An IPM Scouting Guide for Common Pests of Solanaceous Crops in Kentucky
The National IPM Network defines IPM as “A sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health, and environmental risks.” One of the key components of IPM is to continually scout and monitor crops to identify problems before they result in significant economic losses.

Proper identification of pathogens and insect pests as well as nutritional and physiological disorders and even herbicide drift is essential to determining the proper course of action. The pictures included in this guide represent some common pests or problems that growers may encounter when producing solanaceous crops (tomatoes, peppers, eggplant, and potatoes) in Kentucky.

This manual is not all-inclusive, and you may encounter a problem that you do not see here. Please contact your county Extension service for assistance. Also, for more complete growing information for vegetable crops in Kentucky, consult Vegetable Production Guide for Commercial Growers (ID-36), available from your county office or online at http://www.ca.uky.edu/agc/pubs/id/id36/id36.htm.
Physiological and Nutrient Disorders

1. **Vivipary.** Sometimes seeds of fruit will germinate while still inside the fruit. The ability for seed to germinate without passing through the normal stages of development is called vivipary, and is not uncommon in tomato. Some believe that vivipary is the result of cold storage of tomato fruit. The fruit are still edible.

2. **Gold fleck** starts as scattered small green spots on ripening fruit and quickly turns a gold color. The cause is unknown but is likely related to genetics. In some instances damage from concentrated fertilizer sprays can resemble flecking, but the affected tissue is usually brown (necrotic) and not gold in color. Although primarily thought to be genetic, flecking can appear more pronounced under certain environmental conditions.

3. **Catfacing** can be the result of poor pollination generally due to extremely hot or cold temperatures or severe drought conditions. Herbicide drift of some herbicides that contain growth regulators may also be linked to catfacing. The best management strategy is to select varieties that have shown little tendency to catface in the past.

4. **Zippering** is characterized by the presence of brown tissue (resembling a zipper) running down the sides of tomatoes, often from the stem to blossom end. Zippering is the result of an anther remaining attached to newly forming fruit. Some believe it is also associated with incomplete shedding of flower petals when fruit is forming. There is little that can be done to prevent zippering, except selecting varieties that do not seem prone to zipper.

5. **Cracking** generally appears near the stem scar and is the result of rapid fruit growth usually brought on by periods of drought followed by heavy rains or irrigation events. Concentric cracking can often occur when standing water sits on the shoulders of fruit. There are large varietal differences in susceptibility to cracking. Cracking can be greatly reduced by choosing resistant varieties and managing irrigation.

6. **Sunscald on tomato.** Sunscald typically occurs on the shoulders of tomato fruit, though can occur anywhere the fruit are unprotected from full sunlight. Some varieties are more susceptible than others. Avoid varieties that provide little foliar coverage while producing unprotected fruit. Nitrogen fertility and irrigation can also reduce/increase the amount of foliage that a plant produces, affecting the chances for sunscald injury.
physiological and nutrient disorders

7. **Blossom end rot** is caused by inadequate translocation of calcium through the plant during fruit development. Generally the problem is not insufficient soil calcium levels but rather inadequate soil moisture to deliver the calcium to the plant. Once the condition has developed it cannot be corrected on affected fruit; better water management and application of calcium-containing fertilizers, if necessary, can prevent further loss.

8. **Blotchy ripening** is believed to be caused by a number of factors, including inadequate potassium availability, cool and cloudy weather and moisture stress. If blotchy ripening is a persistent problem have a soil test done and check the Hartz Ratio (included on UK soil tests for tomato production). Applications of potassium nitrate during fertigation may help. Some varieties are more susceptible than others.

9. **Yellow shoulder** is a ripening disorder that is distinct from blotchy ripening. Varieties that lack the uniform ripening gene are more susceptible, as are varieties that produce less foliage to shade fruit.

10. **White core** is generally characterized by the presence of a thick, tough, large white core in tomatoes. In general it is believed to be caused by stressful conditions, in particular excessively high temperatures and in some cases, excessive fertility. Some varieties, including those that are not specifically bred for heat tolerance, are more susceptible than others. White core can occur in high tunnel tomatoes when spring temperatures are excessive (> 100°F) due to inadequate ventilation.
11. **Magnesium deficiency** is defined by interveinal chlorosis (the leaf veins stay green while the regions between them turn yellow), typically on older leaves. Some micronutrient deficiencies can have similar symptoms but they generally appear on newer growth. Can be corrected with Epsom salts.

12. **Potassium deficiency** often is associated with death around the leaf margins and yellowing of leaves. Potassium deficiencies are also associated with blotchy ripening in tomato. Check plant potassium status using a Cardy Meter.

