ORGANIC INSECT AND DISEASE CONTROL FOR CUCURBIT CROPS

INTRODUCTION

The Cucurbitaceae is a large family that includes major vegetable crops including cucumber, muskmelon, watermelon, summer squash, winter squash, pumpkin, gourd, and bitter melon. A similar pest and disease complex affects these crops, though individual varieties differ in susceptibility to various pests.

I. INSECT CONTROL

APHIDS (Primarily *Aphis gossypii*)

Aphids do not cause serious direct injury to cucurbits, but various species of aphids can transmit virus diseases to cucurbits. The use of resistant varieties is the only reliable control for diseases caused by viruses. Aphid feeding may cause the leaves to become distorted. Honeydew (a special name for fecal matter of aphids) may also serve as a growing medium for sooty mold, a fungus that can disfigure the fruit with black blotches.

Cultural Control:

1) Reflective mulches may help to repel aphids while also providing horticultural benefits.

2) Separate later planted fields from existing fields

3) Natural enemies will help keep aphid populations in check but will be less effective in very hot weather when aphids reproduce rapidly. Refrain from using broad-spectrum insecticides.

4) Eliminate virus host plants such as burdock, pokeweed, and other perennial broadleaf weeds

Materials Approved for Organic Production:

Unless virus diseases are a problem, such as in late crops, aphid control is generally not needed. Even in that case, the best control is to eliminate virus host crops, rather than treat for aphids.

SQUASH BUG (*Anasa tristis*)

The squash bug **(Photo 2.1)** sucks sap from the leaves and stems of squash and pumpkins and causes the leaves to wilt and then turn black and crisp. This insect can also feed directly on the fruit and cause severe damage. The adults are dark gray and about 5/8 inch in length. They live through the winter in protected areas both under debris in the fields and in buildings and lay eggs on the underside of leaves in the spring and summer. The eggs hatch into light green or gray nymphs that congregate on leaves or fruit.

Cultural Control:

1) Different cucurbits vary in their susceptibility (see Cornell 2004).

2) Crop rotation and sanitation are very important. Avoid leaving cucurbit crop debris available for over wintering sites. Till debris under in the fall and plant a cover crop. Keep headlands mowed. Next year plant cucurbits in new field.

3) During the summer, adults tend to congregate under shelter at night. Place boards on the soil surface near the squash in the evening and the next morning collect and destroy the pest.

4) Destroy egg masses on the underside of leaves.

5) A parasitic fly, *Trichopoda pennipes*, affects adult squash bugs and several wasps parastize the eggs. Provide habitat for these in or near the field.

6) If squash bugs are a problem on your farm, avoid heavy mulch or no-till in susceptible crops such as zucchini. Squash bugs like shelter, and appear more numerous in reduced tillage or mulched crop systems.

Materials Approved for Organic Production:

1) Pyrethrum on young nymphs

2) Neem (2 of 3 recent studies show good control)

SQUASH VINE BORER (*Melittia cucurbitae*)

The squash vine borer **(Photo 2.2)** is found only on squash and pumpkins. Keep a look out for wilting plant parts that may result from the burrowing of a white "worm" in the squash vines. The vine borer is the larva of a moth that lays its eggs at the base of the plant. It overwinters as a larva in the soil. For reasons that are unclear, squash vine borer tends to be less of a problem in large plantings than in smaller ones.

Cultural Control:

1) Winter squash, pumpkins and zucchini are particularly susceptible. Butternut squash (*C. moschata*) is resistant.

2) Soon after crop harvest, plow the vine debris deeply to bury over larvae.

3) Rotate fields.

4) In small plantings, it may be possible to manually remove the larvae. Find the sawdust-like frass on the affected plant stem, and then locate the larva by slicing lengthwise along the stem until you reach it. Destroy the larva, and then cover the slit stem area with soil.

5) Keep floating row covers in place after transplanting or direct seeding until flowering.

Materials Approved for Organic Production:

Application of approved products is not currently a viable management option. Once the larvae bore into the stems, insecticides are generally not effective, but treatments could be effective if applied to the base of the plant prior to the insect entering the plant.

STRIPED CUCUMBER BEETLE (*Acalymma vittatum*)

Striped cucumber beetles (SCB) are 1/4 inch long with black and yellow longitudinal stripes and black head and abdomen **(Photo 2.3)**. In the Northeast, they pass the winter as adults sheltered under plant debris and become active in the spring as soon as cucurbits appear. The overwintered generation lives until August and feeds on all plant parts. Small seedlings are very susceptible and are often killed. Once the plants attain 4-5 true leaves, they are more tolerant of striped cucumber beetle feeding; however, disease transmission is still important (see below). The beetles lay their eggs at the base of cucurbit plants. These hatch into larvae, which feed below ground on the roots and crowns of the plants. The new generation of adults emerges in July, and can cause feeding damage to pumpkins and other cucurbit fruit. They will overwinter and then feed on next year's crop.

