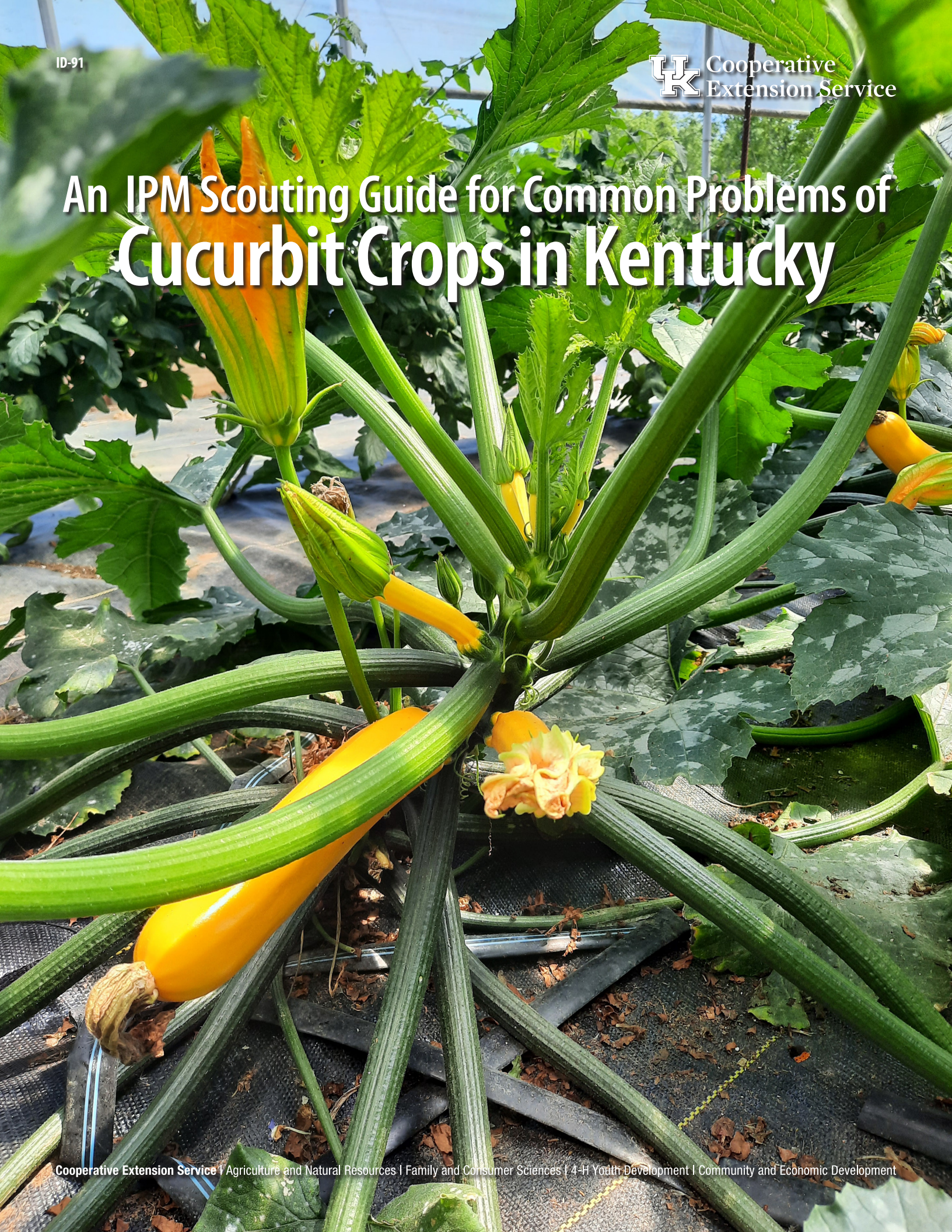
ID-91

Cooperative Extension Service

An IPM Scouting Guide for Common Problems of Cucurbit Crops in Kentucky



Other IPM Scouting Guides

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Cover Photo: Parthenocarpic 'Golden Glory' zucchini planted in a high tunnel.
Rachel Rudolph

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This manual is the result of efforts of the University of Kentucky Vegetable IPM team. This publication is supported by Crop Protection and Pest Management (CPPM), Extension Implementation Program (EIP), grant no. 2021-70006-35440, from the USDA National Institute of Food and Agriculture.

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Introduction

Long before the term "sustainable" became a household word, farmers were implementing sustainable practices in the form of integrated pest management (IPM) strategies. IPM uses a combination of biological, cultural, physical, and chemical methods to reduce and/or manage pest populations. These strategies are used to minimize environmental risks, costs, and health hazards. Pests are managed, to reduce their negative impact on the crop, but they are rarely eliminated entirely.

Essential to the IPM approach is scouting and monitoring of diseases, insects, weeds, and abiotic disorders in order to identify potential problems before they result in serious losses. The key to effective monitoring is accurate identification. This guide covers the more common abiotic and biotic problems that occur on cucurbits (Cucurbitaceae family) in Kentucky. This plant group, also referred to as vining crops, includes cucumber, muskmelon (cantaloupe), watermelon, specialty melons, squash, pumpkin, and gourds.

This guide has been designed to serve as a companion to the University of Kentucky publication *Vegetable Production Guide for Commercial Growers* (ID-36), available from your county office of the Cooperative Extension Service or online at http://www.ca.uky.edu/agc/pubs/id/id36/id36.htm. Within ID-36, you will find detailed information on the production of cucurbits, fertility, and pest management. Should you need additional information on the problems covered by this publication or for a problem not discussed here, please consult ID-36 or contact your county agent.

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Physiological and Nutrient Disorders

Blossom end rot on watermelon fruit.

1. Blossom end rot is a physiological disorder observed in many cucurbits as well as other crops (for example, tomato and pepper). It typically appears as a general rot at the blossom end of developing fruit and is usually the result of inadequate or uneven irrigation, high humidity, poor root growth, or other factors that slow the movement of water through the plant. Since calcium is taken into the plant with the transpiration stream (water), slow water movement can often lead to temporary calcium deficiencies, resulting in blossom end rot. **Management**—Provide consistent and proper irrigation. Do not use high levels of ammonia fertilizer, which can aggravate this problem. Avoid root injury. Avoid water logged soils.

2. Drought stress. Cucurbits are particularly sensitive to drought. Fruit are typically 85% to 90% water and can suffer under drought conditions. Severe drought stress affects fruit development, resulting in unmarketable produce. Affected cucumber fruit may appear curled, distorted, or tapered at the blossom end; pumpkins become soft and wrinkled. Drought-stressed pumpkins fail to gain appropriate size, which affects yields. A loss of foliage during drought may also result in sunburn of the fruit. **Management**—Irrigate when necessary.

