fungal diseases - Anthracnose, black rot (also called gummy stem blight), Fusarium crown and fruit rot, Fusarium fruit rot, Phytophthora blight, Pythium cottony leak, Rhizoctonia belly rot of cucumber, scab, Septoria leaf and fruit spot, white mold, and possibly ground stain of butternut squash. Individual disease sections should be referred to for specific control recommendations, which will include comments on crop rotation, site selection, as well as others. See Cornell fruit rot photos (Link 38).

Management Option	Recommendations for Storage and Fruit Rots
Resistant varieties	No resistant varieties are available.
Harvest	Handle fruits carefully to minimize wounding. Harvest before frost. Discard any suspect fruit as spread of inoculum from diseased to healthy fruit can occur while in storage.
Sanitation	Wooden storage boxes should be disinfected to remove pathogens and contaminating organisms that may cause decay. Storage boxes should be treated in the summer months prior to fall harvest. Whether or not the storage boxes are treated with a disinfectant, air-drying the boxes outside the storage facility during the warm, summer months will promote desiccation and death of organisms on the boxes.
Harvest Conditions	See Section 9: Harvesting, for more information about proper post-harvest handling of winter squash.
Scouting/thresholds, Crop rotation, Site selection, Seed selection/treatment	These are not currently viable management options.

11.2 Management of Nematodes

Primarily Northern root-knot (*Meloidogyne hapla)* and root-lesion *(Pratylenchus spp.)*

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

Affected crop(s): All cucurbits

Key characteristics: In the field, plants severely infected with either nematode generally lack vigor, are stunted and can be chlorotic. Belowground, galls develop on the roots of plants infected by root-knot nematode that disrupt the uptake of nutrients and water by the roots, while the root-lesion nematode does not cause any specific symptoms on the roots.

Management Option	Recommendations for Nematodes
Scouting/thresholds	Use a soil bioassay with lettuce and/or soybean to assess soil root-knot and root-lesion nematode infestation levels, respectively. Or, submit the soil sample(s) for nematode analysis at a public or private nematology lab (Link 39). See Section 4: Field Selection for more information as well as the following Cornell publications for instructions: "How to" instructions for soil sampling for nematode bioassays (Link 40). "How to" instructions for farmers to conduct a field test for root knot nematode using lettuce (Link 41). "How to" instructions for farmers to conduct a field test for root lesion nematode using soybean (Link 42).
Resistant varieties	No resistant varieties are available.
Crop rotation	Root-knot nematode has a wide host range but grain crops including corn, wheat, barley and oat are non-hosts and therefore effective at reducing the nematode population. If both root-lesion and root-knot nematodes are present in the same field then rotation with a grain crop may increase the root-lesion nematode population to a damaging level for the next crop. In addition to grain crops, root-lesion nematode has over 400 hosts including many vegetables that are planted in rotation with cucurbits thus making it difficult to manage root-lesion nematode strictly using a crop rotation. Depending on the size of the infested site, marigold varieties such as 'Polynema' and 'Nemagone' are very effective at reducing nematode populations, where marigold can be established successfully.
Site selection	Assay soil for nematode infestation, if needed.
Biofumigant cover crops	Grain cover crops such as winter rye and oat are poor or non-hosts for the root-knot nematode, thus they are effective at reducing the population. Cover crops with a biofumigant effect, used as green manure are best used for managing root-lesion nematode and will also reduce root-knot nematode populations. 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 uninfested fields via equipment and vehicles, etc. Also limit/avoid surface run-off from infested fields.
Weed Control	Many common weeds including lambsquarters, redroot pigweed, common purslane, common

Management Option	Recommendations for Nematodes
	ragweed, common dandelion and wild mustard are hosts to root-lesion nematode; therefore effective weed management is also important.

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Table 11.2.1 Pesticides Labeled for Management of Nematodes

Class of Compounds Product Name (*active ingredient*)	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
AzaGuard (*Azadirachtin*)	10 oz	0	4	?	Apply with OMRI approved spray oil.
Nema-Q (*Saponins of Quillaja saponaria*)	1.5-3 gal	-	24	?	1.5 gal/a rate – apply in 150-300 gal water/acre 3 gal/a rate – apply in 300-600 gal water/acre

PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.3 MANAGEMENT OF DISEASES THAT OCCUR LESS FREQUENTLY

Specific control strategies for the less commonly occurring diseases are listed in Table 10.3. General control practices for these diseases include plowing under crop debris as soon after harvest as possible to eliminate spores that may infect other plantings and to give the plant material a chance to break down to reduce the amount of inoculum remaining in the soil. For foliar diseases choose sites with good air circulation to minimize leaf wetness periods. For fruit diseases, choose well-drained fields and avoid excessive overhead irrigation.

Table 11.3 Management Strategies for Less Commonly Occurring Cucurbit Diseases.

Disease	Are Resistant Varieties Available?	Rotation out of Cucurbits	Is Disease Seed-borne?	Site Selection
Alternaria leaf blight	No	2 yr	Yes	Choose sites that favor fast leaf drying. Schedule overhead irrigation so it doesn't extend overnight leaf wetness. Avoid planting next to other cucurbits.
Angular and bacterial leaf spot	C	2 yr	Yes	Avoid planting next to other cucurbits
Anthracnose	C	2 yr	Yes	Not a viable management option
Belly rot	No	NE	-	Avoid soils that don't drain well
Choanephora blossom blight and fruit rot	No	2 yr	No	Allow for good air drainage; avoid dense plantings
Cottony leak *Pythium* spp	No	NE	No	Choose well-drained sites, avoid excessive overhead irrigation
Damping off and root rot *Pythium* spp	No	NE	No	Not a viable management option
Fusarium wilt, Fusarium crown rot, Verticillium wilt	No	5 yr *	Yes	Not a viable management option

Disease	Are Resistant Varieties Available?	Rotation out of Cucurbits	Is Disease Seed-borne?	Site Selection
Gummy stem blight and black rot	No	2 yr	Yes	Not a viable management option
Plectosporium blight	No	2 yr	No	Avoid soils that don't drain well. Not a threat for cucumber or butternut squash.
Scab	C	2 yr	Yes	Select sites that have well-drained soils and are conducive to good air movement. Avoid planting next to other cucurbits
Sclerotinia white mold	No	4 yr*	No	Avoid fields with a history of white mold. Avoid dense plantings that hold humidity. Sclerotinia has a wide host range.
Seed-borne diseases and seed decay	No	NE	Yes	Do not plant into cool, wet soils. Select areas that are well-drained.
Septoria leaf spot	No	2 yr	No	Only affects winter squash
Ulocladium leaf spot	C	2 yr	No	Only affects cucumbers
Viruses (PRSV, WMV, CMV, ZYMV)	C	NE	No	Plant late-season fields as far away from existing cucurbits as possible. A weed-free zone around the field may reduce the incidence of CMV and WMV. Reflective mulches or floating row covers may help repel or exclude aphids

C-Cucumber, NE-Not Effective, *Because of the wide host range, rotate away from cucurbits and other susceptible crops. PRSV=Papaya Ringspot Virus, CMV=Cucumber Mosaic Virus, WMV=Watermelon Mosaic Virus, ZYMV=Zucchini Yellow Mosaic Virus.

11.3.1 Alternaria Leaf Blight, *Alternaria cucumerina*

Time for concern: When the canopy closes

Affected crop(s): All cucurbits

Key characteristics: Symptoms first appear on the upper surface of crown leaves as small, circular spots ¼ inch in diameter and later enlarge to show a target-like pattern of rings (See References 1 and 2). See University of Illinois photos (Link 43).

Management Option	Recommendations for Alternaria Leaf Blight
Scouting/thresholds	Scouting: As the plants begin to run (vine types) or flower (bush types), choose five representative sites. At each site, inspect two older leaves on each of five plants, for a total of 50 leaves inspected per field. Record the number of infected plants. After the row closes (vine types) or fruit that have set begin to enlarge (bush types), substitute five plant areas. Examine ten leaves and five fruit per area. Calculate and record the percent of plants infected. Threshold: symptoms found on one leaf per 50 leaves sampled. When the disease threshold is met, spray on a seven to ten day schedule. Use a higher rate or shorter interval under severe disease pressure (See Reference 3).

