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An IPM Scouting Guide for Common Problems of Strawberry in Kentucky

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This manual is the result of efforts of the University of Kentucky Fruit Integrated Pest Management team. Funding for this publication is from the University of Kentucky Integrated Pest Management Program and USDA-NIFA Crop Protection and Pest Management.

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Cover photo: Strawberry anthracnose on fruit
(Nicole Ward Gauthier)

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, economic costs, and health hazards. Pests are managed (although rarely eliminated entirely) to reduce their negative impact on the crop.

Scouting and monitoring diseases, insects, weeds, and abiotic disorders helps identify potential problems before serious losses result. This is essential to the IPM approach. The key to effective monitoring is accurate identification. The pictures included in this guide represent the more common abiotic and biotic problems that occur in Kentucky strawberry plantings. This manual is not all-inclusive, and growers may encounter problems not included here.

Please contact a local Cooperative Extension Service office for further assistance. Additional information on identification, production, fertility, and pest management relevant to strawberries can also be found in the following publications, available at county Extension offices and online:

Commercial Fruit Pest Management Guide (ID-232) http://www2.ca.uky.edu/agcollege/plantpathology/ext_files/PPF5html/ID-232.pdf

Disease and Insect Control Program for Home Grown Fruit in Kentucky including Organic Alternatives (ID-21) <http://www.ca.uky.edu/agc/pubs/id/id21/id21.pdf>

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Trade names are used to simplify information in this publication. No endorsement is intended, nor is criticism implied of similar products that are not named. This guide is for reference only; the most recent product label is the final authority concerning application rates, precautions, harvest intervals, and other relevant information. Contact your county Cooperative Extension Service agent if you need assistance.

Diseases

1. Angular leaf spot (*Xanthomonas fragariae*) is a bacterial disease that leads to plant decline, stunting, and possible sudden plant death. Leaf spots are water-soaked, angular, and delimited by veins; they appear translucent when held up to the light. During rainy periods, the bacterium oozes from lesions and may dry, leaving a white film. As disease spreads and becomes more severe, leaf tissue dies, becomes brown or reddish brown, and moves into major veins and other vascular tissue. Disease is introduced through infected plugs or tips. Bacterium overwinters in infected plants and intact dead leaves, but it cannot survive freely in soil.

Management—Begin with clean plant material. Use sanitation to reduce spread. Consider resistant cultivars. Space plants to improve air circulation. Apply antibiotics or copper products as protectants.

2. Anthracnose crown rot (*Colletotrichum* spp.) is a fungal disease causing sporadic wilt and plant death. Early symptoms begin with plant stunting and browning/wilting of young leaves. During mild to moderate disease, plants may wilt during the heat of the day and then recover at night. As disease progresses, lack of water uptake causes plant collapse and death. If crowns are cut lengthwise, internal tissue appears reddish-brown and white marbled; crowns remain firm. Roots are not affected and remain white. Introduction often occurs through transplants. *Colletotrichum* spp. overwinter on infected plant tissue, in debris, and in mummified fruit; it can remain in soil for 9 months.

Management—Begin with clean plant material. Use proper sanitation; remove diseased plants. Rotate with non-host plants. Use fungicides to suppress disease development; fungicides do not cure disease.

3. Anthracnose fruit rot (*Colletotrichum* spp.), also called black spot, is a fungal disease that causes blossom blight and fruit rot as well as crown rot (see No. 2). Flowers die if infected. Fruit infected shortly after pollination remain small and hard. Fruit infected upon ripening develop firm, sunken lesions and may become hard and mummified as lesions expand to cover entire fruit. During wet or humid conditions, orange-pink spore masses ooze from lesions. Disease



Angular leaf spot lesions initially appear water-soaked (a) and translucent (b), later becoming necrotic (c).



Anthracnose crown rot.

usually is introduced through plugs and tips. *Colletotrichum* spp. overwinter on dead plant tissue, infected plants, and mummified fruit.

Management—Begin with clean plant material. Use proper sanitation; remove infected fruit. Rotate fields with non-host crops. Mulch to prevent spread. Use fungicides to suppress disease development; fungicides do not cure disease.

4. Black root rot complex (*Rhizoctonia* and/or *Pythium* spp.) refers to decline of plantings over time. The complex is often a combination of soil-borne pathogens and abiotic stresses (e.g. excess water, drought, or cold injury). As plantings decline, individual plants become stunted, lose vigor, and lose many older leaves. Plants produce smaller and fewer fruit. Symptoms are usually most severe right before harvest. *Pythium* spp. favor cool, wet conditions and infect young feeder roots beginning from root tips. *Rhizoctonia* spp. infect both feeder roots and structural roots, with scattered infections along roots. Both pathogens overwinter in soil. Lesion nematodes have been associated with black root rot in other states, but this has not been reported in Kentucky. Often, infections by pathogens are secondary to environmental (abiotic) stresses.