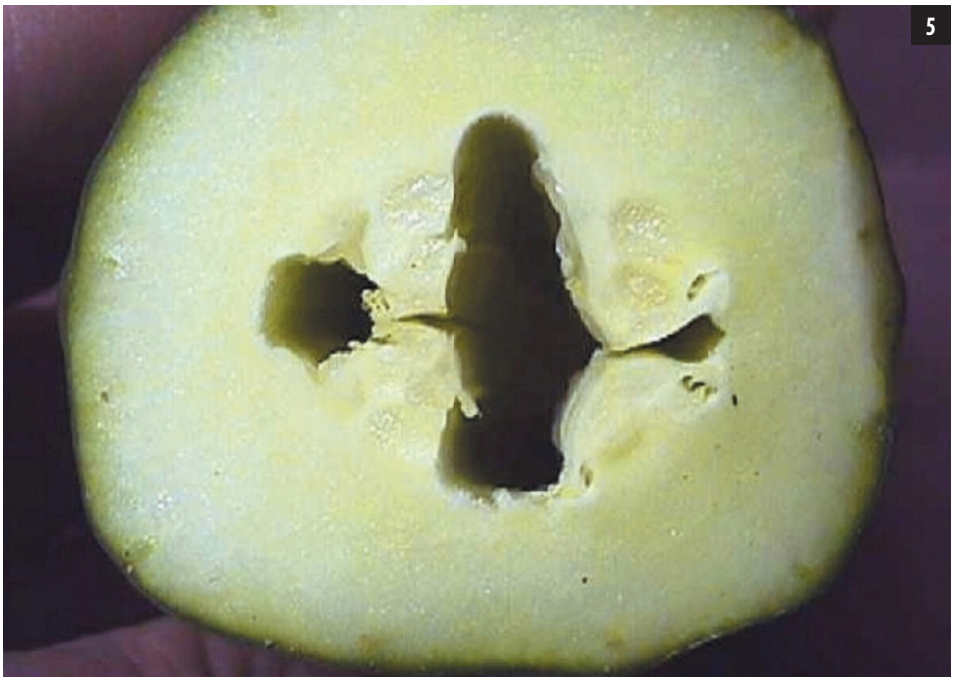
Drought (a) and drought/sunburn (b) symptoms on pumpkin.

3. Flood damage symptoms often appear as nutrient deficiencies or a generalized yellowing. Prolonged exposure to flooded soils will result in anaerobic (low oxygen) conditions for plant roots, eventually causing plant death. When large numbers of roots die, the plant is often unable to take up sufficient nutrients, resulting in nutrient deficiencies. Floods may also bring biological, chemical, and physical changes to the soils depending on the length and severity of the flood.
Management—While damage from flooding is often unavoidable, planting in raised beds will improve drainage. It is recommended to test soils following major flooding events. The use of bioassays can also help to determine if significant changes to the soil have occurred. Growers should avoid planting root crops the season following a major flood event if there are concerns with soil contamination.

4. Fruit cracking , also known as splitting, can cause loss of marketable yield, especially in muskmelons. The most obvious sign of this disorder is a fractured rind often near the end closest to the vine, but can also occur on the blossom end or sides. The cracks can be so severe that the inner flesh of the melon is visible. Multiple factors can cause cracking, including cultivar, ripening stage, irrigation or rain events, excessive nitrogen, inadequate potassium, and solar radiation. Melon cultivars with thin rinds are often more susceptible to cracking as are cultivars with more deep sutures. Allowing the soil to dry completely before a major irrigation or rain event may also cause cracking as well as allowing melons to over-ripen in the field.
Management—Select cultivars less prone to cracking, provide consistent and proper irrigation throughout the development of the fruit, harvest fruit as soon as possible, and do not over-fertilize with nitrogen.

Yellowed foliage due to flooding.

Fruit cracking on muskmelon.



Hollow heart of cucumber.

Magnesium deficiency on muskmelon leaves.

5. Hollow heart is the formation of a hollow cavity inside some cucurbit fruit, particularly melons. This disorder can result from a number of factors, including low boron levels, genetics, and uneven water management. Although not outwardly visible, hollow heart makes fruit unmarketable.

Management—Avoid varieties with a tendency to exhibit hollow heart. Ensure that boron levels in the soil are adequate before planting and be careful not to over fertilize. Follow recommended plant spacing and provide consistent and proper irrigation.

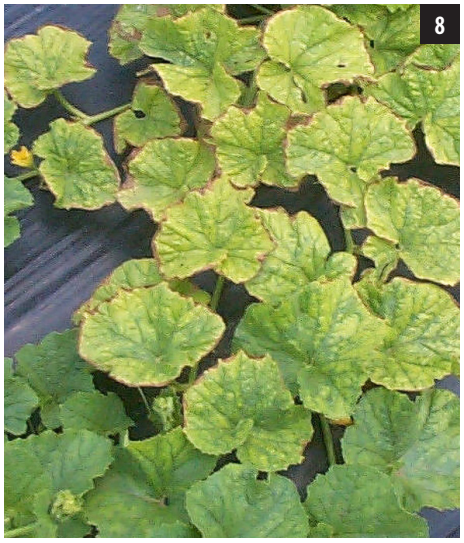
6. Magnesium deficiency symptoms first appear as a yellowing between the leaf veins (interveinal chlorosis), beginning on the oldest leaves and slowly spreading to newer growth. Yellowed tissues may turn brown, die, and drop out, giving the leaf a shot-hole pattern. Magnesium deficiency usually appears during periods of rapid growth, when the fruit is enlarging. This deficiency is more likely to occur in plantings on sandy soils with a low pH, especially in dry years. Sandy soils often have a low cation exchange capacity and may not contain adequate levels of magnesium. Deficiency symptoms are more commonly observed in muskmelon than in other cucurbits.

Management—Maintain the soil pH near 6.5. Soil test results should show approximately 200 lb/acre of magnesium. Potential sources of preplant magnesium include magnesium oxide and dolomitic lime. If necessary, fertilize with Epsom salts (magnesium sulfate) and magnesium oxide through a drip irrigation system. Avoid heavy applications of fertilizers containing competing cations (K^+, Ca^{++}, NH_4^{++}). Foliar sprays are generally ineffective in correcting significant deficiencies.

7. Manganese toxicity symptoms include water-soaked areas on the underside of leaves and yellow or bronzed spots on the upper leaf surface. Although manganese is an essential plant micronutrient, high levels of it can lead to toxicity symptoms in cucurbits. Manganese toxicity can result from low soil pH, which allows manganese to become available to plants at toxic levels. **Management**—Check the soil pH in the fall prior to planting; if it is below 6.0, apply lime in the fall and incorporate into the soil.

Manganese toxicity on a muskmelon leaf.

8. Molybdenum deficiency usually affects muskmelons grown on dark heavy soils with a pH below 6.0. Heavy applications of ammonium nitrate through the drip lines may lower the pH in the plant root zone and contribute to either manganese toxicity or molybdenum deficiency. Other cucurbits do not show symptoms under the same growing conditions. Molybdenum deficiency usually is seen in the crown leaves about the time the plants begin to vine. Leaves become pale green to slightly chlorotic between the veins. As symptoms progress, the leaf margins become necrotic and plant growth ceases. **Management**—Maintain a soil pH between 6.0 to 6.5; foliar treatments with sodium molybdate will help alleviate symptoms and permit normal growth



Molybdenum deficiency.

9. Nitrogen deficiency generally appears as a yellowing of older foliage on plants. Nitrogen is the most abundant nutrient in the plant and often the most limiting nutrient for plant growth. Cucurbits are not particularly heavy nitrogen feeders but can experience nitrogen deficiencies during periods of rapid growth or fruit set. **Management**—For cucurbit crops that are grown with drip tape and black plastic mulch, broadcast and disk in about 1/3 to 1/2 of the total nitrogen requirement for a season prior to forming beds; fertigate the remainder throughout the season. When not using drip irrigation or black plastic, the remaining nitrogen can be banded in one or two side-dressings prior to fruit formation. For specific fertility recommendations in Kentucky, see the *Vegetable Production Guide for Commercial Growers* (ID-36).

Nitrogen deficiency on pumpkin.

Early (a) and severe (b) ozone injury to watermelon.

Poorly pollinated zucchini.

10. Ozone damage is common to cucurbits in many regions of Kentucky. Although mainly observed on watermelons, most cucurbits can be affected. Symptoms first appear as small yellow flecks on leaves, eventually turning into large brown and gray areas that die and slough off. Severe damage can result in almost complete defoliation of some plants. Ozone damage is often mistaken for disease or spray injury.
Management—Tolerance to ozone varies with crop and variety. Seeded (diploid) watermelons tend to be more sensitive to ozone than seedless (triploid) varieties.