13. **Boron deficiency** in potatoes results in necrosis of the tuber tissue. Use Solubor, or other boron-containing fertilizers to correct deficiencies. Do not over-fertilize with boron; it is a micronutrient, and much lower levels are necessary to correct deficiencies than with major nutrients.

14. **Bullishness** is generally caused by excessive nitrogen fertilization resulting in overly “bullish” vegetative growth. Typical symptoms include a curling and distortion of leaves, particularly near the top of the plant. In some cases it may resemble growth regulator injury. Poor fruit set is also associated with bullishness. It is more common during periods of cool, cloudy weather.

Determinate, field-type varieties seem more affected than indeterminate varieties. Bullishness is common in greenhouse or high tunnel grown plants, particularly in late winter. Plants typically will grow out of the condition once light levels and temperatures increase. Reduce nitrogen fertilization during periods of cool cloudy weather to prevent bullish growth.

15. **Frost injury.** Tomato leaves injured by frost first appear water soaked, then turn to a necrotic browning, burned appearance.
Crow-damaged tomatoes.

16. Animal damage. Tomatoes are often damaged by crows, deer, coyotes, raccoons and a variety of other pests. Try to plant away from wooded areas and use deterrents if possible.

17. Silvering occurs on bell peppers when cells adjacent to the cuticle in fruit separate causing a “silvered” appearance. It is considered a defect in fruit and can be a reason for fruit being rejected during times of excess supply. The severity of silvering can range from a small dime-size area on fruit to an area covering more than half of a fruit. It is related to variety; those varieties possessing strong resistance or tolerance to Phytophthora are more likely to exhibit this trait. There is also an environmental link to this disorder as it varies in severity from year to year.

18. Black spot. Irregular black or dark brown spots that are not raised on the pepper fruit. Spots will extend into the fruit as well. Rare, though previously documented in Texas. At this time the cause of this disorder is not known.

19. Flood damage. Prolonged exposure to flooding conditions can lead to a host of problems, including nutrient deficiencies, root death due to a lack of oxygen, and numerous soil-borne pathogens. Raised beds help improve drainage. Vegetables exposed to flood waters may need to be discarded to be in accordance with food safety regulations.
Insect Pests

20. Aphids (various species). Common pests of all solanaceous crops. Pictured are the green peach aphid (*Myzus persicae*) on pepper and potato aphid (*Macrosiphum euphorbiae*) with white cast skins on tomato. Adult aphids are about \( \frac{1}{6} \) inch long and are a common pest of peppers and tomatoes in Kentucky. Aphids remove sap from plants through piercing and sucking mouthparts, and although large numbers can be tolerated, severe infestations such as this can lead to stunting and leaf curl in affected plants. Aphid outbreaks are often the result of over reliance on pyrethroid insecticides. Aphids pose a significant threat as a vector to spread viruses among crops.

21. Vegetable leafminer (*Liriomyza sativae*). Found on many vegetables, including tomato and pepper, vegetable leafminer larvae will make serpentine “mines” in leaves. Adults are \( \frac{3}{16} \) inch long black and yellow flies. Many natural enemies can control this pest.

22. Greenhouse whitefly (*Trialeurodes vaporariorum*). About \( \frac{1}{8} \) inch in length, greenhouse whitefly is a common pest of tomato plants. Nymphs are pale yellow and often found on the underside leaves. The adult whitefly is white and often keeps its wings flat on its back. A generation of greenhouse whitefly can be completed in as short as 3 to 4 weeks, and an adult female can lay hundreds of eggs in just 6 to 8 weeks.

23. Silverleaf whitefly (*Bemisia argentifolii*). Silverleaf whitefly is a relatively new pest to Kentucky. Silverleaf whitefly will not overwinter in Kentucky, however it may be brought in via transplants or greenhouse plants. The silverleaf whitefly can be distinguished from the greenhouse whitefly by looking at how it holds its wings. The silverleaf whitefly will usually hold its wings to its side with a space visible between them; the greenhouse whitefly often holds its wings tight on its back. Silverleaf whitefly larvae inject toxins into tomato fruit when feeding, leading to irregular ripening which can cause significant losses. Affected fruit will not ripen completely.
24. **Tobacco flea beetle** (*Epitrix hirtipennis*). The tobacco flea beetle is about $\frac{1}{10}$ inch long and yellowish brown with a dark band across its wings. They attack solanaceous crops, leaving small round holes in the leaves, and may destroy entire leaves. Potentially they can be serious pests early in the season when the plants are less than 4 to 6 inches tall. As they grow, larger plants can withstand substantial flea beetle damage without loss of yield.