The cucumber beetle also carries the organism that causes bacterial wilt, which can be more damaging than the insect. Cucumbers, summer squash, zucchini and melons are the most susceptible. Reducing the numbers of beetles is the primary way to reduce the risk of wilt.

A related species causing similar damage is the spotted cucumber beetle, which is yellow green with 12 black spots.

Cultural Control:

1) Use varieties that are less attractive to the beetles or less susceptible to bacterial wilt (see Cornell 2004.)

2) Crop rotation and sanitation are important. Avoid leaving cucurbit crop debris available for overwintering sites. Plow debris under after harvest and plant a cover crop to reduce the overwintering population. Keep headlands mowed. Rotate cucurbits to distant fields to help delay infestations.

3) Floating row covers are very effective for avoiding beetle damage. Remember to temporarily remove the covers periodically to weed early, and leave off permanently when the flowers appear to allow pollination.

4) Use of trap crops is possible for this pest. Cultivars vary dramatically in their attractiveness to beetles. The inexpensive variety Dark Green Zucchini is very attractive and takes up little space (see Cornell 2004). Blue Hubbard squash is also an effective trap crop that is not susceptible to wilt. A trap crop can be planted early around the perimeter of the cash crop, and allowed to attract beetles. It should then be sprayed repeatedly with an insecticide or flamed 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.

5) Yellow sticky cups or tape can trap many SCB adults. They should be replaced regularly as they become saturated with beetles and field debris.

6) Use transplants instead of direct seeding. They will be older when beetles arrive and therefore more tolerant, or you can plant later after peak beetle activity is over.

Materials Approved for Organic Production:

1) Kaolin clay (Surround™). Growers report repellency if it is applied frequently—twice a week.

2) Pyrethrum is reported to give some control by growers.

3) A Tank mix of Kaolin clay and pyrethrum may be worth trying.

4) Application of beneficial nematodes to the root systems of plants with early season SCB populations will reduce, but not fully control, the following generation.

5) Rotenone is somewhat effective (Note: No formulations are currently OMRI approved, check with the certification agency).

II. DISEASE CONTROL

The table below for diseases is adapted from the Cornell Pest Management Guidelines for Vegetables (Cornell 2004).

Table 1. Disease Susceptibility of Cucurbits

Disease	Cucumber	Musk melon	Pumpkin	Summer squash	Winter squash	Water melon
Bacterial wilt	H, R	M	M,V	M	L	-
Powdery mildew	M, R	M, R	H, R	H, R	M, R	M
Black rot (gummy stem blight)	L	M	M	L	M	M
Fusarium wilt	-	H, R	-	-	-	-
Fusarium crown rot	L	L	H	M	M	L
Phytophthora blight	H	L	H	H	H	H
Angular leaf spot	L, R	L	M	L	M	L
Downy mildew	M, R	M, R	H	M	H	L
Viruses	L, R	H	M	H, R	M	L

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

DISEASES CAUSED BY BACTERIA

ANGULAR LEAF SPOT

This disease is caused by the bacterial pathogen *Pseudomonas syringae* pv. *lachrymans*. The bacterium can attack leaves, stems and fruit. Leaf symptoms begin as small, water-soaked lesions, which expand to fill the area between large secondary veins, thus giving them an angular appearance **(Photo 2.4)**. Lesions may become dry and fall out, giving the leaves a "tattered" appearance **(Photo 2.5)**. Lesions on stems and fruit are generally circular water-soaked spots with a light tan center.

Cultural Control:

1) Plant resistant varieties (see Cornell 2004).

2) Rotate away from cucurbits for 2-4 years.

Materials Approved for Organic Production:

Copper compounds.

BACTERIAL WILT

This disease is caused by the bacterial pathogen *Erwinia tracheiphila*, and is spread by the striped cucumber beetle and the spotted cucumber beetle (SCB). Bacterial wilt is commonly seen on cucumbers and muskmelons. Some varieties of gourd, pumpkin and squash are also very susceptible to the disease. Information on cucurbit varieties and susceptibility to wilt and other diseases can be found on the Cornell Vegetable MD Online website (McGrath 2001).

Symptoms of the disease on young plants can include wilting of the entire plant and rapid death **(Photo 2.6)**. Symptoms on older plants include wilting of leaf tissue between veins and wilting of one or more runners. Watermelon is quite resistant to both SCB and bacterial wilt. Muskmelons are susceptible to feeding injury and disease transmission especially around the time of runner formation. Some summer and winter squash are not as affected by bacterial wilt as melons and cucumbers.