11. Poor pollination. With the exception of parthenocarpic cultivars, cucurbits require pollination to produce fruit. Several visits from pollinators on the day that a flower is open are often required to ensure appropriate fruit development. Fruit will appear misshapen and small when pollination is poor. Cucumbers will be reduced in size at the fruit stem end. Very high and low temperatures, and high relative humidity, can also affect pollen viability, resulting in poor pollination. If too much nitrogen is used (resulting in excessive vegetative growth) or plants were improperly spaced, bees may have difficulty locating the flowers.
Management—Provide pollinators to ensure good fruit set and high yields. Spray insecticides at sundown or before sunrise when pollinators are not active.

Stem split on summer squash.

12. Stem splitting is most often observed in transplant production when temperatures are low or when there is a period of rapid growth resulting from high temperatures, increased irrigation, or high fertility. In minor cases plants can be transplanted with few ill effects; however, in severe cases, seedlings should not be transplanted if possible.

Management—Prior to transplanting, provide warm uniform temperatures for seedlings to help prevent uneven growth during transplant production. Once plants are in the field, provide consistent irrigation and fertilization.

Wind damage to field (a), sandblasting injury to stem (b), and wind burn to leaves (c).

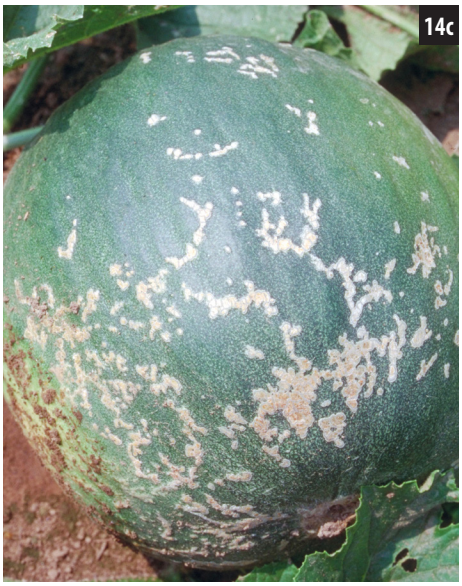
13. Wind damage/sandblasting is relatively common in cucurbits due to their large leaves. High winds often cause stem damage and drying of transplants, particularly on the area of the stem facing prevailing winds. Excessive winds will desiccate leaves, causing them to die from the margins toward the center. Entire fields can be affected, leading to significant losses.

Management—Employ windbreaks along fields and avoid transplanting in high winds whenever possible.

Insect Pests

14. Cucumber beetles. The striped cucumber beetle (*Acalymma vittatum*) and the spotted cucumber beetle (*Diabrotica undecimpunctata howardi*) are the most common insect pests on all the cucurbit crops. The spotted cucumber beetle is recognized by the 12 black spots on its yellow-green body, while the striped cucumber beetle has three black stripes on its wings. Both of these pests are highly attracted to cucurbits and will cause significant damage to young seedlings and ripening fruit. They also transmit the bacterium that causes bacterial wilt of cucurbits, which is particularly problematic in cucumbers and melons. Close to harvest, a second generation may appear that can feed on the fruit's developing rinds.

Management—Early treatment is essential both for beetle and management of bacterial wilt. Begin treatment as soon as seedlings emerge or immediately after transplanting. A single post-transplant soil drench with a systemic insecticide can provide three to five weeks of control. Scout for beetles and apply foliar insecticides as necessary to protect susceptible plants, particularly close to harvest. Because watermelon is not susceptible to bacterial wilt, so protection is necessary only when plants are small and beetle populations are high and again closer to harvest in order to prevent rind scarring by adult feeding.



Spotted and striped cucumber beetle adults (a) and damage to leaves (b), melon fruit (c), pumpkin fruit (d), and seedlings (e).

Melonworm larva.

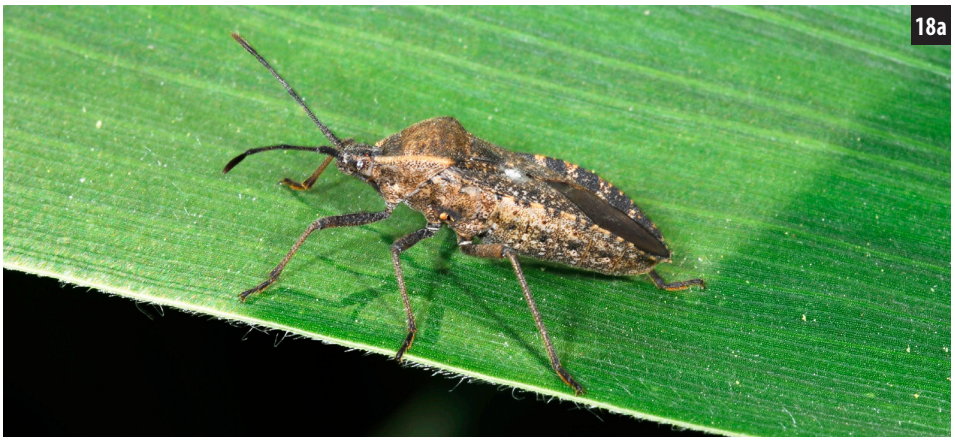
15. Melonworm (*Diaphania hyalinata*) is an uncommon late-season pest of cucurbits. The 1-inch larva is yellow-green and will have fine yellow stripes running down its back in its last instar. The melonworm feeds on the foliage of summer and winter squashes but also may feed on muskmelon rinds. Some growers refer to these insects as rindworms.
Management—Treat with foliar insecticides if feeding on rinds is observed.

16. Squash Bee (*Peponapis pruinosa*) is a pollination specialist of squash and pumpkin flowers. This is a ground nesting bee. The female will dig vertical holes in the ground to make solitary nests, but often a site has multiple females and nests. The females collect pollen and nectar from cucurbit flowers and are synchronized with the flowering pattern of squashes. They are active very early in the morning, with activity diminishing by midmorning.

17. Squash beetle (*Epilachna borealis*) is a coppery-colored leaf-feeding lady beetle similar to other lady beetles. This particular beetle, which is bigger than other lady beetles, has 12 black spots on its back and an orange thorax (the area just in front of the wings). It does not feed on other insects and can be a serious pest of squash and pumpkin. Squash beetle feeds on the underside of leaves and causes skeletonized,, lace-like damage to the leaves. The larva is found on the underside of leaves and is yellow with branched black spines covering the body. The pupa hangs from the leaf, is yellow in color, and lacks spines.
Management—Apply foliar insecticides as necessary during the mid- and late season. While this insect is common in some areas of the state, economic levels on commercial cucurbit plantings are uncommon.

Squash bee in pumpkin flower.

Squash beetle.



Squash bug adult (a), damage (b), eggs (c), and nymphs (d).

18. Squash bug (*Anasa tristis*) is brown and about 1 inch in length. Adults move into fields in early June and damage plants by removing sap as well as causing leaves to wilt and collapse. With newly set plants, the adults may feed on the stem base near the soil. Young plants may be killed, and infested leaves on older plants may wilt. More importantly, this insect is the vector of a newly recognized disease of cucurbit crops (yellow vine decline) that affects melons, watermelon, and pumpkins. The bronze eggs are football-shaped and lie on their sides in groups of 12 or more. Eggs hatch in one to two weeks. Initially, the nymphs are dark with a light green abdomen. Older nymphs are light gray in color with black legs. Young nymphs feed together in groups and require five to six weeks to mature into adults. While all the cucurbit crops can be attacked, squash bugs show a preference for squashes and pumpkins. This insect can be very difficult to control in mid- and late summer if populations are allowed to build up.