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.1 Pesticides Labeled for Management of Alternaria Leaf Blight						
Class of Compounds Product Name (*Active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
BIOLOGICALS						
Actinovate AG (*Streptomyces lydicus*)	C, WS	3-12 oz	0	1 or until dry	?	Foliar application
Mycostop Mix (*Streptomyces griseoviridis str. K61*)	C, WS	7.6-30 oz/A as soil spray or drench 0.5-1 lb/ treated acre as band, in-furrow or side dress.	-	4	?	Do not treat cucurbit seeds with Mycostop Mix. Use at planting. Irrigate within 6 hours after soil spray or drench with enough water to move Mycostop into the root zone. Lightly incorporate furrow or band applications.
Mycostop *(Streptomyces griseoviridis* Strain K61)	C, WS	15-30 oz/a as soil spray or drench	-	4	?	Irrigate within 6 hours after soil spray or drench with enough water to move Mycostop into the root zone.
OILS						
Sporan (*Rosemary oil)*	C, WS	1-3 pts in a minimum of 25 gal water.	0	0	?	
Trilogy *(Neem extract)*	C, WS	0.5%-1% in 25-100 gal water	None listed	4	?	May reapply every 7-14 days. Maximum labeled rate of 2 gal/acre/application.
COPPER						
Basic Copper 53 *(Basic copper sulfate)*	C, WS	2 lbs/Acre	Up to day of harvest	24	1	+ out of ++++ in Cornell Guidelines
Champ WG (*Copper hydroxide*)	C, WS	1½ -3 lbs	-	24	?	
Cueva Fungicide Concentrate (*copper octanoate*)	C, WS	0.5-2.0 gal/100gal water	Up to day of harvest	4	?	Note that mixed material is applied at 50-100 gallons of diluted spray per acre.
POTASSIUM BICARBONATE						
Milstop *(Potassium bicarbonate)*	C, WS	2-5 lbs	-	1	?	
OxiDate *(Hydrogen dioxide)*	C, WS	1/3-1 gal/100gal.	0	Until dry	?	Do not spray OxiDate during conditions of intense heat, drought or poor vine canopy

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.
+ = may be ineffective under high disease pressure; ++++ = very effective.

11.3.2 Angular Leaf Spot, *Pseudomonas syringae* pv. *lachrymans*, and Bacterial Leaf Spot, *Xanthomonas campestris* pv. *cucurbitae*

Time for concern: Early to mid-season as immature fruit appear and develop

Affected crop(s): All cucurbits

Key characteristics: Angular leaf spot - brown, water-soaked spots are 1/25 to 3/25 inch in length and angular in shape. See Cornell photos of angular appearance and tattered appearance (Links 44 and 45).

Bacterial leaf spot - spots are similar in color and size to angular leaf spot, but circular. Under moist conditions, small droplets of ooze come from the water-soaked areas and dry as white residue. The fruit may have sunken craters with white crust (References 1 and 2).

Management Option	Recommendations for Angular Leaf Spot
Scouting/thresholds	Scouting: Use the following scouting method for angular leaf spot, anthracnose, scab, Septoria, and Ulocladium. As the plants begin to run (vine types), choose five representative sites. At each site, inspect two older leaves on each of five plants, for a total of 50 leaves inspected per field. Record the number of infected plants. After the row closes (vine types) or fruit that have set begin to enlarge (bush types), substitute five plant areas. Examine ten leaves and five fruit per area. Calculate and record the percent of plants infected. Threshold: symptoms found on one leaf per 50 leaves sampled (see Reference 3).
Resistant Varieties	Plant resistant varieties (Section 6: Varieties).
Crop Rotation	Rotate away from cucurbits for 2 to 4 years.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.2 Pesticides Labeled for Management of Angular Leaf Spot

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BOTANICAL OIL						
Trilogy *(Neem oil extract)*	C, WS	0.5%-1% in 25-100 gal water	None listed	4	?	May reapply every 7-14 days. Maximum labeled rate of 2 gal/acre/application.
COPPER						
Basic Copper 53 (*Basic copper sulfate)*	C, WS	2 lbs	Up to day of harvest	24	1	+ of ++++ in Cornell Guidelines.
Champ WG (*Copper hydroxide*)	C, WS	1½ -3 lbs	-	24	?	
Cueva Fungicide Concentrate (*copper octanoate*)	C, WS	0.5-2.0 gal/100gal water	Up to day of harvest	4	?	Note that mixed material is applied at 50-100 gallons of diluted spray per acre.
Nu Cop 50WP *(Copper hydroxide)*	C	1.5-2 lbs	1	24	1	+ of ++++ in Cornell Guidelines. Labeled for cucumber only.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.
+ = May be ineffective under high disease pressure; ++++ = very effective.

11.3.3 Anthracnose, *Colletotrichum orbiculare*

Time for concern: During warm, moist seasons and also a post harvest problem for winter squash

Affected crop(s): All cucurbits

Key characteristics: Leaf lesions begin as water-soaked spots that become yellow and circular. The fruit develops circular, black, sunken cankers. When moisture is present, the black center of the lesion is covered with salmon-colored spores (see References 1, 4, 5, and 6). See Cornell fact sheet (Link 46)

Scouting/thresholds: Use the following scouting method for angular leaf spot, anthracnose, scab, septoria, and ulocladium. As the plants begin to run, choose five representative sites. At each site, inspect two older leaves on each of five plants, for a total of 50 leaves inspected per field. Record the number of infected plants. After the row closes, substitute five plant areas. Examine ten leaves and five fruit per area. Calculate and record the percent of plants infected. **Threshold**: symptoms found on one leaf per 50 leaves sampled (See Reference 3).

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.3 Pesticides Labeled for Management of Anthracnose

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BOTANICALS						
Actinovate AG (*Streptomyces lydicus*)	C, WS	3-12 oz	0	1 or until dry	?	Foliar application
Trilogy *(neem extract)*	C, WS	0.5-1% in 25-100 gal water	None listed	4	?	Maximum labeled rate of 2 gal/acre/application.
COPPER						
Basic Copper 53 *(basic copper sulfate)*	**C, WS**	2 lbs/Acre	Up to day of harvest	24	1	+ out of ++++ in Cornell Guidelines
Champ WG (*Copper hydroxide*)	C, WS	1½ -3 lbs	-	24	?	
Cueva Fungicide Concentrate (*copper octanoate*)	C, WS	0.5-2.0 gal/100gal water	Up to day of harvest	4	?	Note that mixed material is applied at 50-100 gallons of diluted spray per acre.
OTHER						
Milstop *(potassium bicarbonate)*	C, WS	2-5 lbs	-	1	?	
OxiDate (Hydrogen dioxide)	C, WS	1/3 to 1 gal/100 gallons	0	Until dry	?	Do not spray OxiDate during conditions of intense heat, drought or poor vine canopy.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.
+ = may be ineffective under high disease pressure; ++++ = highly effective.

11.3.4 Belly Rot, Rhizoctonia solani

Time for concern: Fruit set through harvest

Affected crop(s): Cucumber

Key characteristics: Water-soaked, tan to brown lesions on undersides and blossom ends of cucumber fruits. Lesions become sunken, irregular, and dry as they enlarge. Belly Rot is a possible cause of ground stain in winter squash. See Reference 1. See Penn State University symptoms on fruit (Link 47).

Scouting/thresholds: The most critical time to scout is when immature fruit are in contact with the soil. No thresholds have been established.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.4 Pesticides Labeled for Management of Belly Rot

Class of Compounds Product Name (*Active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BIOLOGICALS						
Actino-Iron (*Streptomyces lydicus WYEC 108*)	C, WS	10-15 lb	-	4	?	Water in after application.
Actinovate AG *(Streptomyces lydicus)*	C, WS	3-12 oz drench	0	1 or until dry	?	Soil drench at planting, seedling, or transplanting.
Serenade Soil (*Bacillus subtilis str. QST 713*)	C, WS	2.2-13.2 fl oz/1000 row feet	0	4	?	Used as a in furrow application.
OTHER						
Oxidate (*Hydrogen dioxide)*	C, WS	1/2 to 1 gal	0	Until dry	?	In-furrow applications at planting as a drench.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.3.5 Choanephora Blossom Blight and Fruit Rot

Time for concern: Rainy weather during blossom and fruit set stage

Affected crop(s): Winter squash

Key characteristics: Fungus gets established in senescent blossoms and grows into fruit, which then rot (see Reference 1).

Scouting/thresholds: Record the occurrence and severity of blossom blight and fruit rot. No thresholds have been established.

11.3.6 Cottony Leak, *Pythium spp.*

Time for concern: Fruit set through harvest

Affected crop(s): Cucumber and winter squash

Key characteristics: Brown, water-soaked lesions appear on the fruit and become watery and soft. Infected areas become covered with cottony growth (see Reference 1).