25. **Potato flea beetle** (*Epitrix cucumeris*). The potato flea beetle is about $\frac{1}{16}$ inch long and feeds on tomato and potato plants. They differ from the tobacco flea beetle in that they are uniformly colored black to brown.

26. **Margined blister beetle** (*Epicauta pes-tifera*). Margined blister beetles are common in the Midwest can be distinguished from other blister beetles by the orange striping on the wing margins. Only one generation is produced per year and they are generally not a major threat, though large numbers of adults can appear in swarms and rapidly defoliate plants.

27. **Stink bugs** (brown: *Euschistus servus*; green: *Acrosternum hilare*; brown marmorated: *Halyomorpha halys*). Stink bugs are about $\frac{1}{2}$ to $\frac{3}{4}$ inch long and are common pests in Kentucky. They feed on plants and fruit by inserting their needle-like mouthparts into stems, leaves, or seed pods. While feeding, they inject materials into the plant to aid in digestion and sap removal. Adult stink bugs can be difficult to manage with insecticides. Stink bugs commonly feed on pepper and tomato fruit, causing significant damage that extends from the surface into the fruit. The brown marmorated stink bug is new to Kentucky and has the potential to build to very high numbers on and cause extensive damage to many fruit and vegetables including solanaceous crops. Penetration by the mouthparts can cause physical damage, much like stabbing the plant with a fine needle, and the materials injected can also damage plant tissues. A combination of mechanical and chemical damage may be responsible for the injury and symptoms seen in the field.
28. **Leaf-footed bugs** (*Leptoglossus* spp). Leaf-footed bugs get their name from the expanded tibia of the hind leg. They are closely related to stink bugs and also feed with piercing-sucking mouthparts but are not in the same family. Leaf-footed bugs are becoming more common, particularly on tomatoes, causing damage similar to that of stink bugs. Leaf-footed bugs may be observed after flowering through the fall.

29. **Western flower thrip** (*Frankliniella occidentalis*). Thrips of all types can feed on tomatoes. When they pierce the tomato they leave behind small holes, leaving the fruit unmarketable. Thrips are extremely small (<\(\frac{1}{16}\) inch) and often hard to detect. They thrive in hot weather and can transmit tomato spotted wilt virus.

30. **Twospotted spider mite** (*Tetranychus urticae*). Twospotted spider mites are very small and difficult to see without the aid of a magnifying lens. Typically damage appears as a yellow flecking of leaves, which turns to a general browning of the leaves. Careful scouting for twospotted spider mite is important as they are resistant to many classes of insecticide. Spider mites are more common in hot, dry weather.
31. **Colorado potato beetle** (*Leptinotarsa decemlineata*). Colorado potato beetle can be a serious pest of tomato, eggplant, and pepper. Adult beetles are about \( \frac{3}{8} \) inch long with black and yellow stripes over its back. Each female can lay 500 or more eggs over a four- to five-week period. Eggs hatch in four to nine days and the larvae begin to feed on potato foliage. Larvae are humpbacked with two rows of black spots on each side. They usually feed in groups, and damage can be severe. The larval stage lasts two to three weeks. Full grown larva burrow in the ground to pupate. In five to 10 days, the adult beetle emerges. This insect can go from egg to adult in as little as 21 days.

32. **Tobacco hornworm** (*Manduca sexta*). Tobacco hornworms are very similar to tomato hornworms, and both cause significant foliar injury to tomato as well as peppers. Both can be several inches in length. Tobacco hornworms generally have a red “horn” and diagonal white stripes on their sides; tomato hornworms have a black horn and white v-shaped stripes. Both pests are common in Kentucky. The green hornworms may blend in and be hard to locate at first; however, they leave behind rather large black-brown frass deposits as evidence of their presence, and further scouting is warranted when such deposits are seen. Adult hornworms first appear as moths in late spring to lay eggs. Moths are quite large, approaching several inches in length. Often tobacco hornworms will be attacked by a parasitic wasp, *Cotesia* sp., which lays eggs inside tobacco hornworms. Wasp larvae grow internally and emerge in white cocoons.
33. **Pepper maggot** *(Zonosemata electa).* Pepper maggot larva (yellow) and pupa (black) are shown. They are about \( \frac{1}{2} \) inch long and will feed on actively growing peppers. Good sanitation and rotation are important.