Management—Timing is the key to successful squash bug control, and eliminating squash bugs is the key to management of yellow vine decline. Because this insect is a persistent vector, disease management is dependent on control of the vector. Use insecticides to control squash bug as soon as the plants are set or seedlings emerge in the field. Systemic insecticides used for cucumber beetle control will provide up to three weeks of squash bug suppression. Foliar sprays targeting newly hatched nymphs are more effective than sprays used against larger stages. Multiple foliar sprays are often needed for extended periods of control.

19. Squash vine borer (*Melittia cucurbitae*) adults are stout, dark gray moths with "hairy" red hind legs, opaque front wings, and clear hind wings with dark veins. Unlike most moths, they fly about the plants during the daytime, appearing more like a paper wasp than a moth. The cream-colored, 1-inch larva tunnels into the stems of cucurbits. Symptoms appear in midsummer, when a long runner or an entire plant wilts suddenly. Infested vines usually die beyond the point of attack. Sawdust-like frass near the base of the plant is the best evidence of squash vine borer activity. Careful examination will uncover yellow-brown excrement pushed out through holes in the side of the stem at the point of wilting. The small brown eggs, laid individually on leaf stalks and vines, hatch in seven to 10 days. The newly hatched larva immediately bores into the stem. A larva feeds for 14 to 30 days before exiting the stem to pupate in the soil. A degree-day model has been developed that estimates adult emergence at 1,000 degree-days (base 50ºF with a March 1 biofix).

Management—The key to management of squash vine borer is controlling the borers before they enter the stem. Once they're inside the vine, insecticidal control is not possible. Poor timing of sprays is the usual cause of inadequate control. Monitor plants weekly from mid-June (or at 900 degree-days) through August for initial signs of borer frass. Very early signs of larval feeding indicate that other eggs will be hatching soon. Use two insecticide applications seven days apart to control newly hatching larvae and continue to monitor for additional activity. In order to be effective, sprays need to penetrate the canopy to cover the vines.

Squash vine borer moth (a) and larva tunneling into cucurbit stem (b).

Two-spotted spider mite (a) and damage to melon leaf (b).

20. Two-spotted spider mite (*Tetranychus urticae*) females are yellow to dark green, with two to four dark dorsal spots. At 1/60 of an inch, they are almost microscopic. Males are smaller and have more pointed abdomens. The tiny, spherical eggs are laid on the underside of leaves, often under the webbing produced by the mites. Mites attacking cucurbits are more common in hot, dry weather, and infestations usually begin around the field margins. Under optimum conditions of high temperature and low humidity, the life cycle may be completed in seven days; females can lay 200 eggs. Initial damage appears as tiny, light spots in the leaves (stippling), which over time will turn brown, with the leaves dying prematurely.
Management— Natural enemies of mites can keep their populations low, but the use of insecticides to control insect pests severely reduces the numbers of these beneficial insects. Therefore, apply insecticides only as needed rather than at regularly scheduled intervals. Destroy weeds adjacent to and in fields during the fall or early spring, and carefully manage weeds around fields during the season. Spraying or mowing of weeds after growth has become rank may increase the movement of mites to cultivated plants. Irrigation with an overhead sprinkler may provide some short-term relief of mite infestations. Use miticides only when needed. Because mite populations are often localized, spot spraying may be effective. When spraying only a portion of the field, expand the spray zone to include an area 100 to 200 feet beyond the mite-infested area.

Trichopoda pennipes fly.

21. Trichopoda pennipes is a fly that parasitizes the squash bug. It lays one or more eggs on the outside of large nymph and adult squash bugs. Upon hatching, the fly larva burrows into the squash bug and eventually kills it. The fly larva exits the squash bug to pupate in the soil. This fly can also attack other true bugs. This insect is a naturally occurring squash bug enemy common across the state.

22. Greenhouse whitefly (*Trialeurodes vaporarium*) is about 1/8 inch in length. A common pest of cucurbits, all stages (eggs, nymphs, and adults) can be found on the underside of leaves, particularly on older foliage. The adult whitefly is white and holds its wings roof-like over its back. A generation can be completed in as little as three to four weeks. Each female can lay hundreds of eggs over of six to eight weeks.

Management—Greenhouse whitefly is not common outside the greenhouse. In the greenhouse, a small parasitoid wasp, *Encarsia formosa*, can be very effective. In the field, controls for silverleaf whitefly will be effective.

Greenhouse whitefly.

Silverleaf whitefly (a), damage symptoms (b).

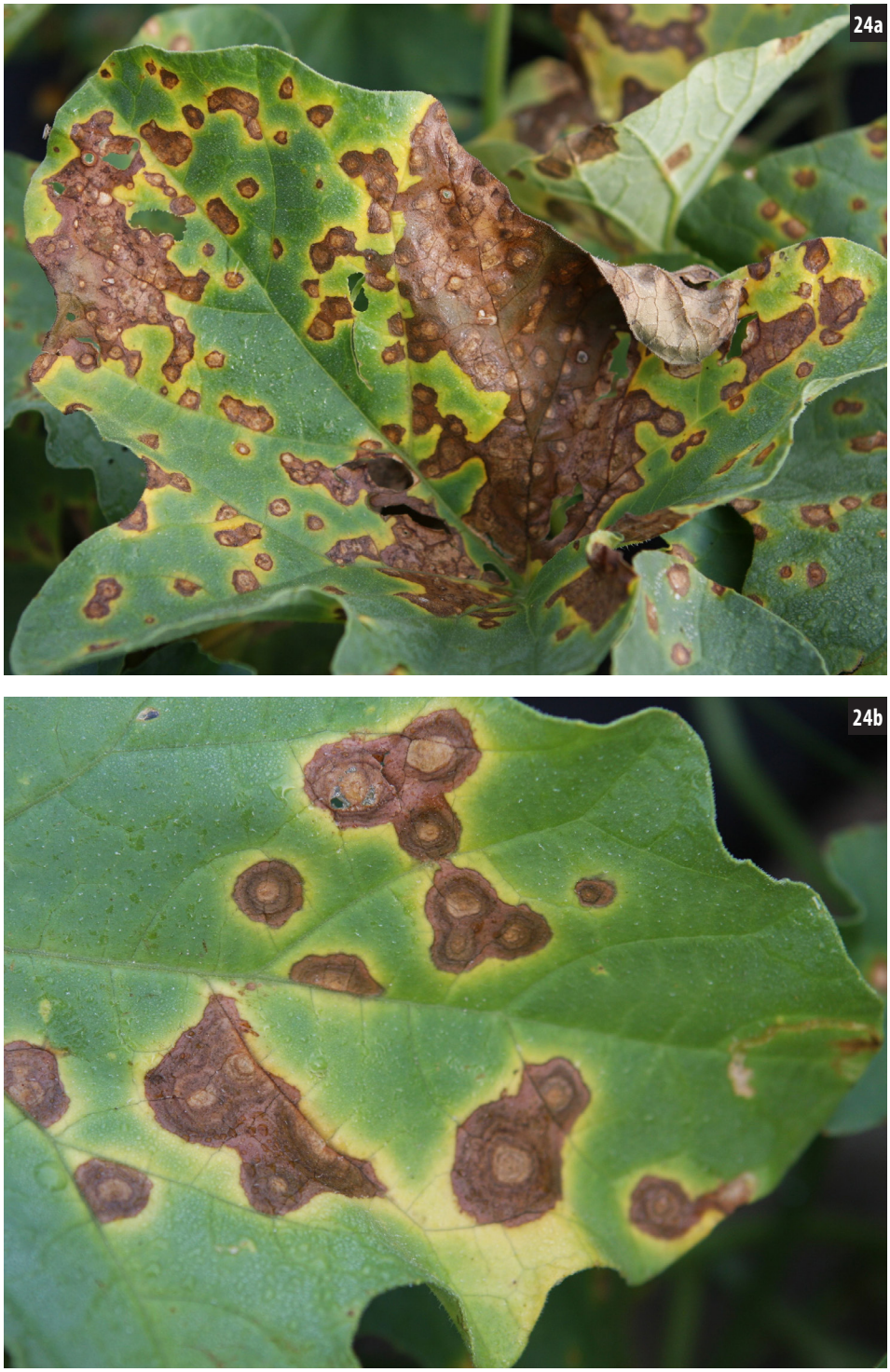
23. Silverleaf whitefly (*Bemisia tabaci*) can sometimes be distinguished from the greenhouse whitefly by how it holds its wings. The silverleaf whitefly often holds its wings with a visible space between them, while the greenhouse whitefly usually holds its wings touching the abdomen or slightly overlapping it. The silverleaf whitefly gets its name because it injects a toxin into the plant that causes whitening of the undersurface of newly emerging leaves. Unfortunately, small numbers of silverleaf whitefly can cause silvering of small squash transplants. Damage may be more severe on younger plants than to plants closer to harvest. Once whiteflies stop feeding, the new foliage will emerge with normal color.