Scouting/thresholds: Primarily a problem for cucumbers, but also observed on winter squash. No thresholds have been established.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.6 Pesticides Labeled for Management of Cottony Leak

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BIOLOGICAL						
Actino-Iron (*Streptomyces lydicus WYEC 108*)	C, WS	10-15 lb	-	4	?	Water in after application.
Actinovate AG (*Streptomyces lydicus*)	C, WS	3-12 oz as a soil drench	0	1 or until dry	4	Soil drench at planting, seedling, or transplanting.
Serenade Soil (*Bacillus subtilis str. QST 713*)	C, WS	2.2-13.2 fl oz/1000 row feet	0	4	?	Used as in furrow application.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.3.7 Damping-off and Root Rot, *Pythium spp*.

Time for concern: Seeding through harvest

Affected crop(s): Cucumber and winter squash that are direct-seeded

Key characteristics: Watery rot develops in taproot and hypocotyl at or near the soil line. Seedlings eventually die. Mature plants show symptoms of root and crown rot. See Reference 1.

Scouting/thresholds: This problem occurs early in the season if the soil is excessively wet. No thresholds have been established.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.7 Pesticides Labeled for Management of Damping-off and Root Rot						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
BIOLOGICALS						
Actino-Iron (*Streptomyces lydicus WYEC 108*)	C, WS	10-15 lb	-	4	?	Water in after application.
Actinovate AG (*Streptomyces lydicus*)	C, WS	3-12 oz as soil drench	0	1 or until dry	?	
Mycostop Mix (*Streptomyces griseoviridis str. K61*)	C, WS	1-4 g/ cu. yd.	-	4	?	Do not treat cucurbit seeds with Mycostop Mix. Only labeled for pythium suppression in greenhouse.
Mycostop *(Streptomyces griseoviridis* Strain K61)	C, WS	15-30 oz/a as soil spray or drench	-	4	?	Irrigate within 6 hours after soil spray or drench with enough water to move Mycostop into the root zone.
PlantShield (*Trichoderma harzianum*)	C, WS	1-2 oz/acre	0	Until dry	3	Not effective in 1 out of 1 trials. Used in furrow or as a starter solution.
RootShield WP (*Trichoderma harzianum Str. T-22 (KRL-AG2))*	C, WS	3-5 oz/100 gal soil drench 16-32 oz/A – in furrow or transplant solution	-	Until dry	?	Applied as a soil drench, in furrow spray or transplant starter solution.
RootShield Granule *(Trichoderma harzianum str. T-22 (KRL-AG2))*	C	1-1.5 lb/cu. Yd. soil mix	-	0	?	For use when grown as a hydroponic crop.
Serenade Soil (*Bacillus subtilis str. QST 713*)	C, WS	2.2-13.2 fl oz/1000 row feet	0	4	?	Used as in furrow application.
T-22 HC (*Trichoderma harzianum*)	C, WS	2-8 oz/cwt seed 1-2 oz/A in furrow	-	Until dry	3	Not effective in 1 out of 1 trials. Used in furrow or as a seed treatment.
OTHER						
OxiDate (*hydrogen dioxide*)	C, WS	1/2 to 1 gal	0	Until dry	1	Effective in 1 out of 1 trials. In-furrow applications at planting as a drench. See label.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.3.8 Fusarium Wilt, *Fusarium oxysporum f. sp. melonis (Races 0, 1, and 2); Fusarium crown and foot rot, Fusarium solani f. sp. cucurbitae (Race 1); and Verticillium wilt, Verticillium dahliae*

Time for concern: Mid-season to harvest

Affected crop(s): Squash are particularly susceptible to Fusarium crown and foot rot. Cucumbers are less susceptible.

Key characteristics: Two races of Fusarium wilt of melon (Race 1 and 2) occur in New York. Leaves yellow and wilt. Stems may show gummy exudate and exhibit vascular discoloration. Affected plants exhibit crown necrosis and often visible fungal growth (mycelium); plants are stunted and eventually wilt. Verticillium wilt has been implicated with wilt of cucumber (see References 1 and 6). See Cornell fact sheet (Link 48).

Scouting/Thresholds: Record the occurrence and severity of these diseases. No thresholds have been established. (see References 3 and 6).

Notes: Liming soil to a pH of 6.5-7.0 can reduce wilt.

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TABLE 11.3.8 Pesticides Labeled for Management of Fusarium Wilt

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BIOLOGICAL						
Actino-Iron (*Streptomyces lydicus WYEC 108*)	C, WS	10-15 lb	-	4	?	Water in after application.
Actinovate AG (*Streptomyces lydicus*)	C, WS	3-12 oz as soil drench	0	1 or until dry	?	Soil drench at planting, seedling, or transplanting.
Mycostop Mix (*Streptomyces griseoviridis str. K61*)	C, WS	7.6-30 oz/A as soil spray or drench 0.5-1 lb/ treated acre as band, in-furrow or side dress.	-	4	?	Do not treat cucurbit seeds with Mycostop Mix. Use at planting. Irrigate within 6 hours after soil spray or drench with enough water to move Mycostop into the root zone. Lightly incorporate furrow or band applications.
Mycostop (*Streptomyces griseoviridis* Strain K61)	C, WS	15-30 oz/a as soil spray or drench	-	4	?	Irrigate within 6 hours after soil spray or drench with enough water to move Mycostop into the root zone.
RootShield WP (*Trichoderma harzianum Str. T-22 (KRL-AG2))*	C, WS	3-5 oz/100 gal – soil drench 16-32 oz/A – in furrow or transplant	-	Until dry	?	applied as a soil drench, in furrow spray or transplant starter solution.

TABLE 11.3.8 Pesticides Labeled for Management of Fusarium Wilt						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
		solution				
Serenade Soil (*Bacillus subtilis str. QST 713*)	C, WS	2.2-13.2 fl oz/1000 row feet	0	4	?	Used as in furrow application.
T-22 HC (*Trichoderma harzianum*)	C, WS	2-8 oz/cwt seed 1-2oz/A	-	Until spray has dried	?	In furrow or starter solution or as seed treatment
OTHER						
OxiDate (*hydrogen dioxide*)	C, WS	1/2 to 1 gal	0	Until dry	?	In-furrow applications at planting as a drench.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.3.9 Gummy Stem Blight (foliar phase) and Black Rot (fruit rot phase); *Didymella bryoniae* (sexual stage) and *Phoma cucurbitacearum* (asexual stage)

Time for concern: Mid-July through harvest and storage

Affected crop(s): All cucurbits

Key characteristics: On foliage, symptoms vary from water-soaked areas often first near the margin or as individual, circular tan to dark brown spots. On stems, brown cankers develop, and reddish to black exudate may appear. Often, black pepper-sized specks appear in the spots and cankers, which are the small, fruiting bodies of the fungus. Foliar symptoms are less common on winter squash (see References 1, 7, and 8). See Cornell fact sheet (Link 49)

Management Option	Recommendations for Gummy Stem Blight and Black Rot
Scouting /Thresholds	None established
Crop Rotation	Rotate to a non-cucurbit crop for 2 years
Sanitation	As soon as a cucurbit crop is harvested, the decaying crop debris should be plowed under to destroy infected debris and reduce inoculum.
Harvest	Avoid injuring fruit when harvesting, as these wounds allow the pathogen to enter and the fruit could rot in storage. Cutting stems short can help reduce injury.
Notes	Do not use seed from infected fruit Moisture is necessary for the pathogen to infect. Optimal conditions for the pathogen are: relative humidity of 85% or higher, and 1-10 hours of free moisture on the leaves (due to rainfall, dew, or irrigation). Thus, it is important to minimize free moisture on the leaf surfaces by using drip rather than overhead irrigation.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.9 Pesticides Labeled for Management of Gummy Stem and Black Rot						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
BIOLOGICAL						
Regalia SC (Reynoutria sachalinensis)	C,WS	0.5% volume to volume	7	24	?	Labeled only for gummy stem blight. A preventative fungicide. Apply with 0.02% wetting agent in 50-100 gal water
Serenade MAX (*Bacillus subtilis*) Serenade ASO (*Bacillus subtilis)*	C, WS	1-3 lbs 2-6 qts	0 0	4 4	? ?	
COPPER						
Basic Copper 53 (*Basic copper sulfate)*	C, WS	2 lbs	Up to day of harvest	24	1	Only labeled for gummy stem blight. + out of ++++ in Cornell Guidelines
Champ WG (*Copper hydroxide*)	C, WS	1½ -3 lbs	-	24	?	Only labeled for gummy stem blight.
OIL						
Organic JMS Stylet Oil	C, WS	3-6qt/100 gallons	0	4	?	Only labeled for gummy stem blight. See label for sulfur and other incompatibility information.
OTHER						
OxiDate (*Hydrogen dioxide*)	C, WS	1/3 to 1 gal. Per 100 gal.	0	Until dry	?	Only labeled for gummy stem blight. Do not spray OxiDate during conditions of intense heat, drought or poor vine canopy.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.
+ = may be ineffective under high disease pressure; ++++ = highly effective.