34. **Beet armyworm** *(Spodoptera exigua).* Beet armyworm is a serious pest of vegetables in Kentucky, often appearing in August or September. Mature larvae are about 1½ inch long and can rapidly defoliate plants. Female moths lay masses of up to 80 eggs under a covering of cottony-white scales, as many as 600 eggs over a three- to seven-day period. Eggs hatch in two to three days, with the larvae first feeding together in a group near the egg cluster. As the larvae grow, they gradually move away from the egg masses. In fresh market tomatoes, treatment is needed when 3% fruit feeding (shallow, dry cavities in the fruit) is noted. Beet armyworm is resistant to pyrethroid insecticides. Larvae often feed on pigweed, so when scouting take time to look at any pigweeds in the vicinity of your crop.
35. **Yellow striped armyworm** (*Spodoptera ornithogalli*). Yellow striped armyworms are similar to beet armyworms but are generally brown in color with a yellow strip and triangular black marks on their back.

36. **Tomato fruitworm** (*Helicoverpa zea*). Tomato fruitworm is the same pest as corn earworm. Early fruitworm generations attack corn, particularly when it is silking. However, tomatoes are preferred for egg laying over corn when the silks turn brown and dry. Adult moths usually have light brown wings with a dark spot near the middle. Moths fly at night looking for a suitable place to lay their eggs.
37. **European corn borer** (*Ostrinia nubilalis*). European corn borer is a common pest of peppers in Kentucky. Corn borers overwinter as full-grown larvae in corn stubble. European corn borers enter pepper fruit near the calyx and destroy the inside of the pepper. If you have peppers with damage and entry holes near the calyx then corn borers are likely inside. Adults emerge in late spring to mate and females will typically lay egg masses on foliage. Generally there are two generations per year. Male moths are attracted to pheromone traps, which are effective tools to scout for European corn borer.

Adult female European corn borer (a), adult male (b), and damage on pepper (c, d).
Diseases

Fungi and Fungus-like Organisms on Tomatoes

38. Anthracnose (*Colletotrichum* spp.). Often referred to as “ripe rot,” anthracnose appears on ripening fruit in the form of sunken, circular spots (lesions). Lesions enlarge and darken over time, and concentric patterns may be observed. Under humid conditions, salmon-pink masses of spores may be seen.

**Control**—prompt destruction and removal of residues from previous tomato crops, rotation, weed control, irrigation management (don’t over-water when using overhead systems), and fungicides (applied beginning at fruit set).

39. Early blight (*Alternaria solani*). The most common fungal disease of tomatoes in Kentucky. Symptoms may appear on leaves, stems, and fruit in the form of dark-brown lesions with a concentric pattern. Older leaves are usually affected first, but the disease will spread to newer growth under favorable conditions. Lesions enlarge and coalesce, and can result in extensive blighting and loss of foliage. Fruit are affected in severe outbreaks; the primary symptom is the presence of dark-brown lesions with a concentric ring pattern.

**Control**—prompt destruction and removal of residues from previous tomato crops, rotation, weed control, irrigation management, and fungicides.

40. Fusarium wilt (*Fusarium oxysporum* f.sp. *lycopersici*). Can be problematic in warm and dry years and is usually most severe if associated with infestations of root-knot nematode. Symptoms include stunting, yellowing of older leaves, and wilting. Wilting may be seen initially on one side of the plant, and may be worse in the hottest part of the day. Plants decline over a period of days or weeks, and eventually die. Vascular tissue (xylem) of plants affected by fusarium wilt is brown in color—a key diagnostic feature.

**Control**—resistant varieties, rotation, sanitation, pathogen-free seed/plants, and control of nematodes.
41. **Gray mold** (*Botrytis cinerea*). Can be found on field-grown plants, but most commonly occurs on tomatoes produced in greenhouses and high tunnels. Cool temperatures and high humidity favor disease. Leaves, stems, and fruit may be affected, and the disease is characterized by tan-brown lesions and abundant masses of gray spores. Spore masses have a velvety appearance. Occasionally, green fruit may show "ghost spots," which make fruit unmarketable. **Control**—adequate ventilation and plant spacing, sanitation (removal of debris), and fungicides (limited options).

42. **Late blight** (*Phytophthora infestans*). A relatively rare disease in Kentucky, most likely to occur during periods of cool and wet weather (often in the fall). Leaves, stems, and fruit can be affected; on foliage, individual lesions begin as water-soaked areas. Lesions can enlarge quickly, resulting in extensive blighting of foliage. Under cool and humid conditions, sporulation (whitish-gray downy-type growth) can be observed on the undersides of affected leaves. Fruit affected by late blight exhibit darkened, water-soaked spots that coalesce, often covering much of the fruit. Severely infected fruit are invaded by secondary organisms, resulting in a rapid, soft decay. **Control**—sanitation (including removal and destruction of tomato debris at season's end), resistant varieties, adequate ventilation in greenhouses, and fungicides.