Management—A number of predaceous insects feed on silverleaf whitefly and one commercial parasitoid wasp, *Eretmocerus emericus,* has been used successfully in greenhouses. Chemical control of whiteflies can be difficult, as the adults and immature stage occur on the underside of leaves, particularly older leaves, making spray coverage critical for good control.

Diseases

Diseases Caused by Fungi and Fungus-like Organisms

24. Alternaria leaf blight (*Alternaria cucumerina*) primarily affects watermelon and muskmelon but may occur on other cucurbits. Symptoms first appear at the time of fruit set on older leaves, beginning as small, necrotic spots that may be surrounded by a yellow halo. Lesions expand to form brown spots ranging from 1/2" to 3/4" in size; a concentric ring pattern may be present if conditions are wet. As lesions expand, they merge to form large, blighted areas followed by leaf curling and eventual leaf drop.
Management—Space plants for air circulation and rapid drying; apply protectant fungicides beginning at fruit set; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 2 years.



Alternaria leaf blight on foliage (a) and close-up of leaf lesions (b).

Anthracnose on melon fruit (a), cucumber (b), and on foliage (c).

Belly rot on cucumber.

25. Anthracnose (*Colletotrichum orbiculare*) is most common on cucumber, muskmelon, gourds, and watermelon. All aboveground plant parts can be affected. Disease may become more severe in late summer, especially if weather is rainy. Small, circular lesions develop initially on leaves; these lesions enlarge to form irregular, tan-to-brown spots that coalesce to create extensive blighting. On watermelon, leaf lesions tend to be smaller, irregularly shaped, and darker in color. The centers of older lesions may crack or fall out entirely. Lesions on stems are tan-brown, somewhat elongated, and sunken. Girdling stem lesions result in vine wilting. On maturing fruit, lesions appear as small, circular, sunken areas. Lesions may grow to 1" or larger on melons. Lesions on watermelon can be cracked and irregularly shaped. Under humid conditions, lesions turn black, and salmon-pink masses of spores develop.
Management— Select resistant cultivars (watermelon - races 1 and 3; cucumber - races 1, 2, and 3); space plants for air circulation and rapid drying; apply protectant fungicides beginning at vine touch; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 2 years.

26. Belly rot (*Rhizoctonia solani*) primarily affects cucumber (rarely on other cucurbits) and develops where fruit comes into contact with soil. Symptoms include sunken cankers (lesions) that are tan-brown in color and resemble a dry rot. Disease may be more prevalent when powdery mildew (see #38) is present. This fungus may also cause damping-off of seedlings.
Management— Space plants for air circulation and rapid drying; use physical barriers (mulches) to prevent fruit from contacting soil; apply protectant fungicides when weather becomes warm and wet; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; avoid movement of infested soil to clean fields; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 3 years.

Cercospora leaf spot on foliage.

Choanephora on yellow squash (a, b).

27. Cercospora leaf spot (*Cercospora citrullina*) affects all cucurbits, especially melons. Symptoms on foliage begin as small, round, light colored spots on older leaves that develop dark margins as they expand. Centers of spots may fall out. Yellow halos may develop as spots expand and coalesce; leaves may turn yellow. Under wet or humid conditions, stems and petioles may become infected.

Management— Space plants for air circulation and rapid drying; apply protectant fungicides beginning at vine touch; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 2 years.

28. Choanephora fruit rot/Wet rot (*Choanephora cucurbitarum*) is most common on summer squashes, but may occur on other cucurbits. Senescing flowers are often infected first, serving as a bridge for the fungus to colonize fruit. Fruit symptoms develop from the blossom end as a soft, wet rot. Profuse, fuzzy growth increases under wet conditions, eventually forming large masses of black spores that resemble a pincushion.

Management – Promptly remove and destroy diseased material; use physical barriers (mulches) to prevent fruit from contacting soil; space plants for air circulation and rapid drying; manage excess moisture (drainage, irrigation); prevent wounds; apply fungicides during prolonged wet periods; avoid storing damaged and diseased fruit.

29. Cottony leak (*Pythium aphanidermatum* and *Pythium* spp.) affects fruit of most cucurbits but is more common on cucumber and squash. The disease first appears on portions of fruit in contact with soil. Small, water-soaked spots expand rapidly until large portions of fruit are necrotic and soft. Disease is more severe during warm weather under wet conditions or when soil is saturated. Profuse, white fungal growth resembling tufts of cotton develops on rotted areas when humidity is high.

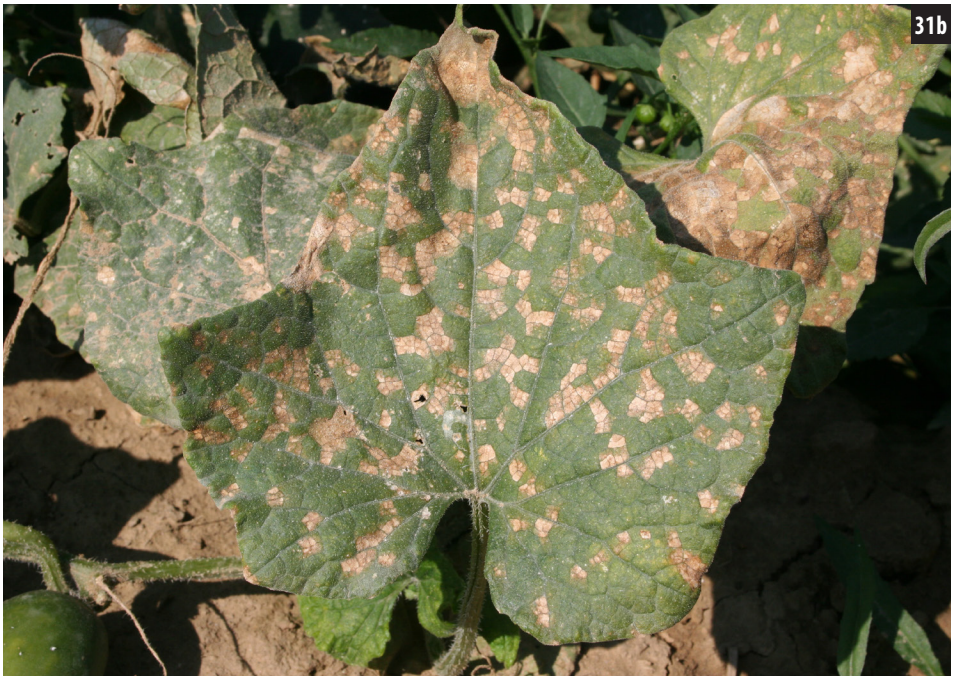
Management—Use physical barriers (mulches) to prevent fruit from contacting soil; fungicides applied before or at planting may provide some disease suppression; manage excess soil moisture (drainage, irrigation); promptly remove and destroy diseased plant material during the growing season; avoid movement of infested soil to clean fields.