11.3.10 Plectosporium Blight, *Plectosporium tabacinum*

Time for concern: From flowering to fruit set and following, especially during periods of extended rainfall.

Affected crop(s): A rare disease on winter squash and cucumber.

Key characteristics: Light tan to "bleached", sunken, spindle-shaped lesions, primarily on the main stems, petioles and main veins (upper and lower leaf surfaces), and spindle and/or circular lesions on fruit.

Scouting/thresholds: Begin scouting at the first sign of powdery mildew and when vines begin to run and fruit set begins. Frequent rainy periods promote infection and spread in the canopy.

Resistant varieties: Waltham winter squash is reported to have high resistance.

11.3.11 Scab - *Cladosporium cucumerinum*

Time for concern: When vines begin to run

Affected crop(s): All cucurbits

Key characteristics: The fungus can attack any aboveground portion of the plant, including leaves, petioles, stems, and fruits. On leaves, the initial pale green, water-soaked areas turn brown, are irregular in shape, and have a yellow halo around the lesion. Eventually, the center of the lesion decays, giving a "shot-holed" appearance that is very diagnostic. Lesions also develop on the fruit. A mean temperature range of 63° to 70°F with wet weather is required for spore dispersal and infection (see References 1, 4, and 11). See Cornell fact sheet (Link 50).

Scouting/thresholds: Use the following scouting method for angular leaf spot, anthracnose, scab, Septoria, and Ulocladium. As the plants begin to run, choose five representative sites. At each site, inspect two older leaves on each of five plants, for a total of 50 leaves inspected per field. Record the number of infected plants. After the row closes, substitute five plant areas. Examine ten leaves and five fruit per area. Calculate and record the percent of plants infected. Threshold: symptoms found on one leaf per 50 leaves sampled (see Reference 3).

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.11 Pesticides Labeled for Management of Scab

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BIOLOGICALS						
Trilogy (*Neem extract*)	C, WS	0.5-1% in 25-100 gal water	None listed	4	?	Maximum labeled rate of 2 gal/acre/application.
COPPER						
Basic Copper 53 (*Basic copper sulfate)*	C, WS	2 lbs	Up to day of harvest	24	1	+ out of ++++ in Cornell Guidelines.
Cueva Fungicide Concentrate (*copper octanoate*)	C, WS	0.5-2.0 gal/100gal water	Up to day of harvest	4	?	Note that mixed material is applied at 50-100 gallons of diluted spray per acre.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.
+ = may be ineffective under high disease pressure; ++++ = highly effective.

11.3.12 Sclerotinia White Mold, *Sclerotinia sclerotiorum*

Time for concern: Fruit set to end of season

Affected crop(s): Winter squash

Key characteristics: Rapid decay characterized by a watery, odorless rot and an abundance of white, cottony mold. Black, pea-sized sclerotia embedded in the cottony mycelium are diagnostic (see References 1 and 7). See Cornell photos (Link 51).

Scouting/thresholds: Record the occurrence and severity of Sclerotinia white mold. No thresholds have been established.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.12 Pesticides Labeled for Management of Sclerotinia White Mold

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BIOLOGICALS						
Actino-Iron (*Streptomyces lydicus WYEC 108*)	C, WS	10-15 lb	-	4	?	Water in after application.
Actinovate AG (*Streptomyces lydicus*)	C, WS	3-12 oz	0	1 or until dry	?	Apply to foliage or as soil drench.

Table 11.3.12 Pesticides Labeled for Management of Sclerotinia White Mold						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
Contans WG (*Coniothyrium minitans)*	C, WS	1-4 lbs/A	-	4	2	Effective in 7 out of 10 trials. Apply to soil.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.3.13 Seed-Borne Diseases and Seed Decay

Time for concern: Seedling

Affected crop(s): All cucurbits

Key characteristics: Many seed-borne and soil-borne fungi can cause early seedling death. This can occur early in the season as damping-off or later as stem cankers.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.13 Pesticides Labeled for Management of Seed-Borne Disease and Seed Decay						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
Actino-Iron (*Streptomyces lydicus WYEC 108*)	C, WS	10-15 lb	-	4	?	Water in after application.
Actinovate AG (*Streptomyces lydicus*)	C, WS	3-12 oz	0	1 or until dry	?	Apply as soil drench.
RootShield WP (*Trichoderma harzianum Str. T-22 (KRL-AG2))*	C, WS	3-5 oz/100 gal-soil drench 16-32 oz/A- in furrow or as transplant solution	-	Until dry	?	Applied as a soil drench, in furrow spray or transplant starter solution.
Serenade Soil (*Bacillus subtilis str. QST 713*)	C, WS	2.2-13.2 fl oz/1000 row feet	0	4	?	Used as in furrow application.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.3.14 Septoria Leaf Spot, *Septoria cucurbitacearum*

Time for concern: June through harvest

Affected crop(s): Winter squash

Key characteristics: Spots are normally circular, beige to white with a narrow brown border, and measure 1 to 2 mm in diameter. Older spots have small, black, speck-like fruiting bodies embedded within the tissues. A mean temperature range of 58° to 64°F with wet weather is required for spore production, dispersal, and infection (see References 1, 12, and 13). See Cornell fact sheet (Link 52).

Scouting/thresholds: Use the following scouting method for angular leaf spot, anthracnose, scab, Septoria, and Ulocladium. As the plants begin to run (vine types) or flower (bush types), choose five representative sites. At each site, inspect two older leaves on each of five plants, for a total of 50 leaves inspected per field. Record the number of infected plants. After the row closes (vine types) or fruit that have set begin to enlarge (bush types), substitute five plant areas. Examine ten leaves and five fruit per area. Calculate and record the percent of plants infected. Threshold: symptoms found on one leaf per 50 leaves sampled. See Reference 3.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.14 Pesticides Labeled for Management of Septoria Leaf Spot

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
COPPER						
Basic Copper 53 (Copper sulfate)	C, WS	2 lbs	Up to day of harvest	24	1	+/- effectiveness from Cornell Guidelines

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.
+/- = May be ineffective under high disease pressure; ++++ = highly effective

11.3.15 Ulocladium Leaf Spot

Time for concern: Mid-August into September

Affected crop(s): Cucumber

Key characteristics: Leaves develop spots with beige centers and brown rings. Lesions may also occur on the stems, but no fruit lesions occur (see Reference 1).

Scouting/thresholds: Use the following scouting method for angular leaf spot, anthracnose, scab, Septoria, and Ulocladium. As the plants begin to run, choose five representative sites. At each site, inspect two older leaves on each of five plants, for a total of 50 leaves inspected per field. Record the number of infected plants. After the row closes, substitute five plant areas. Examine ten leaves and five fruit per area. Calculate and record the percent of plants infected. Threshold: symptoms found on one leaf per 50 leaves sampled (see Reference 3).

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 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 11.3.15 Pesticides Labeled for Management of Ulocladium Leaf Spot						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
Cueva Fungicide Concentrate (*copper octanoate*)	C, WS	0.5-2.0 gal/100gal water	Up to day of harvest	4	?	Note that mixed material is applied at 50-100 gallons of diluted spray per acre.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

11.3.16 Viruses Diseases of Cucurbits

Virus diseases of cucurbit are spread by aphids, however, the use of insecticides to kill aphid vectors is not effective for controlling these viruses. Virus incidence is lower if crop is maintained with a healthy green color as opposed to yellowing. Irrigating in dry years may help mitigate impacts of virus infection. Record the occurrence and severity of any viruses present. A list of weed and crop hosts of plant pathogenic viruses can be found in the Cornell publication, Virus Diseases of Cucurbits (Link 53). Photos of symptoms may be found at the Cornell cucurbit virus photo (Link 54, References 3 and 7).