Recent studies suggest that asymptomatic weed hosts may play a major role in survival of the bacterium over the winter.

Cultural Control:

1) Control of bacterial wilt depends on control of the cucumber beetle. Therefore, all the measures described above for control of SCB will aid in the control of bacterial wilt as well.

2) Resistant cucumber varieties, such as County Fair pickling cucumber, are becoming available.

Materials Approved for Organic Production:

See cucumber beetle controls.

DISEASES CAUSED BY FUNGI AND FUNGAL-LIKE ORGANISMS

BLACK ROT AND GUMMY STEM BLIGHT

Black rot is caused by the same fungus, *Didymella bryonia* that causes gummy stem blight. Black rot is the fruit-infecting phase of the disease, and is most common on butternut squash and pumpkins **(Photo 2.7)**. The black rot fungus penetrates the rind, allowing entry to other organisms that cause the whole fruit to rot. Gummy stem blight refers to the foliar and stem-infecting phase of the disease **(Photo 2.8)**, which is commonly seen on muskmelons and watermelons. On foliage, symptoms begin as water-soaked areas or pale brown spots. Brown cankers develop on stems, and a brown to black exudate may appear (gummy stem). The fungus can be seed-borne and may also overwinter in the soil. Infection by powdery mildew increases the opportunity for gummy stem blight infections.

Cultural Control:

1) Crop rotation to a non-cucurbit crop for 2 years.

2) Plant disease-free seed. Do not use seed from an infected fruit.

3) 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 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.

4) 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.

5) As soon as a cucurbit crop is harvested, the decaying crop debris should be plowed under to destroy infected debris and reduce inoculum.

Materials Approved for Organic Production:

Application of approved products is not currently an effective management option.

DOWNY MILDEW

Downy mildew, caused by the fungal-like organism *Pseudoperonospora cubensis*, can be particularly severe during wet and humid weather. Symptoms on the upper leaf surface are angular pale green to yellow areas, similar to symptoms of angular leaf spot **(Photo 2.9)**. On the lower leaf surface, fuzzy gray sporulation occurs. As the disease progresses, lesions dry out and become brown. The inoculum for downy mildew blows north from southern states, and in many years may not occur as far north as New York.

Cultural Control:

1) Plant resistant varieties.

2) Select planting sites with good air movement. Decreasing humidity in the crop canopy will help prevent downy mildew infections.

3) Avoid overhead irrigation.

Materials Approved for Organic Production:

Copper compounds (one poor result in recent studies; four good and three poor results against different species of downy mildew on other crops).

FUSARIUM WILT AND CROWN ROT

These diseases can be caused by several different members of the genus *Fusarium*, which has many subspecies that are host-specific. *Fusarium* species can be seed-borne, but also persist in the soil as spores with some subspecies surviving for many years without a host. Spread of the pathogen most commonly occurs through movement of infested soil and plant debris.

Fusarium wilt is a serious disease of cantaloupe and muskmelon. Mature plants are most commonly affected by this pathogen, with symptoms including yellowing of older leaves and wilting of runners. Vascular discoloration will be apparent if the stem is cut along its length near the crown.

Fusarium crown rot can attack all cucurbits. Symptoms include wilting of leaves, followed by plant death, which can occur within several days **(Photo 2.10)**. Necrotic rot of the crown and upper root area can be seen. Fruit can also be attacked at the fruit-soil interface.

Cultural Control:

1) Crop rotation is ineffective for the *Fusarium* wilt of melons and cucumbers, but the crown rot organism persists for only 2 years and so a 3-4 year rotation is effective.

2) Liming the soil to a pH 6.5-7.0 can reduce wilt.

3) Resistant varieties are the best defense. The muskmelon variety Athena is resistant.

Materials Approved for Organic Production:l

Trichoderma (T22®) may have some efficacy against Fusarium species.

PHYTOPHTHORA BLIGHT

Phytophthora blight, caused by the fungal-like organism *Phytophthora capsici*, is a difficult problem. The disease is currently limited to certain regions, however the range of the pathogen appears to be increasing each year. There is no treatment available once the plants are infected. Symptoms include a sudden wilt of infected plants and/or white yeast-like growth on affected fruit **(Photo 2.11)**.

Cultural Control:

1) Select well-drained sites, or improve the drainage. Use raised beds

for non-vining crops. Manage drainage and irrigation to avoid puddling of water. Subsoil plow before planting or between beds for better drainage. Remove any soil dams at the end of rows that might hold water. Avoid leaks in irrigation systems. Don't plant low areas of the field; infections generally start in low areas where water sits.