43. **Leaf mold** (*Fulvia fulva*). Found mainly on greenhouse-grown tomatoes in Kentucky. Cool temperatures and high humidity favor disease. Symptoms appear mainly on foliage, in the form of light green or yellow spots on the upper surface of leaves. As lesions mature, a green, velvet-like layer of sporulation can be seen. Affected leaves eventually die and drop from the plant. **Control**—sanitation (including removal and destruction of tomato debris at season's end), resistant varieties, adequate ventilation in greenhouses, and fungicides.
44. **Powdery mildew** (*Leveillula taurica*). Powdery mildew is found mainly on tomatoes grown in greenhouses and high tunnels, but can be found on field-grown tomatoes during dry summers. The disease is characterized by a white, talc-like growth on upper and lower leaf surfaces. Over time, necrotic areas will form, resulting in blighting of affected leaves. Stems may be infected in severe outbreaks.

**Control**—proper plant spacing and adequate ventilation (greenhouses), and fungicides.

45. **Septoria leaf spot or blight** (*Septoria lycopersici*). Favorited by moderate temperatures and high humidity/rainfall, Septoria leaf spot usually is first observed in the lower plant canopy but can spread eventually to newer growth. Circular lesions with darkened borders and tan-brown centers are characteristic of this disease, and can be numerous under favorable conditions, resulting in severe blighting. Small, black specks (pycnidia) are often found in the centers of older lesions.

**Control**—follow recommendations for management of early blight.
46. **Southern blight** (*Sclerotium rolfsii*). Favored by warm and humid weather. In most cases the first noticeable symptom of southern blight is a sudden yellowing/browning and wilting of affected plants, followed by death. Lesions or cankers may be found at the base of the stem near the soil line, and these may extend several inches above this point. When humidity is high, a dense, white fungal growth (mycelium) may be present on affected plant parts and surrounding soil. In a short period of time, numerous tan-to-reddish brown sclerotia (spherical resting structures) roughly the size of mustard seed can be found on the surface of the mycelium. Fruit that touch infested soil can become infected, resulting in a wet rot and rapid decay of fruit. **Control**—rotation with non-hosts (grasses primarily), deep turning of soil, removal and burial of diseased plants, and fungicides (limited options). Removal and destruction of symptomatic plants and fungal matter can be practical if relatively few plants are affected.

47. **Timber rot or white mold** (*Sclerotinia sclerotiorum*). Occurs in Kentucky on both greenhouse- and field-grown tomatoes, and is most common in late spring following periods of cool, wet weather. The main stem is affected primarily, and lesions can occur at the soil line or several inches above this level. Under favorable conditions, lesions elongate and become tan with a faint, zonate pattern within the symptomatic area. Eventually, the stem is girdled and the entire plant collapses or wilts suddenly. Infected plants rarely survive. Splitting the stem of symptomatic plants longitudinally reveals one or more irregular-to-cylindrical, black sclerotia, a key diagnostic character for this disease. **Control**—rotation, proper plant spacing, adequate ventilation (greenhouses and high tunnels), sanitation (including prompt removal and destruction of crop residues at the end of the season), and fungicides. Removal and destruction of symptomatic plants and fungal matter can be practical if relatively few plants are affected.
48. **Verticillium wilt** (*Verticillium dahliae* and *V. albo-atrum*). Can be problematic in years when conditions are cool, and is usually most severe if associated with wounding of roots or infestations of root-knot nematode. Symptoms may be more pronounced during fruiting as well. Verticillium wilt can be difficult to distinguish from Fusarium wilt. In many cases, the first symptom of this disease to be seen is wilting of the whole plant during the hottest part of the day followed by recovery at night. Leaves may show yellowing (chlorosis) around leaf margins or between veins, and often show v-shaped or fan-like lesions that extend from the leaf margin inward. Vascular tissue (xylem) of plants affected by Verticillium wilt is discolored as with Fusarium wilt.

**Control**—resistant varieties, rotation, sanitation, pathogen-free seed/plants, and nematode control.
Bacterial Diseases on Tomatoes

49. Bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*). Plants of all ages are susceptible to bacterial canker, and the disease can be devastating in the greenhouse or field. The disease is favored by warm temperatures and high humidity or rainfall. All above-ground parts of the tomato plant are susceptible to bacterial canker. A characteristic symptom of the disease is wilting of systemically infected plants; open cankers (from which the disease gets its name) can be found on the stems. When split lengthwise, stems will show reddish-brown discoloration of the vascular system, and the pith may be grainy or pitted. Symptoms on plants not infected systemically may appear on older leaves as a marginal browning, or necrosis, called “firing.” A yellow margin may border the brown tissue, and affected leaves tend to curl upward. Seedlings affected by bacterial canker may appear stunted and will often wilt and die. The primary symptom on fruit is the presence of raised lesions with a white margin, roughly $\frac{1}{4}$ inch in diameter, called “bird’s eye” spots.