Table 11.3.16 Virus Diseases of Cucurbits

Disease/Symptoms	Spread by	Time for concern	Resistant Varieties	Notes
Papaya ring spot virus (PRSV). Foliar symptoms are more severe than those of WMV and some strains of CMV. Leaves show severe malformations, and extreme reduction of leaf lamina, causing a "fern-leaf" or "strap-leaf" appearance. Fruit symptoms may be severe for most cucurbits and consist of malformation, knobby outgrowths, and color breaking (see Reference 1).	Aphids	Mid-June through the end of the season	See Section 6:Varieties	Affects winter squash more often than cucumber
Watermelon mosaic virus (WMV). This virus causes milder symptoms on foliage than CMV. Mixed infections with CMV are common by the end of the season (see References 1, 4, and 14).	Aphids	Mid-June through the end of the season	See Section 6: Varieties	
Cucumber Mosaic Virus (CMV). On susceptible cucumbers, young leaves become mottled and distorted. Growth is dwarfed, and V-shaped, yellow blotches form on the older leaves. Fruit show a mosaic pattern of pale green or white areas mixed with dark green bumps. Mosaic patterns can appear on the foliage of winter squash (see References 1, 4, and 14).	Aphids	Early June through end of the season	See Section 6: Varieties	Affects winter squash more often than cucumber.
Zucchini yellow mosaic virus (ZYMV). Extreme reduction of leaf lamina can occur as with PRSV, giving a "fern-leaf" or "strap-leaf" appearance. Fruits remain small, malformed, and green-mottled (see References 1, 4, and 14).	Aphids	Mid-June through harvest	None available	Affects winter squash more often than cucumber

PRSV=Papaya ring spot virus, CMV=Cucumber mosaic virus, WMV=Watermelon mosaic virus, ZYMV=Zucchini yellow mosaic virus.

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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 11.3.16 Pesticides Labeled for Management of Viruses

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
Glacial Spray Fluid (*Mineral oil*)	C, WS	0.75-1 gal/100gal	up to day of harvest.	4	?	See label for specific application volumes
Organic JMS Stylet Oil (*Paraffinic oil*)	C, WS	3 qt/100 gal	0	4	?	See label for sulfur and other incompatibility information.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

12. NONPATHOGENIC DISORDERS

Environmental factors can cause symptoms that appear to be diseases but are actually not caused by a pathogen or insect. Table 12.1 provides a list of disorders that may be confused with diseases.

Table 12.1 Nonpathogenic Disorders of Winter Squash and Cucumbers

Disorder	Affected crop(s)	Cause/Recommendation
Oedema	Winter squash	Provide a consistent level of moisture to help reduce this moisture-stress related problem.
Poor fruit set	Cucumber/Winter squash	Related to poor pollination. Also, weather dependent. Provide honeybee hives at a rate of 1 hive per 2 acres.
No female flowers	Cucumber/Winter squash	Variety or weather related.
Misshapen fruit	Cucumber	Poor pollination or water management during fruit enlargement.
Fruit hollows	Cucumber	Good water management during fruit enlargement is essential.

13. INSECT MANAGEMENT

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

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

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

Natural Enemies

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

Vegetable Insect Pests (Reference 69) and *A Guide to Natural Enemies in North America* (Reference 70).

Regulatory

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

Efficacy

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

Resources:

Natural Enemies of Vegetable Insect Pests (Reference 69).
Biological Control: A Guide to Natural Enemies in North America (Reference 70).
Resource Guide for Organic Insect and Disease Management (Reference 3).

Table 13 Pesticides Labeled for Insect Control in Organic Cucumbers and Winter Squash

Product Trade Name (*Common name*)	Aphids	Spider Mites	Squash Bug	Squash Vine Borer	Striped and Spotted Cucumber Beetle
BOTANICAL					
Aza-Direct (*Azadirachtin*)	X	X	X	X	X
AzaGuard (*Azadirachtin*)	X				X
Azahar (*Azadirachtin*)	X	X	X		X
AzaMax (*Azadirachtin*)	X	X	X		X
Azatrol (*Azadirachtin*)	X	X	X	X	X
Neemazad (*Azadirachtin*)	X		X		
Neemix 4.5 (*Azadirachtin*)	X		X	X	
PyGanic EC 5.0 (*Pyrethrins*)			X		X
PyGanic EC 1.4 (*Pyrethrins*)			X	X	X
Safer Brand #567 (*Pyretrhin & potassium salts of fatty acids*)	X	X			X
Trilogy (*Neem extract*)	X	X			
OILS					
Glacial Spray Fluid (*Mineral oil*)	X	X			X
Golden Pest Spray Oil (*Soybean oil*)	X	X	X		
Organic JMS Stylet Oil (*Paraffinic oil*)		X			
Saf-T-Side (*Petroleum oil*)	X	X			
SuffOil-X (*Petroleum oil*)	X	X			X
OTHER					
Surround WP (*Kaolin clay*)					X
SucraShield (*Sucrose octanoate*)	X	X			

13.1 Aphids, primarily the melon aphid, *Aphis gossypii*

Time for concern: When runners are present

Affected crop(s): All cucurbits

Key characteristics: Melon aphids vary in color, but all stages have black cornicles, "tail pipes," eyes, and leg joints. They are about 1/16 inch long. See Cornell fact sheet for photo (Link 56).

Transmission of viruses: Aphids are vectors of viruses. See Section 10.3.16: Viruses for symptoms and management of these diseases. Where possible, eliminate virus host plants such as pokeweed, burdock, and other perennial broadleaf weeds.

Direct damage: Aphid infestations usually occur on the undersides of leaves where they extract plant sap with their sucking/piercing mouthparts. Infested leaves will twist, pucker, or cup. Heavy infestations can cause severe leaf distortion. Aphids excrete honeydew which gives leaves a glossy appearance. Sooty mold may buildup on honeydew resulting in cosmetic damage to fruit at harvest (see References 1 and 15).

Management Option	Recommendations for Aphids
Scouting/thresholds	Aphids are found on the undersides of leaves. Examine two runners at five sites. Record the number of runners with aphids present. If more than 20 percent of the runners have live aphids, treatment may be required. Careful examination of infestations should show the presence of a variety of natural enemies including lady beetles, syrphids, lacewings, and mummified aphids (those parasitized by wasps).See Cucurbit IPM Scouting Procedures (Reference 3).
Natural enemies	Naturally occurring predators, parasitoids, and pathogens help suppress aphid infestations. Use Reference 16 or see Cornell guide to natural enemies (Link 55). Increases in aphid infestations are sometimes associated with applications of insecticides that have killed natural enemies. Natural enemies will not kill aphids in time to prevent the spread of viruses.
Resistant varieties	Planting resistant varieties is the primary means of controlling aphid-transmitted viruses. Section 6: Varieties.
Site selection	Plant later season fields as far away from existing cucurbits as possible.
Mulches	Where feasible, reflective mulches may repel aphids. Direct seeding through the foil is recommended for maximum protection.
Crop rotation, Postharvest, Sanitation	These are not currently viable management options.
Notes	Hot, dry weather can cause melon aphid populations to rapidly increase. If scouting indicates localized infestations, spot spraying should be considered. Good coverage is critical for control of aphid infestations with insecticides.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 13.1 Pesticides Labeled for Management of Aphids						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
BOTANICAL						
AZA-Direct (*azadirachtin*)	C, WS	1-2 pts	0	4	?	May be tank mixed at rates as low as 4 oz/A. Maximum rate is 3.5 pt/A under extremely heavy pest pressure.
AzaGuard (*Azadirachtin*)	C, WS	10 oz	0	4	?	Apply with OMRI approved spray oil.
Azahar (*Azadirachtin*)	C, WS	10-41 fl oz/A	0	4	?	
AzaMax (*Azadirachtin*)	C, WS	1.33 fl oz/1000 ft^2	0	4	?	
Azatrol EC (*azadirachtin)*	C, WS	Up to 57 oz/ 1000ft^2	0	4	?	
Neemazad 1% EC (*Azadirachtin*)	C, WS	22.5-31.5 fl oz	-	4	?	Suppression and adult feeding deterrence. Not labeled for melon aphid.
Neemix 4.5 (*azadirachtin*)	C, WS	5-7 oz	0	12	?	Only labeled for green peach aphid.
OILS						
Glacial Spray Fluid (*Mineral oil*)	C, WS	0.75-1 gal/100gal	up to day of harvest.	4	?	See label for specific application volumes.
Golden Pest Spray Oil (*Soybean oil*)	C, WS	2 gal	-	4	?	
Saf-T-Side (*Petroleum oil*)	C, WS	1-2 gal/100 gal water	Up to day of harvest	4	?	
SuffOil-X (*Petroleum oil*)	C, WS	1-2 gal/100 gal water	Up to day of harvest	4	?	Do not mix with sulfur products.
OTHER						
Safer Brand #567 Pyrethrin & Insecticidal Soap Concentrate II (*pyrethrin & potassium salts of fatty acids*)	C, WS	1:20 parts water applied at 1 gal mix/700ft^2	Until spray has dried	12	?	
SucraShield (*Sucrose octanoate esters*)	C, WS	0.8-1% vol to vol solution	0	48	?	Use between 25 and 400 gal per acre of mix per acre depending on type, growth state and spacing of crop.
Trilogy *(neem extract)*	C, WS	0.5-1% in 25-100 gal water	None listed	4	?	Maximum labeled rate of 2 gal/acre/application.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