2) Use a 4-5 year crop rotation of 4-5 years.

3) Do not use seed from an infected fruit.

4) The pathogen survives in the soil, and can easily be transferred from an infected field to a healthy field by farm equipment or shoes. Thoroughly clean equipment after working in affected fields or when sharing or purchasing equipment from another farm.

5) Note that peppers, tomatoes, eggplants, lima beans and snap beans are also hosts for this pathogen.

6) Avoid returning crop culls that may be infected with *Phytophthora* to the field.

7) Compost may contain organisms that are antagonistic to the pathogen.

Materials Approved for Organic Production:

No materials are currently available for control of *Phytophthora* blight.

POWDERY MILDEW

Powdery mildew, caused by the fungus *Podosphaera xanthii*, appears later in the growing season than bacterial wilt, and can reduce yields by decreasing the size, or number of fruit. Fruit quality can also be reduced because of sunscald, lower sugar content, or incomplete ripening. The disease is quite easily recognized by a white powdery growth on both upper and lower leaf surfaces **(Photo 2.12)**. As the disease advances the leaves yellow, turn brown and die **(Photo 2.13)**. All cucurbit species are susceptible although resistant varieties of cucumber, melon, summer squash, winter squash, and pumpkin are available.

The fungus is thought to blow into the Northeast from southern states each year, and probably does not overwinter in this region outside of greenhouses.

Cultural Control:

1) Growing the crop in smaller parcels may slow disease spread.

2) Field-grown plants are resistant until fruit start to enlarge, unless they are stressed such as by heavy weed competition.

3) Vigorous indeterminate varieties may maintain sufficient numbers of healthy leaves to tolerate PM longer in the season.

4) Grow resistant or tolerant varieties (see Cornell 2004).

Materials Approved for Organic Production:

1) Sulfur.

2) Copper (one good, one fair, and 5 poor results).

3) Mineral oil (two fair and one poor result).

4) Several plant oils are reported to reduce powdery mildew.

5) Potassium bicarbonate (two of 13 studies showed fair control; 11 poor).

6) *Bacillus subtilis* (Serenade®) (One of seven studies showed fair control; 6 poor).

7) Combinations of oil and potassium bicarbonate have been more effective than either alone.

LESS COMMON DISEASES

There are many diseases of cucurbits that can be present at low levels or are important only in certain regions. Generally, these all respond to cultural techniques such as a good four-year rotation, pathogen-free seed, raised beds, good soil drainage, careful watering preferably with trickle irrigation, and vigorous plants.

REFERENCES

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McGrath, M. 2001. Options for Managing Bacterial Wilt Affecting Cucurbit Crops. Cornell Univ. MD OnLine, Dept. of Plant Pathology. http://vegetablemdonline.ppath.cornell.edu/NewsArticles/CucBW.htm

CHAPTER 2 - CUCURBIT

Photo2.1 Squash bug adults.

Photo 2.2 Squash vine borer damage. Larva shown in inset (courtesy Purdue University).

Photo 2.3 Striped cucumber beetle.

Photo 2.4 Young angular leaf spot lesions.

Photo 2.5 Older angular leaf spot lesions (courtesy T.A. Zitter).

Photo 2.6 Bacterial wilt symptoms on pumpkin.

Photo 2.7 Black rot symptoms on butternut squash (courtesy T.A. Zitter).

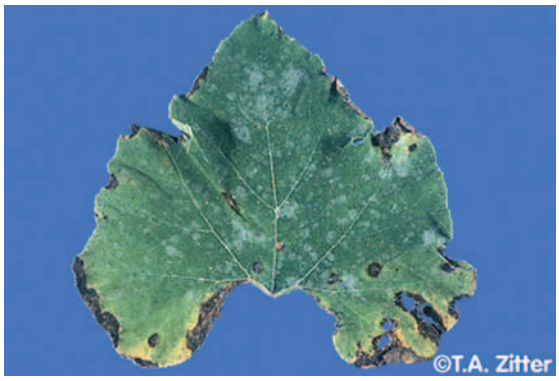

Photo 2.8 Gummy stem blight foliar symptoms (courtesy T.A. Zitter).

Photo 2.9 Downy mildew symptoms on cucumber.

Photo 2.10 Fusarium crown rot symptoms on zucchini (courtesy G.S. Abawi)

Photo 2.11 Phytophthora blight symptoms on pumpkin.

Photo 2.13 Severe powdery mildew epidemic.

Photo 2.12 Young powdery mildew lesion.