**Control**—pathogen-free seed and transplants, sanitation (tools, implements), rotation with unrelated crops, avoidance of overhead irrigation or working plants when foliage is wet, and prompt destruction of crop residues at season’s end. Removal and destruction of symptomatic plants and fungal matter can reduce spread of canker, but is practical only if relatively few plants are affected.

![Bacterial canker on foliage (a, b), fruit (c), and tomato plant stem (d). Pith necrosis (e)](image-url)
50. **Bacterial speck** (*Pseudomonas syringae* pv. *tomato*). Most likely to occur when conditions are cool and rainy. Leaves, stems, and fruit can be affected. On foliage, lesions are small, circular, and brown in color and may be surrounded by a yellow border or “halo.” Over time, lesions can coalesce and form large blighted areas in the plant canopy. Defoliation may occur in severe cases. It is difficult to differentiate foliar symptoms of bacterial speck and bacterial spot. On green fruit, lesions are small (specks) and tend to be somewhat sunken.

**Control**—refer to recommended controls for bacterial canker. In addition, chemical control measures are available.

51. **Bacterial spot** (*Xanthomonas campestris* pv. *vesicatoria*). Most likely to occur when conditions are warm and humid or rainy. Leaves, stems, and fruit can be affected by this disease. On foliage, lesions are small, circular, and brown in color and infrequently have a yellow halo. As with bacterial speck, lesions can coalesce and form large blighted areas in the plant canopy. Defoliation may occur in severe cases. It is difficult to differentiate foliar symptoms of bacterial speck and bacterial spot; however, lesions of bacterial spot tend to take on a wet or “greasy” appearance. On green fruit, lesions begin as raised blisters and reach a maximum size of about ¼ inch. Fruit lesions tend to have a scabby appearance and can be slightly raised or depressed in the center.

**Control**—refer to recommended controls for viral diseases.
Viral Diseases on Tomatoes

52. Cucumber mosaic virus (CMV). Symptoms of cucumber mosaic on tomato are varied, including stunting, yellow/green mottling of leaves, and filiformity. The latter gives the leaves of affected plants a “strappy” or “shoestring” appearance and is the symptom most identified with cucumber mosaic. Few fruit are produced on CMV-infected plants. The virus is vectored by aphids.

Control — destruction of weed hosts, barrier crops, and vector control (inconsistent results).

53. Tobacco mosaic virus (TMV) and tomato mosaic virus (ToMV). The principal symptom is mottling of foliage. Stunting and leaf curling may also occur. External symptoms on fruit include uneven ripening, mottling, and reduced size. Internal discoloration, called “brownwall” can occur in some cases. TMV and ToMV are mechanically transmitted and easily spread.

Control — resistant varieties, sanitation, and rotation.

54. Tomato spotted wilt virus (TSWV). A number of symptoms occur on TSWV-infected plants, including stunting, wilting, ringspots on leaves, lesions on stems, bronzing of leaves, and root necrosis. Fruit may show mottling, ringspots, and irregular growth.

Control — resistant varieties and reflective mulches.

Nematodes on Tomatoes

55. Root-knot nematodes (Meloidogyne incognita). Above-ground symptoms include stunting, uneven growth, and nutrient deficiencies. The characteristic symptom caused by the root-knot nematode is the production of numerous galls on roots.

Control — rotation, resistant varieties, and nematicides or soil fumigants.
Fungi and Fungus-like Organisms on Peppers

56. Anthracnose (*Colletotrichum* spp.). Appears on ripening fruit in the form of sunken, circular spots (lesions), but may also develop on immature fruit. Lesions enlarge and darken over time, and concentric patterns may be observed. Under humid conditions, salmon-pink masses of spores may be seen.

**Control**—pathogen-free seed, prompt destruction and removal of residues from previous crops, rotation, weed control, irrigation management (don’t over-water when using overhead systems), and fungicides.

Phytophthora blight stem canker (a), damage to foliage (b), and on fruit (c).

57. Phytophthora blight (*Phytophthora capsici*). Phytophthora blight is favored by warm and wet weather. The most common symptoms are rotting or necrosis of roots and crowns, and darkened cankers on stems. Plants with infected roots and stems wilt and eventually die. Leaves may become infected, resulting in water-soaked, pale-green to yellow lesions. Infected fruit develop water-soaked lesions and may show a thin layer of white fungal growth when humidity is high. Phytophthora blight is an aggressive, fast-moving disease under ideal conditions, and can cause extensive losses.

**Control**—sanitation, rotation, elimination of standing water, irrigation management, resistant varieties, and fungicides.

Anthracnose.