Cottony leak on cucumber.

30. Damping-off (*Pythium* spp., *Phytophthora* spp.) can affect all cucurbits. It is characterized by a soft rot of seeds before germination or death of seedlings pre- and post-emergence. On emerged plants, a soft and water-soaked necrosis occurs just above the soil line and extends to roots belowground. Seedlings wilt rapidly and die.

Management—Use fungicide-treated seed; plant into warm soils (greater than 65°F); apply fungicides before or at planting; manage excess soil moisture (drainage, irrigation).

Damping-off.



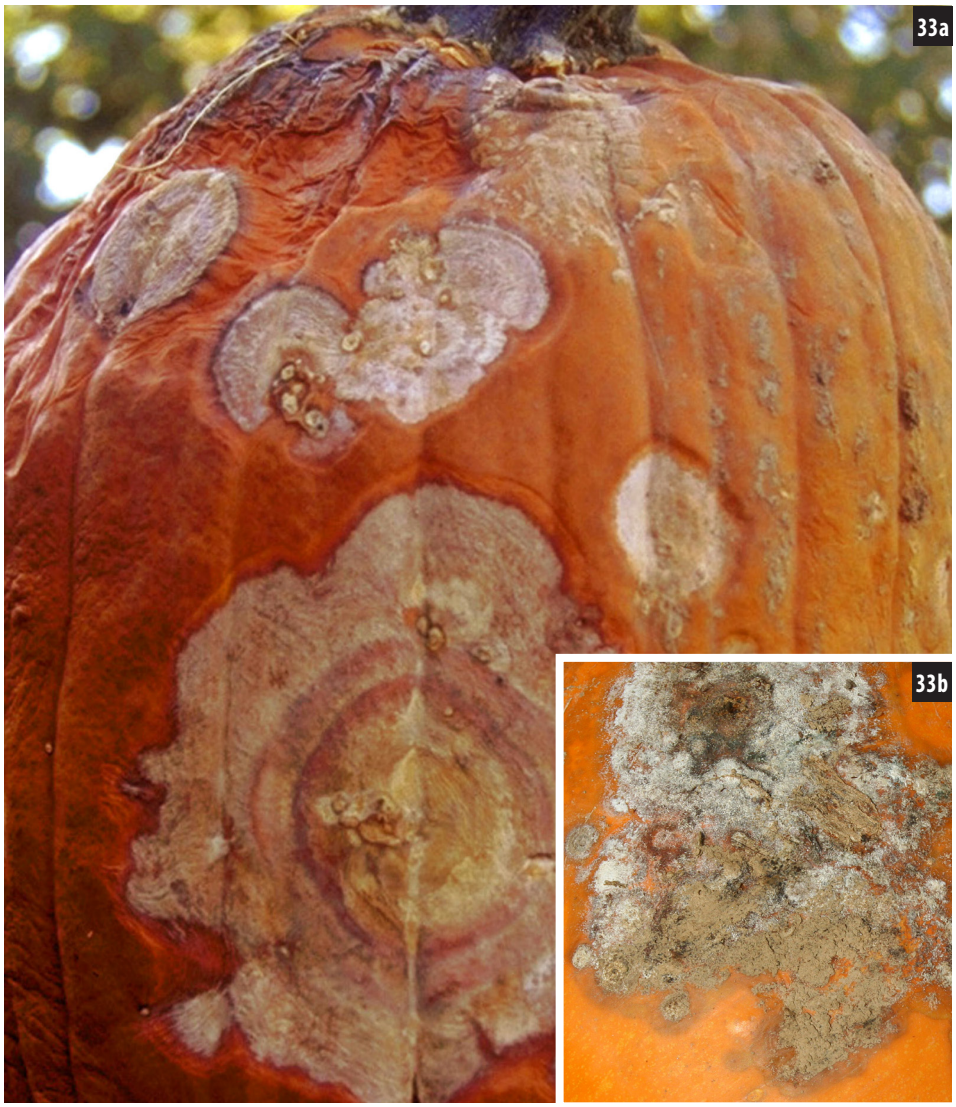
31. Downy mildew (*Pseudoperonospora cubensis*) affects most cucurbits beginning in July or August as wind-blown spores arrive from the South. Disease first appears as pale-to-bright yellow spots on the upper surface of leaves in the crown area of the plant; these spots may be irregular or "blocky" in appearance as lesions are limited by leaf veins. As lesions expand and the number of lesions increases, leaves become necrotic and plants appear scorched or blighted. On the underside of leaves, lesions develop downy spore masses (light-to-dark gray or even purple in color), which increase in wet or humid conditions. **Management**—Select resistant cultivars; space plants for air circulation and rapid drying; avoid overhead irrigation; monitor disease using the forecasting website www.imppipe.org; apply protectant fungicides beginning when disease is reported in nearby states; maintain a spray program for the remainder of the season.

Downy mildew on foliage—upper (a,b) and lower side of leaves (c,d).

32. Fusarium crown and foot rot (*Fusarium solani* f. sp. *cucurbitae*) primarily affects winter squash and pumpkin, but other cucurbits may be affected, especially when soil is wet or saturated. Wilting of one or more leaves is often the first noticeable symptom, followed by plant collapse. A dark, necrotic canker is normally present at the soil line (crown of plant) and can extend into the main root. Stems become brittle and break off at the soil line. Sporulation, white to pink in color, may be present on infected crown tissue. Affected tissue may take on a "shredded" appearance in later stages as soft tissues degrade, leaving only the vascular bundles behind. This is the same pathogen that causes Fusarium fruit rot (see #33).
Management—Space plants for air circulation and rapid drying; apply protectant fungicides before or at planting; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; avoid movement of infested soil to clean fields; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 3 years.

An example of Fusarium crown and foot rot.

33. Fusarium fruit rot (*Fusarium solani* f. sp. *cucurbitae*) affects most cucurbits but is particularly devastating to pumpkin. Disease can occur in the field or in storage after harvest. Infected fruit develop circular lesions of varying size. The tissue beneath the lesions may be discolored and corky. Pink to white sporulation is prevalent under high moisture conditions, often appearing in a concentric ring pattern. This is the same pathogen that causes Fusarium crown rot (see #32).
Management—Space plants for air circulation and rapid drying; use physical barriers (mulches) to prevent fruit from contacting soil; apply protectant fungicides before or at planting; manage weeds and potential alternative hosts; promptly remove and destroy diseased plant material during the growing season; avoid movement of infested soil to clean fields; avoid wounding during harvest and storage; properly cure fruit before storage; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 3 years.



Fusarium fruit rot on pumpkin (a, b).

Fusarium wilt vascular discoloration (a) and symptoms in melon planting (b).

34. Fusarium wilt (*Fusarium oxysporum*) primarily affects watermelon but can also occur on melons and cucumber. Symptoms include stunting, yellowing, and wilting of plants. Initially, individual runners wilt; later the entire plant collapses. Wilted plants may recover at night but gradually decline and die. Vascular tissue (xylem) from the crown and lower stem becomes discolored (brown), which is visible when the stem is cut and examined. Disease may be more severe if nematodes are present. Note: Watermelon, melon, and cucumber are affected by different *formae speciales* (groups adapted to a specific host), and each of these groups have different pathogenic races. In the case of watermelon (caused by *F. oxysporum* f.sp. *niveum*), there are three races—0, 1, and 2. Resistant cultivars are available to races 0 and 1, but not race 2. As of this printing, race 2 has not been reported in Kentucky. Muskmelons are affected by *F. oxysporum* f.sp. *melonis*, which has four known races (0; 1; 2; and 1,2); race 2 is the most widely distributed in the United States, and resistant cultivars are available to races 0, 1, and 2. Three races of *F. oxysporum* f.sp. *cucumerinum* affect cucumbers; race 1 is the most common in the United States.