13.2 Striped and Spotted Cucumber Beetle, *Acalymma vittatum* and Spotted Cucumber Beetle, *Diabrotica undecimpunctata howardi*

Time for concern: Entire season, but especially when plants are small

Affected crop(s): Cucumber, and winter squash

Key characteristics:

***Cucumber beetles*:** See Cornell fact sheet (Link 57). The striped cucumber beetle is 1/4 inch long with black and yellow longitudinal stripes that extend to the tip of the abdomen. The head and abdomen are black. The spotted cucumber beetle is yellow green with 12 black spots, a black thorax, and yellow abdomen. Full grown larvae are 3/8 inch long, creamy white with a dark head and "tail," and three pairs of short legs. Larvae feed on cucurbit roots. Cucumber beetle adults aggregate on leaves and in flowers. Leaf damage may appear as shot holes in cotyledons or young leaves or leaves may be netlike. Beetles may aggregate in blossoms or feed on fruit and fruit handles. Small seedlings are very susceptible and are often killed. Once the plants attain 4-5 true leaves, they are more tolerant of beetle feeding.

***Bacterial wilt*:** (Section 10.1.1) Cucumber beetles transmit the bacterium, *Erwinia tracheiphila,* which causes bacterial wilt. Cucumbers are the most susceptible. Wilting is most severe when plants are growing rapidly. To determine if a plant is infected, press together two freshly cut sections of a stem and slowly pull them apart. If a "stringy" sap extends between the ends, the plant has bacterial wilt (see References 1, 4, 17, 18, and 24). No rescue treatments are available once the crop is infected with bacterial wilt.

Management Option	Recommendations for Striped and Spotted Cucumber Beetles
Scouting/thresholds	Scout twice a week, especially when plants have less than five leaves. Examine the undersides of cotyledons, young leaves, and stems. At each of five sites in a field, inspect five plants (one per hill). Pay special attention to field edges. Calculate the average number of beetles per plant. Recommended thresholds vary depending on susceptibility to bacterial wilt (Section 10.1.1). Cucumber is susceptible to bacterial wilt. If plants along the edges are heavily damaged or have ≥5 beetles per plant, an insecticide should be applied within 24 hours. Thereafter, only treat if the average number of beetles per plant is 1. See Cucurbit IPM Scouting Procedures (Reference 3). Although young plants are most susceptible, treatment may be necessary when there are ≥5 leaves per plant; if feeding damage is apparent throughout the field; blossoms are heavily infested and being damaged during peak bloom; or young fruit are being fed upon. If feeding on mature fruit or fruit handles is noted and is a concern, treatment may also be warranted.
Transplants	If possible, use transplants instead of direct seeding. They will be older when beetles arrive and therefore more tolerant, or plant later after peak beetle activity is over. Treat transplants with Surround.
Natural enemies	A variety of natural enemies may help suppress cucumber beetle infestations including tachinid flies, parasitoid wasps, and predacious nematodes. Use Reference 16 or see Cornell guide to natural enemies (Link 55) for identification of natural enemies Syrrhizus diabroticae and Celatoria diabroticae.
Perimeter trap crop	Use of trap crops is possible for this pest but has not been researched in organic systems. Cultivars vary dramatically in their attractiveness to beetles. The inexpensive variety Dark Green Zucchini is very attractive and takes up little space. Blue Hubbard squash is also an effective trap crop that is not susceptible to bacterial wilt. A trap crop can be planted early around the perimeter of the cash crop. It is important for trap crop plants to be larger than the main crop plants. It should then be sprayed repeatedly with an insecticide on a cool morning after attracting beetles. Be sure the trap crop completely encircles the main crop to gain the most benefit and discourage entry to the main crop. At low populations, sprays may not be needed. Yellow sticky cards placed in the trap or yellow mulch will enhance the attractiveness of the trap crop. Applications of Surround may reduce the attractiveness of the main crop and discourage beetle movement into the crop. Organic growers who use this technique should disk up the trap crop after the first generation beetles have disappeared to reduce the second generation population. See more information on trap crops from the Connecticut IPM Program (http://www.hort.uconn.edu/IPM/veg/htms/directptc.htm).

Management Option	Recommendations for Striped and Spotted Cucumber Beetles
Trapping	Yellow sticky cup traps should be placed every 20 feet in the outer rows of large fields. Traps should be replaced when saturated with dust and/or beetles.
Row covers	Row covers are an expensive option that may not be well suited to larger fields of cucumbers. They will provide protection from beetles for the first 3 to 4 weeks of the season, but they must be removed when blossoms appear to permit pollination.
Resistant varieties	The presence of cucurbitacins stimulates cucumber beetle feeding, and varieties with less cucurbitacin show less damage (see Section 6: Varieties).
Crop rotation and sanitation	Deep plowing and clean cultivation after harvest may reduce overwintering populations. Keep headlands mowed. Rotate cucurbits to distant fields to help delay infestations.
Beneficial Nematodes	Some beneficial nematodes, particularly Steinernema riobravis, have shown promise for management of both striped and spotted cucumber beetles. Application to the root systems of plants with early season populations will reduce, but not fully control, the following generation. Read more about their use and find suppliers at http://www.nysaes.cornell.edu/ent/biocontrol/pathogens/nematodes.html.
Notes	Treat hot spots if possible. Insecticide applications may be more effective if made between dusk and dawn, when the striped cucumber beetle is most active. Striped cucumber beetles colonize cucurbits and continue to buildup over a two to three week period early in the season. Waiting until the field is fully colonized and at threshold will result in adequate control with one or two applications. When making this decision, consideration must be given to the susceptibility of the variety to bacterial wilt (see Section 10.1.1).

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 13.2 Pesticides Labeled for Management of Striped and Spotted Cucumber Beetles

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BOTANICALS						
AZA-Direct (*azadirachtin*)	C, WS	1-2 pts	0	4	?	May be tank mixed at rates as low as 4 oz/A. Maximum rate is 3.5 pt/A under extremely heavy pest pressure.
AzaGuard (*Azadirachtin*)	C, WS	8 oz	0	4	0	Apply with OMRI approved spray oil.
Azahar (*Azadirachtin*)	C, WS	12-41 fl oz/A	0	4	?	
AzaMax (*Azadirachtin*)	C, WS	1.33 fl oz/1000 ft^2	0	4	?	
Azatrol EC (*azadirachtin)*	C, WS	Up to 57 oz/ 1000 sq. ft.	0	4	?	
Pyganic EC 5	C, WS	4.5-18 oz	0	12	2	
PyGanic EC 1.4 (*pyrethrins)*	C, WS	64 oz	0	12	2	Effective in 1 of 2 trials. Multiple applications at 3-day intervals might be needed.
KAOLIN						

Table 13.2 Pesticides Labeled for Management of Striped and Spotted Cucumber Beetles						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
Surround WP (*kaolin clay)*	C, WS	12.5-50 lbs	Up to day of harvest	4	2	Effective in 1 of 2 trials
OILS						
Glacial Spray Fluid (*Mineral oil*)	C, WS	0.75-1 gal/100gal	up to day of harvest.	4	?	Only for use against larvae. See label for specific application volumes
SuffOil-X (*Petroleum oil*)	C, WS	1-2 gal/100 gal water	Up to day of harvest	4	?	Labeled for beetle larvae only. Do not mix with sulfur products.
OTHER						
Safer Brand #567 Pyrethrin & Insecticidal Soap Concentrate II (*pyrethrin & potassium salts of fatty acids*)	C, WS	1 part concentrate to 20 parts water applied at 1 gal mix/700ft^2	Until spray has dried	12	?	
Surround WP *plus* PyGanic EC 1.4 (or Pyganic 5EC)	C, WS	12.5-25 lbs 64oz (4.5-18oz)	0	12	?	