Phytophthora blight wilting.
58. Southern blight (*Sclerotium rolfsii*). This disease is favored by warm and humid weather. In most cases the first noticeable symptom of southern blight is a sudden yellowing/browning and wilting of affected plants, followed by death. Lesions or cankers may be found at the base of the stem near the soil line, and these may extend several inches above this point. When humidity is high, a dense, white fungal growth (mycelium) may be present on affected plant parts and surrounding soil. Numerous tan-to-reddish brown sclerotia (spherical resting structures) roughly the size of mustard seed can be found on the surface of the mycelium. Fruit that touches infested soil can become infected, resulting in a wet rot and rapid decay of fruit.

**Control**—rotation with non-hosts (grasses primarily), deep turning of soil, removal and burial of diseased plants, and fungicides (limited options). Removal and destruction of symptomatic plants and fungal matter can be practical if relatively few plants are affected.

59. Bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*). Bacterial spot is most likely to occur when conditions are warm and humid or rainy. Leaves, stems, and fruit can be affected. On foliage, lesions are circular and brown in color and infrequently have a yellow halo. Lesions can coalesce and form large blighted or yellowed areas in the plant canopy. Loss of foliage may occur in severe cases, exposing fruit to sunlight. On green fruit, lesions begin as raised blisters and reach a maximum size of about \( \frac{1}{8} \) inch. Fruit lesions tend to have a rough, scabby appearance and may crack over time.

**Control**—disease-free seeds and transplants, rotation, resistant varieties, and bactericides.
Viral Diseases on Peppers

60. Cucumber mosaic virus (CMV). Symptoms of cucumber mosaic on pepper are variable, and include lesions on leaves, chlorosis, mosaic, distortion, ringspots, and necrosis or “oakleaf” patterns around veins. Fruit infected by CMV may be pale in color and exhibit ringspots or necrotic areas. Fruit production can be reduced on CMV-infected plants. The virus is vectored by aphids. **Control**—destruction of weed hosts, use of barrier crops, and vector control (inconsistent results).

61. Tobacco etch virus (TEV). Mottling or distortion of foliage is common with tobacco etch on pepper, along with stunting of plants and necrosis of roots. Fruit may show mottling or mosaic symptoms. Aphids are the vector for TEV. **Control**—resistant varieties, mineral oils, and reflective mulches.

62. Tomato spotted wilt virus (TSWV). A number of symptoms occur on TSWV-infected plants, including stunting, leaf distortion, ringspots on leaves, lesions on stems, and bronzing of leaves. Fruit may show mottling, ringspots, and irregular growth. **Control**—resistant varieties and reflective mulches.

63. Alfalfa mosaic virus (AMV). Typical symptoms are a bright yellow mosaic or white blotches on leaves. AMV is transmitted by aphids and can survive in a number of plant species. **Control**—Do not rely on insecticide sprays, as aphids will transmit the virus quickly, and do not plant peppers in or next to an area planted with alfalfa.
**Fungi and Fungus-like Organisms on Eggplant**

64. **Phomopsis blight** *(Phomopsis vexans).* Can be problematic during warm and wet conditions. Symptoms may appear on leaves and stems; however, fruit are most commonly affected. Small, circular lesions appear on fruit and enlarge rapidly. Lesions often coalesce, covering a large portion of the fruit surface. Darkened rings may be evident in older lesions, giving them a zonate appearance. These rings are comprised of numerous pycnidia (fruiting bodies) of the fungus embedded in the diseased tissue. Phomopsis-infected fruit are unmarketable and are often invaded by secondary organisms that cause rapid decay of the fruit.

**Control**—prompt destruction of crop residue at season’s end and rotation.

65. **Verticillium wilt** *(Verticillium albo-atrum and V. dahliae).* Symptoms are similar to fusarium wilt (see Tomato Diseases), and are usually first noticed following fruit set. Plants may be stunted, and lower leaves may begin to yellow or develop necrotic lesions. Necrotic v-shaped lesions that begin at the tips of leaves are often associated with Verticillium wilt. Wilting occurs eventually and is sometimes confined to one side of the plant. As with Fusarium wilt, browning of vascular tissue is a key diagnostic symptom.

**Control**—rotation and destruction/removal of infected plants (where practical).

**Fungi and Fungus-like Organisms on Potatoes**

66. **Early blight** *(Alternaria solani).* Symptoms may appear on leaves and stems in the form of dark-brown lesions with a concentric pattern. Older leaves are usually affected first, but the disease will spread to newer growth under favorable conditions. Lesions enlarge and coalesce, and can result in extensive blighting and loss of foliage. Tubers are affected in severe outbreaks; the primary symptom is the presence of small, sunken spots that are brown in color.