Management— Select resistant cultivars; space plants for air circulation and rapid drying; use physical barriers (mulches) to prevent fruit from contacting soil; apply protectant fungicides before or at planting; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; avoid movement of infested soil to clean fields; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 3 years.

35. Gummy stem blight / Black rot (*Didymella bryoniae*) affects most cucurbits, although it is less common on squash. This disease can occur on all plant parts—leaves, stems, and fruit (black rot). Lesions on leaves are circular, tan to brown in color, and can expand quickly. Affected leaf veins appear water-soaked and orange-brown in color. Lesions on stems and vines are water-soaked initially, orange-brown in color, and may exhibit a gummy, amber-colored exudate. Older lesions tend to form tan-colored cankers. Lesions on fruit begin as small, water-soaked spots that later expand and may exude a gummy ooze. Lesions on all plant parts develop numerous, tiny black fruiting bodies (pycnidia).

Management—Space plants for air circulation and rapid drying; use physical barriers (mulches) to prevent fruit from contacting soil; apply protectant fungicides; prevent wounds by cucumber beetles (see #14), powdery mildew (see #38), and other diseases and pests; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; avoid movement of infested soil to clean fields; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 3 years.

Gummy stem blight—exudate on muskmelon vine (a) and symptoms on watermelon fruit (b), foliage (c), vine (d), and in field (e).

36. Phytophthora blight (*Phytophthora capsici*) affects all cucurbits, although different plant parts are affected on a given host. Symptoms on cucumber, muskmelon, and watermelon are common on leaves and fruit. Pumpkin and squash are susceptible to damping-off, root rot, crown rot, stem rot, wilting/collapse of plants, and lesions on leaves and fruit. Lesions on stems are constricted, darkened, and soft, often extending a few inches above the soil line. Lesions on leaves tend to be circular and initially water-soaked in appearance, turning tan to dark brown color. Circular lesions, common on fruit, are soft, water-soaked, and sunken. Lesions can be wet or slimy with a thin layer of mycelia and sporangia, particularly when weather is wet.

Management— Improve soil drainage; select resistant cultivars when available; space plants for air circulation and rapid drying; apply protectant fungicides; promptly remove and destroy diseased plant material during the growing season; avoid movement of infested soil to clean fields; promptly destroy crop residues after harvest; rotate with nonhost crops for at least 4 years.

Phytophthora blight—crown rot (a), fruit rot (b), and leaf lesion (c) on yellow squash; fruit rot on melon fruit (d).

37. Plectosporium blight (*Plectosporium tabacinum*), formerly called Microdochium blight, primarily affects pumpkin, but all cucurbits are susceptible. Symptoms include elongated, white lesions that are approximately ¼-inch in size. Stem, petiole, and leaf vein lesions are diamond shaped; lesions expand and coalesce causing leaf death and blighting. Large circular patches of affected vines may be visible. Lesions on fruit are usually round and remain small, dry, and scabby.
Management— Space plants for air circulation and rapid drying; apply protectant fungicides beginning at fruit set; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 3 years.

Plectosporium blight on pumpkin fruit (a), foliage (b), and stem (c).

38. Powdery mildew (*Podosphaera xanthii, Golovinomyces* spp.) affects all cucurbits. Symptoms first appear on older leaves or on shaded portions of plants. Mildew-like fungal growth appears on upper and lower leaf surfaces beginning at fruit set. As disease progresses, the entire leaf surface becomes colonized, often spreading to stems and fruit. Severely infected leaves become necrotic and die within a short period, which can result in blighting or complete defoliation. Affected plants are more susceptible to other diseases.

Management—Select resistant cultivars (cucumber, muskmelon, and pumpkin); space plants for air circulation and rapid drying; apply protectant fungicides beginning at fruit set and through the season; manage weeds and potential alternative hosts.

Powdery mildew on upper (a) and lower (b) pumpkin foliage and on cucurbit vine (c).

39. Southern blight (*Athelia rolfsii,* syn *Sclerotium rolfsii*) occurs primarily on cucumber, melons, and pumpkin. Symptoms begin as wilting followed by plant death. Lesions or cankers develop at the base of infected stems near the soil line. White fungal growth and numerous small, round, tan-to-reddish fungal survival structures (sclerotia) develop at the crown. Fruit infections begin where fruit comes into contact with the soil surface. Affected areas are soft, water-soaked, and covered with a dense mat of white, fan-like fungal growth; sclerotia may develop on fruit at the soil line.

Management—Space plants for air circulation and rapid drying; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; avoid movement of infested soil to clean fields; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 3 years. Limited fungicides are available, and efficacy of these fungicides can be variable.

Southern blight on pumpkin (a) and close-up of sclerotia (b).

Diseases Caused by Bacteria

40. Angular leaf spot (*Pseudomonas syringae* pv. *lachrymans*) primarily affects cucumber but may occur on any cucurbit. Leaves develop small, water-soaked spots (lesions) with yellow halos. Lesions become tan to straw-colored, enlarge, and become angular as they encounter veins. Under wet or humid conditions and warm temperatures, white ooze may be found on the underside of lesions. Stems and fruit may develop water-soaked spots and soft rot.

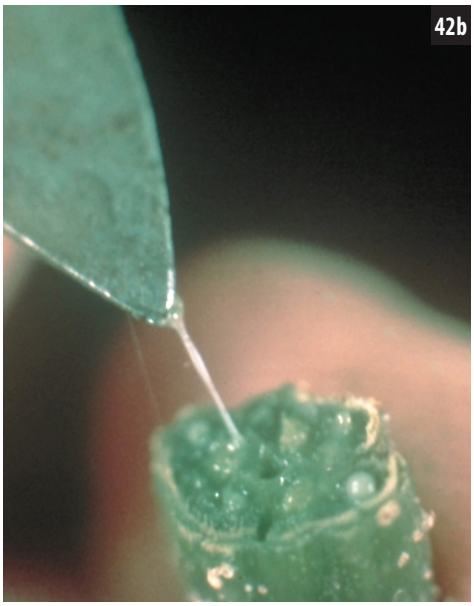
Management—Select resistant cultivars (cucumber); use clean seed; space plants for air circulation and rapid drying; apply preventative copper or bactericide; promptly remove and destroy diseased plant material during the growing season; manage weeds and potential alternative hosts; promptly destroy crop residues after harvest; deep plow to bury residual inoculum; rotate with nonhost crops for at least 2 years.

Angular leaf spot on cucumber foliage.

41. Bacterial rind necrosis (*undetermined bacterial pathogen[s]*) only affects watermelon. Dry areas that are hardened, brown to reddish-brown, and corky develop in the rind interior. These necrotic spots can expand or merge to affect large portions of the rind. Symptoms are rarely visible on the outer surface of the rind, and flesh is not commonly affected.
Management—No controls are available; however, there is some indication that the pathogen can carry over in infested fields. Avoid fields where this disease has occurred in the past.

42. Bacterial wilt (*Erwinia tracheiphila*) is most prevanent cucumber and muskmelon; however, this disease may occur on any cucurbit. Initially, individual leaves or groups of leaves wilt on vines followed by rapid wilting of entire runners or whole plants. Collapsed foliage may be dark green in appearance and become necrotic. Cut stems may emit a sticky exudate, and a slight discoloration of xylem tissue may be seen (a key diagnostic features for bacterial wilt). Cucumber beetles vector this bacterium; beetles or evidence of their feeding are often present on symptomatic vines and leaves.
Management—Manage insects beginning at emergence or transplanting to prevent feeding by cucumber beetles; protect plants with netting or row covers; promptly remove and destroy diseased plant material during the growing season; rotate with nonhost crops for at least 3 years. Refer also to the section on cucumber beetles (#14).