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

13.3 Seedcorn Maggot, *Delia platura*

Time for concern: Seed sprouting to emergence

Affected crop(s): All cucurbits

Key characteristics: Adult flies are about 1/4 inch long and gray black in color. Maggots are yellowish white. Infested seeds and other plant parts are hollowed out. Damaged plants are weak and may not develop. Stand may be poor. See University of Minnesota fact sheet (Link 58).

Management Option	Recommendations for Seedcorn Maggot
Scouting/thresholds	Areas in the field where seedling emergence is poor may indicate seedcorn maggot injury. Examine five to ten seedlings in these areas and note if heavy root feeding is apparent. Growing tips may also be destroyed. Record the percentage of plants damaged.
Natural enemies	Predators, parasitoids, and pathogens, including nematodes help suppress infestations. Use Reference 16 or see Cornell guide to natural enemies (Link 55)..
Resistant varieties	No resistant varieties are available.
Planting date	Where feasible, delay planting until the first generation maggots has pupated. In New York, this is about June 21. Warmer soils will allow seedlings to germinate and grow faster, leaving less time for maggots to feed and cause injury.
Transplants	If feasible, use transplants rather than seed.
Site selection/preparation	Root maggots prefer soil with high organic matter. Do not spread manure directly before planting, and incorporate crop residues well before planting. Shallow planting and other means to speed up germination and emergence will reduce damage.

13.4 Squash Bug, *Anasa tristis*

Time for concern: When plants develop runners through harvest

Affected crop(s): All cucurbits

Key characteristics: Adults are flat, grayish or yellowish brown, and about 5/8 inch long. The edges of the abdomen, which protrude from beneath the wings, are orange and brown striped. Eggs are reddish orange and laid in clusters on the upper leaf surface. Nymphs are pale green, but become dark, greenish gray, or brown as they mature. Young nymphs feed in clusters. Adults and nymphs feed on leaves and stems. If the infestation is severe, leaves on mature plants will appear blackened as if burned. These bugs also feed directly on developing fruit. Squash bugs are known to vector a bacterial pathogen (*Serratia marcescens*), the causal agent for cucurbit yellow vine decline. This disease has not been identified in New York but has been reported in New England. See Cornell squash bug photos and life cycle description (Links 59 and 60).

Management Option	Recommendations for Squash Bugs
Scouting/thresholds	Seedling stage: overwintering adults may attack plants. If wilting is observed, check the undersides of plants for bugs. Early flowering stage: if greater than 1 egg mass per plant, treat. Time spray to kill small nymphs (see References 3 and 19).
Indicator trap	Squash bug adults can also be detected by placing boards, 12 inches by 12 inches, between plants. Turn the boards over early in the morning and destroy aggregated bugs.
Natural Enemies	Naturally occurring predators, parasitoids, and pathogens help suppress infestations. A parasitic fly, Trichopoda pennipes, is very common. It lays one or more cream colored, oval eggs on the squash bug's cuticle. Parasitism rates greater than 80% have been reported. Several wasp species parasitize eggs. Use Reference 16 or see Cornell guide to natural enemies (Link 55).
Resistant varieties	Resistant varieties are not available.
Postharvest	Removal or thorough destruction of crop debris and other field trash after harvest will remove overwintering shelter for the bugs. Deep tillage will bury and kill overwintering adults.
Crop rotation	Rotate annually to a non-cucurbit crop (Link 63).
Crop rotation, Site selection, Seed selection/ treatment, and sanitation	Avoid heavy mulch or no-till in susceptible varieties. Squash bugs like shelter and appear more numerous in reduced tillage or mulched crop systems. Removing shelter can help to reduce overwintering populations.
Notes	Squash bugs are secretive and difficult to reach with insecticides. Thorough coverage is important. Insecticides should be directed against young nymphs. See information on product efficacy at: Resource Guide for Organic Insect and Disease Management (Reference 24) and ATTRA publication on organic squash bug control (Link 63).

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 13.4 Pesticides Labeled for Management of Squash Bug						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
BOTANICALS						
Azadirachtin						
AZA-Direct (*azadirachtin*)	C, WS	1-2 pts	0	4	2	Effective in 2 of 3 trials. May be tank mixed at rates as low as 4 oz/A. Maximum rate is 3.5 pt/A under extremely heavy pest pressure.
Azahar (*Azadirachtin*)	C, WS	10-41 fl oz/A	0	4	?	
AzaMax (*Azadirachtin*)	C, WS	1.33 fl oz/1000 ft^2	0	4	?	
Azatrol EC (*azadirachtin)*	C, WS	Up to 57 oz/1000 sq. ft.	0	4	2	Effective in 2 of 3 trials.
Neemazad 1% EC (*Azadirachtin*)	C, WS	18-72 fl oz	-	4	?	Target nymphs
Neemix 4.5 (*azadirachtin)*	C, WS	7-16 oz	0	12	2	Effective in 2 of 3 trials.
Pyrethrins						
PyGanic EC 5	C, WS	4.5-18 oz	0	12	2	
PyGanic EC 1.4 (*pyrethrins)*	C, WS	64 oz	0	12	?	
OTHER						
Neemix 4.5 *plus* PyGanic EC 1.4 (or PyGanic EC 5)	C, WS	16 oz 32oz 4.5-18oz	0 0	12	? ?	Weekly sprays recommended, but tighter if longer egg laying period. Nymphs are the only susceptible stage.
Golden Pest Spray Oil (*Soybean oil*)	C, WS	2 gal	-	4	?	

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

13.5 Squash Vine Borer, *Melittia cucurbitae*

Time for concern: Mid-June through August

Crops: Squash vine borer rarely affects cucumbers and butternut squash are practically immune to attack (Reference 24).

Key characteristics: The adult of the squash vine borer is a wasp-like moth having a 1 to 1½ inch wingspan, with metallic green forewings. The mature larva or caterpillar is a thick, white wrinkled worm with a brown head and is about 1 inch in length. The eggs are dull red, 1/25th inch in diameter and are found glued to the stalks and stems of squash vines. The pupa is dark brown, 5/8 inch long and found in an earthen cell. See Cornell squash vine borer photos and life cycle description (Links 61 and 62).

Management Option	Recommendations for Squash Vine Borer
Scouting/thresholds	Because larvae are protected from insecticides once they have bored into the stem, adult activity should be used to time insecticide applications where squash vine borer is a perennial problem. Adult activity may be monitored using pheromone traps or predicted using base 50° F degree-day (DD_{50}) accumulations. The flight begins around 1000 base 50 degree-days, which coincides with the beginning of chicory flowering. Refer to the NYS IPM Program's Network for Environment and Weather Awareness (NEWA) to calculate degree-days (Link 3).
Natural enemies	Predators, parasitoids, and pathogens, including beneficial nematodes help suppress infestations. Use Reference 16 or see Cornell guide to natural enemies (Link 55).
Resistant varieties	Both cucumber and butternut squash are at low risk of infestation.
Row Covers	Lightweight row covers can be also used to protect plants until the vines come into flower. Remove covers at bloom time to allow for pollination. However this method is best suited to small fields and is not practical or economical for larger production areas.
Rotation/Sanitation	Rotate annually to a non-cucurbit crop but keep in mind, adult squash vine borers are strong fliers and are known to have the ability to fly up to 1/2 mile from their emergence site (Link 63).
Cultural	Fall tillage exposes cocoons (pupae) to predation and deep incorporation in early spring further helps to keep populations suppressed. However leaving ground bare for the winter runs contrary to good organic practices. Consider planning a cover crop if time allows (Link 63).
Sanitation	To reduce the number of borers for the next year, destroy crop residue after harvest.
Notes	Application of insecticides is not currently a viable management option. Treatments could be effective if applied to the base of the plant prior to boring into the stem. The ATTRA publication Squash Bug and Squash Vine Borer: Organic Controls (Link 63) has more specific information on squash vine borer management.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 13.5 Pesticides Labeled for Management of Squash Vine Borer

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BOTANICALS						
Azatrol EC (*azadirachtin)*	C, WS	Up to 57 oz/1000 sq. ft.	0	4	?	
AZA-Direct (*azadirachtin*)	C, WS	1-2 pts	0	4	?	May be tank mixed at rates as low as 4 oz/A. Maximum rate is 3.5 pt/A under extremely heavy pest pressure.
Neemix 4.5 (*azadirachtin)*	C, WS	7-16 oz	0	12	?	
PyGanic EC 1.4 (*pyrethrins)*	C, WS	64 oz	0	12	?	