**Control**—pathogen-free seed stock, resistant varieties, prompt destruction and removal of residues from previous crops, rotation, and fungicides.
67. Late blight (*Phytophthora infestans*). Rarely seen in Kentucky; occurs during periods of cool and wet weather. Leaves, stems, and fruit can be affected; on foliage, individual lesions begin as water-soaked areas. Lesions can enlarge quickly, resulting in extensive blighting of foliage. Under cool and humid conditions, sporulation (white-gray downy-type growth) can be observed on the undersides of affected leaves. Tubers may also be affected; severely infected tubers are invaded by secondary organisms, resulting in a soft rot.

**Control**—pathogen-free planting stock, proper fertility and plant spacing, and fungicides.

### Bacterial Diseases on Potatoes

68. **Scab** (*Streptomyces scabies*). Scab is most problematic in soils with a pH above 5.5. Symptoms include rough, raised lesions that are variable in shape and size. Lesions (scabs) may have a corky texture, and range from superficial to those that extend deep into the tissue of the tuber.

**Control**—resistant varieties, pathogen-free seed pieces, rotation, proper soil pH (between 5.0 and 5.2), and adequate moisture.

69. **Black leg** (*Erwinia carotovora*). Infection can occur in seed pieces, preventing them from even sprouting, but often occurs after plants are up and will appear as a black to brown decay that extends from the seed piece to several inches or more above ground. Seed pieces can be infected, leading to black leg. High temperatures and wet soils greatly increase the risk of black leg.

**Control**—Plant only disease-free seed, avoid fields with a history of black leg, and do not over-irrigate.
Herbicide Injury

70. **Roundup (glyphosate)** injury to tomato. Labeled for postemergence non-selective control of broadleaves and grasses. Due to the high risk of drift injury, it is not recommended to spray in row middles.

71. **2,4 D (2,4 dichlorophenoxyacetic acid)** injury on tomato. For nonselective control of broadleaf weeds in grasses, cereals, and right of ways. 2,4-D is a synthetic plant hormone which leads to abnormal growth in broadleaf plants. Typical injury symptoms include stem curling. Take care to situate vegetable plantings away from other crops or areas where 2,4 D drift could be a problem.

72. **Gramoxone (paraquat)** injury. Labeled for preplant application for nonselective contact control of grasses and broadleaves. Leaf burn and necrosis is a common injury associated with paraquat and other contact herbicides. Typical injury symptoms include necrotic regions on leaves where contact with the herbicide was made.
Herbicide injury

73. **Command (Clomazone) injury.** Not labeled for use in eggplant or tomato in Kentucky. However it is labeled for several other vegetables, including cabbage, and for preplant control of weeds. Injury typically appears as a distinct bleaching of affected leaves.

74. **Callisto (Mesotrione) injury.** Callisto is not labeled for use on solanaceous crops in KY. However it is labeled for postemergence control of annual broadleaves in sweet corn. If spraying on sweet corn, be aware of the possibility of drift injury in other vegetables. Callisto injury to broadleaves will generally appear as a bleaching of leaves.
For more information:

**Aphids**
*Tomato Insect IPM Guidelines* (ENTFACT-313)
http://www.ca.uky.edu/entomology/entfacts/ef313.asp

*Aphids* (ENTFACT-103)
http://www.ca.uky.edu/entomology/entfacts/ef103.asp

**Greenhouse whitefly**
*Whiteflies in Gardens* (ENTFACT-303)
http://www.ca.uky.edu/entomology/entfacts/ef303.asp

**Tobacco flea beetle**
*Tomato Insect IPM Guidelines* (ENTFACT-313)
http://www.ca.uky.edu/entomology/entfacts/ef313.asp

**Brown and green stink bugs**
*Stink Bug Damage to Corn* (ENTFACT-305)
http://www.ca.uky.edu/entomology/entfacts/ef305.asp

**Colorado potato beetle**
*Colorado Potato Beetle Management* (ENTFACT-312)
http://www.ca.uky.edu/entomology/entfacts/ef312.asp

**Pepper maggot**
*Pepper Maggot in Kentucky* (ENTFACT-316)
http://www.ca.uky.edu/entomology/entfacts/ef316.asp

**Beet armyworm**
*Beet Armyworm in Kentucky* (ENTFACT-308)
http://www.ca.uky.edu/entomology/entfacts/ef308.asp

**Tomato fruitworm**
*Tomato Insect IPM Guidelines* (ENTFACT-313)
http://www.ca.uky.edu/entomology/entfacts/ef313.asp

**European corn borer**
*Predicting European Corn Borer Development* (ENTFACT-106)
http://www.ca.uky.edu/entomology/entfacts/ef106.asp