Internal (a) and external (b) symptoms of bacterial rind necrosis.



Bacterial wilt in pumpkin field (a) and sticky exudate in infected stem (b).

43. Yellow vine decline (*Serratia marcescens*) affects muskmelon, pumpkin, squash, and watermelon. Symptoms begin to appear approximately 2 weeks before fruit matures, although infection occurs several weeks before symptoms develop. Initial symptoms include stunting of plants and/or intense yellowing of foliage, which is followed by a slow decline in plant health. In some cases, a sudden collapse of vines may occur with no other symptoms. Vascular tissue (phloem) from crowns of affected plants turns light brown. The pathogen is transmitted through feeding by the squash bug, particularly between seed emergence and flowering. Refer also to the section on squash bug (#18).
Management—Manage insects beginning at seed emergence or transplanting; protect plants with netting or row covers until flowering; promptly remove and destroy diseased plant material; rotate with nonhost crops for at least 3 years.

Yellow vine decline.

Diseases Caused by Viruses

44. Cucumber mosaic virus (CMV), **papaya ringspot virus** (PRSV), **squash mosaic virus** (SqMV), **watermelon mosaic virus** (WMV), and **zucchini yellow mosaic virus** (ZYMV) are among the most common viral pathogens. Virus diseases are common on all cucurbits in Kentucky, especially during warm weather and later in the season, when insect populations tend to be higher. Symptoms include stunting, mosaic patterns on leaves, and leaf distortion; different viruses may cause similar symptoms. The major viruses infecting cucurbits are primarily vectored by aphids, although SqMV is vectored by cucumber beetles. Aphid-transmitted-viruses are part of a complex belonging to the Potyvirus group.
Management—Plant earlier in the season; select resistant cultivars; manage weeds and potential alternative hosts; manage insect vectors using reflective mulches and netting.

Potyvirus complex symptoms on pumpkin foliage (a, b) and fruit (c); and on zucchini squash (d).

Diseases Caused by Nematodes

45. Root-knot nematode (*Meloidogyne incognita*) affects all cucurbits. In Kentucky, root-knot nematode is a problem mainly in areas with lightly textured or sandy soils. Aboveground symptoms include stunting and chlorosis of plants. Leaves of affected plants may develop chlorosis between veins or symptoms of nutrient deficiency; roots show a characteristic knotting and galling. **Management**—Manage weeds and potential alternative hosts; avoid movement of infested soil to clean fields; rotate with a non-host or nematode suppressive crop for 3 years.

Root-knot nematode on summer squash roots.

Chemical Injuries

46. Fertilizer burn occurs when chemical fertilizers (which are composed of salts) are applied at high concentrations. All vegetables can be affected by fertilizer burn. Cucurbits are particularly sensitive because they do not have a thick waxy cuticle on leaves. When the water containing the fertilizer evaporates from the leaves, all that is left is the fertilizer salt, which can quickly desiccate (dry out) the leaves, leading to fertilizer burn. Seedlings are very tender and are particularly sensitive. Symptoms include a generalized burned appearance or flecking resembling a spray pattern.

Management—Avoid foliar feeding if possible; care should be taken when it is necessary. Compared to roots, the leaves are capable of taking up only very small quantities of fertilizer. When using a water-soluble fertilizer in the greenhouse, growers may want to rinse the fertilizer off the leaves. Growers should plan on providing all the necessary fertility for their crops through fertigation or soil applications as recommended by soil testing and production guidelines.

Fertilizer burn to cucumber seedlings.

47. Chlorothalonil (Bravo, others) **injury.** Damage from this commonly used cucurbit fungicide has been observed on watermelon late in fruit development. Symptoms appear as a light brown or white burned appearance on watermelon fruit.

Chlorothalonil injury to watermelon.

Clomazone injury to foliage.

Dinitroanaline injury to watermelon roots.

48. Clomazone (Command 3ME) **injury.** Used to control annual grasses and small-seeded broadleaf weeds, this herbicide is a chlorophyll/carotenoid pigment inhibitor. Affected leaves appear bleached, sometimes with a tinge of pink/purple. New growth initially appears normal except for the lack of green and yellow pigments. Clomazone is labeled for preplant incorporated or pre-emergence application.
Management—Use according to the label and apply with a shielded sprayer if spraying row middles.

49. Dinitroanaline injury. This class of herbicide contains an active ingredient which generally ends with "alin," (for example, ethalflur*alin*). Ethalfluralin is the active ingredient in Curbit, a commonly used herbicide labeled for cucurbit crops. Dinitroanalines alter root and shoot development and are used for pre-emergent control of grasses and broadleaf weeds. Symptoms of injury include a swelling or splitting of the primary root and shoot, which will eventually lead to poor growth, wilting, and typically death later in the season. Ethalfluralin is also an active ingredient in the herbicide Strategy.
Management—This herbicide should be applied to the soil surface (not incorporated) *after* seeding. Dinitroanalines prevent the full germination of weed seeds near the surface; seed of the crop to be grown is generally not affected since it is planted deep enough to avoid damage. However, if the soils are wet or a heavy rain occurs after application, the herbicide will move deeply enough into the soil to affect the crop. For this reason, do not incorporate, do not apply to wet soils, and do not apply prior to an anticipated rain.

50. Glyphosate (Round-up) **injury.** This non-selective herbicide, which is used to control grasses and broadleaf weeds, is systemic. Any spray drift will be absorbed by leaves and translocated throughout the entire plant, often resulting in death. Symptoms appear as a strong yellowing of newly emerged leaves and a yellowing of the center/base of older leaves.
Management—Avoid spray drift by using shielded sprayers and spraying on calm days.

51. Halosulfuron (Sandea) **injury.** An herbicide labeled for use on many cucurbits (cucumbers, melons, pumpkins), halosulfuron controls many broadleaf weeds and yellow nutsedge but not grasses. This herbicide can be applied pre-plant under plastic or post-transplant on bare ground and row middles. Cool temperatures at time of application and/or use of an organophosphate insecticide may enhance injury. The application of Sandea over the top of melons or cucumbers growing on plastic can cause injury. Symptoms appear as a patchy yellowing of leaves on affected plants.
Management—Use only on labeled crops and at appropriate rates. Do not spray on plastic mulch, as this herbicide may wash from the surface of the plastic and concentrate in the planting hole.

Glyphosate injury to pumpkin foliage.

Halosulfuron injury to pumpkin foliage (a) and muskmelon foliage (b).

For more information

Specific pest management and crop production information can be found in the following University of Kentucky publications available at county Extension offices, as well as on the Internet.

Production and pest management information

Vegetable Production Guide for Commercial Growers (ID-36)

http://www.ca.uky.edu/agc/pubs/id/id36/id36.htm

Home Vegetable Gardening in Kentucky (ID-128)

http://www.ca.uky.edu/agc/pubs/id/id128/id128.pdf

Plant Pathology fact sheets

Blossom End Rot (PPFS-VG-02)

http://www.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/PPFS-VG-2.pdf

Southern Blight (PPFS-VG-03)

http://www.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/PPFS-VG-3.pdf

Entomology fact sheets

Cucumber Beetles (ENTFACT-311)

http://www.ca.uky.edu/entomology/entfacts/ef311.asp

Silverleaf Whitefly on Squash (ENTFACT-319)

http://www.ca.uky.edu/entomology/entfacts/ef319.asp

Squash Vine Borer and Squash Bug (ENTFACT-314)

http://www.ca.uky.edu/entomology/entfacts/ef314.asp

Two-Spotted Spider Mites (ENTFACT-310)

http://www.ca.uky.edu/entomology/entfacts/ef310.asp

Whiteflies in Gardens (ENTFACT-303)

http://www.ca.uky.edu/entomology/entfacts/ef303.asp

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