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

13.6 Spider Mites, primarily the two-spotted spider mite, *Tetranychus urticae*

Time for concern: summer when the weather is hot and dry.

Affected crop(s): Cucumber

Key characteristics: The two-spotted spider mite is very small, 1/64 inch long, and greenish yellow with two dark spots on its back. Use a hand lens to confirm identification. Infestations occur primarily on leaf undersides. Webbing indicates presence of mites and hundreds may be present on a single leaf. Heavily infested leaves will turn yellow; undersides of infested leaves will appear crusty. See University of Rhode Island fact sheet with photo to help identify (Link 64).

Management Option	Recommendations for Spider Mites
Scouting/thresholds	No specific scouting or threshold recommendations are available for New York. Watch for infestations as the field is scouted for aphids. Infestations often start at the edge of a field.
Natural enemies	Predatory mites, minute pirate bugs, predatory thrips, and fungal pathogens help suppress mite infestations. Use Reference 16 or see Cornell guide to natural enemies (Link 55). Insecticides applied for other pests can eliminate mite natural enemies.
Resistant varieties	Resistance is not an option for providing control.
Site selection	Avoid planting in areas where dust occurs, such as near dirt roads.
Crop rotation, Seed selection/ treatment, Postharvest, & Sanitation	These are not currently viable management options.
Notes	The problem is worse when the weather is hot and dry. Rains can reduce infestations.

At the time this guide was produced, the following materials were labeled 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. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website (Link 2). ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 13.6 Pesticides Labeled for Management of Mites

Class of Compounds Product Name (*active ingredient*)	Crop	Product Rate/Acre	PHI (days)	REI (hours)	Efficacy	Comments
BOTANICALS						
AZA-Direct (*azadirachtin*)	C, WS	1-2 pts	0	4	?	May be tank mixed at rates as low as 4 oz/A. Maximum rate is 3.5 pt/A under extremely heavy pest pressure.
Azahar (*Azadirachtin*)	C, WS	10-41 fl oz/A	0	4	?	
AzaMax (*Azadirachtin*)	C, WS	1.33 fl oz/1000 ft^2	0	4	?	
Azatrol EC (*azadirachtin)*	C, WS	Up to 57 oz	0	4	?	
OILS						
Glacial Spray Fluid (*Mineral oil*)	C, WS	0.75-1 gal/100gal	up to day of harvest.	4	?	See label for specific application volumes
Golden Pest Spray Oil (*Soybean oil*)	C, WS	2 gal	-	4	?	
Organic JMS Stylet Oil	C, WS	3-6 qts/100gal	0	4	?	Labeled for spider and red mites

Table 13.6 Pesticides Labeled for Management of Mites						
Class of Compounds Product Name (*active ingredient*)	**Crop**	**Product Rate/Acre**	**PHI (days)**	**REI (hours)**	**Efficacy**	**Comments**
(*paraffinic oil)*						only.
Saf-T-Side (*Petroleum oil*)	C, WS	1-2 gal/100 gal water	Up to day of harvest	4	?	
SuffOil-X (*Petroleum oil*)	C, WS	1-2 gal/100 gal water	Up to day of harvest	4	?	Do not mix with sulfur products.
OTHER						
Safer Brand #567 Pyrethrin & Insecticidal Soap Concentrate II (pyrethrin & potassium salts of fatty acids)	C, WS	1 part concentrate to 20 parts water applied at 1 gal mix/700ft^2	Until spray has dried	12	?	
SucraShield (*Sucrose octanoate esters*)	C, WS	0.8-1% vol to vol solution	0	48	?	Use between 25 and 400 gal per acre of mix per acre depending on type, growth state and spacing of crop.
Trilogy *(neem extract)*	C, WS	0.5-1% in 25-100 gal water	None listed	4	?	Maximum labeled rate of 2 gal/acre/application.

C = cucumber; WS = winter squash, PHI = pre-harvest interval, REI = re-entry interval
Efficacy: 1-effective in some research studies, 2- mixed efficacy results, 3-not effective, ?-not reviewed or research not available.

14. Pesticides & Abbreviations Mentioned in this Publication

Table 13.1 Insecticides Mentioned in this Publication

TRADE NAME	COMMON NAME	EPA REG. NO.
Aza-Direct	*Azadirachtin*	71908-1-10163
AzaGuard	*Azadiracthin*	70299-17
Azahar	*Azadirachtin*	71908-1-10163
AzaMax	*Azadiracthin*	71908-1-81268
Azatrol EC	*Azadirachtin*	2217-836
Glacial Spray Fluid	*Mineral oil*	34704-849
Golden Pest Spray Oil	*Soybean oil*	57538-11
Organic JMS Stylet oil	*Mineral oil*	65564-1
Neemazad	*Azadirachtin*	70051-104
Neemix 4.5	*Azadirachtin (neem)*	70051-9
PyGanic EC 1.4	*Pyrethrin*	1021-1771
PyGanic EC 5.0	*Pyrethrin*	1021-1772
Safer Brand #567	*Pyrethrin & Potassium salts of fatty acids*	59913-9
Saf-T-Side	*Aliphatic petroleum solvent*	48813-1
SucraShield	*Sucrose octanoate*	70950-2-84710
SuffOil-X	*Aliphatic petroleum solvent*	48813-1-68539
Surround WP	*Kaolin*	61842-18
Trilogy	*Neem oil*	70051-2

Table 13.2 Fungicides and Disinfectants Mentioned in this Publication

TRADE NAME	COMMON NAME	EPA REG. NO.
Actinovate AG	*Streptomyces lydicus*	73314-1
Actino-Iron	*Streptomyces lydicus WYEC108*	73314-2
Basic Copper 53	*Basic copper sulfate*	45002-8
Champ WG	*Copper hydroxide*	55146-1
Cueva Fungicide Concentrate	*Copper octanoate*	67702-2
Contans WG	*Coniothyrium minitans*	72444-1
Glacial Spray Fluid	*Mineral oil*	34704-849
Organic JMS Stylet oil	*Mineral oil*	65564-1
Kaligreen	*Potassium bicarbonate*	11581-2
Kumulus DF	*Sulfur*	51036-352
Milstop	*Potassium bicarbonate*	70870-1-68539
Micro Sulf	*Sulfur*	55146-75
Microthiol Disperss	*Sulfur*	70506-187
Mildew Cure GC-3	*Cottonseed oil, corn oil, garlic oil*	exempt – 25(b)
Mycostop	*Streptomyces griseoviridis*	64137-5
Mycostop Mix	*Streptomyces griseoviridis*	64137-9
Nu Cop 50 WP	*Cupric hydroxide*	45002-7
Organocide	*Sesame oil*	exempt – 25(b)
Oxidate	*Hydrogen dioxide*	70299-2
PlantShield HC	*Trichoderma harzianum*	68539-4
Regalia SC	*Reynoutria sachalinensis*	84059-2
RootShield WP	*Trichoderma harzianum Str. T-22 (KRL-AG2)*	68539-7
RootShield Granule	*Trichoderma harzianum Str. T-22 (KRL-AG2)*	68539-3
Serenade ASO	*Bacillus subtilis*	69592-12
Serenade MAX	*Bacillus subtilis*	69592-11
Serenade Soil	*Bacillus subtilis*	69592-12
Sonata	*Bacillus pumilis*	69592-13
Sporan EC	*Rosemary oil, clove oil, thyme oil*	exempt – 25(b)
Surround WP	*Kaolin*	61842-18
T-22 HC	*Trichoderma harzianum*	68539-4
Trilogy	*Neem oil*	70051-2

Abbreviations and Symbols Used in This Publication

A	acre	NI	no information
AG	agricultural use label	NFT	not frost tolerant
AR	annual rye	P	phosphorus
ASO	aqueous suspension-organic	PHI	pre-harvest interval
AS	aqueous suspension	P_2O_5	phosphorus oxide
C	cucumber	PR	perennial rye
CMV	cucumber mosaic virus	PRSV	papaya ring spot virus
DF	dry flowable	R	resistant varieties
EC	emulsifiable concentrate	REI	reentry interval
F	flowable	WS	winter squash
HC	high concentrate	WMV	watermelon mosaic virus
K	potassium	WP	wettable powder
K_2O	potassium oxide	WPS	worker protection standards
N	nitrogen	WG	water dispersible granular
NE	not effective	ZYMV	zucchini yellow mosaic virus

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