Management—Provide good drainage and avoid heavy soils. Rotate with non-host crops; rotate away from strawberry for 3 to 5 years. Mulch to prevent winter injury. Irrigate during drought. Eliminate other sources for plant stress.



3a



3b



3c

Anthracnose fruit rot lesions (a, b) and mummy (c).



4a

Black root rot (left) compared to healthy roots (a); and blackened root lesions (b).



4b

5. Botrytis gray mold (*Botrytis cinerea*) is a fungal disease that primarily affects ripening or damaged fruit. Fuzzy gray (moldy) growth is diagnostic of Botrytis rot. Fungal growth contains infective spores that cause new infections, creating a repetitive cycle. If entire fruit rots, it may dry and mummify. In some cases, blossoms become infected and serve as a pathway for fruit infections. Botrytis is ever-present, but primary inoculum comes from overwintering in dead leaf tissue and fallen fruit.

Management—Apply preventative fungicides beginning at flowering. Use proper sanitation; remove infected and damaged fruit. Increase air circulation to encourage drying. Mulch to prevent splash.

6. Leaf blight (*Phomopsis obscurans*), also known as Phomopsis leaf blight, causes rapid death of older leaves. Young plants may die as a result of severe blighting. Symptoms begin as small spots with gray centers that resemble common leaf spot (see No. 7). As disease progresses, lesions become V-shaped, brown and necrotic, often with a yellow outer margin. Black fungal fruiting structures that resemble black pepper flakes are visible in centers of lesions. Disease may affect petioles, stolons, and fruit (see No. 10). Pathogen overwinters on old foliage that remains attached to plants. Infection may also be introduced on infected plugs or tips.

Management—Begin with clean plant mate-



Botrytis gray mold fungus sporulating on berries.

rial. Use proper sanitation; remove affected leaves. Increase air circulation to encourage leaf drying. Use fungicides if disease is severe.

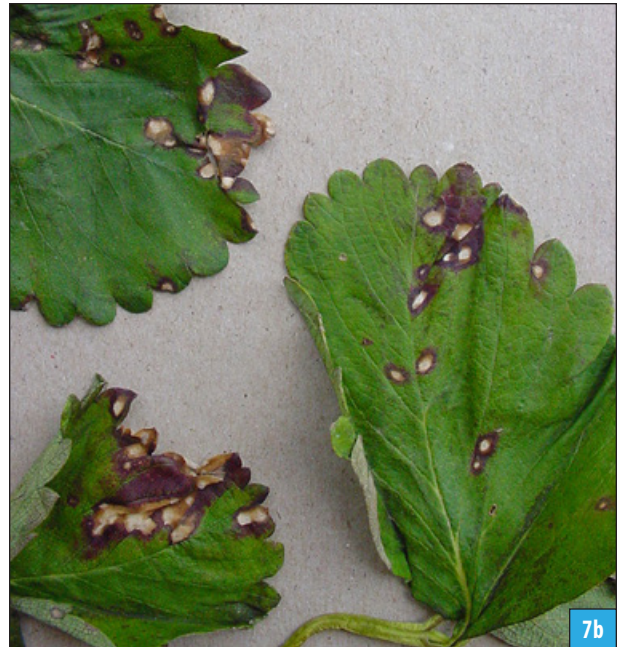
7. Leaf spot (*Mycosphaerella fragariae*), also known as common leaf spot, is the most prevalent strawberry leaf disease. Initially, spots are purple and remain about ¼ inch in diameter. Eventually, spot centers turn white or gray with a red or purple border. Black fungal fruiting

bodies are visible in light-colored spot centers. Lesions also may develop on petioles and stems. The fungus spreads via splashing rain and is worse during wet years. The pathogen overwinters on leaf debris and infected plants.

Management—Use good sanitation practices; remove infected leaves and leaf debris. Mulch to prevent splash. Increase air circulation to encourage leaf drying. Consider resistant cultivars. Use fungicides if disease becomes severe.



Phomopsis leaf blight (a and b).



Strawberry leaf spot (a and b).

8. Leaf scorch (*Diplocarpon earliana*) is a fungal disease with early symptoms that resemble common leaf spot (see No. 7), but centers do not turn tan/white. Instead, spots develop black centers with dark spore masses. As spots enlarge, they become irregular or blotchy; leaf tissue turns brown and dries up; leaf margins often curl

upward. Petioles, stems, and flower parts can also become infected. Diseased plants are predisposed to other stress factors. The fungus overwinters in plants and debris; it may also be introduced through tips and plugs. Disease becomes progressively worse in multi-year plantings, but is often a minor problem in single-year systems.

Management—Begin with clean plant material. Use proper sanitation; remove infected leaves and debris. Increase air circulation to encourage leaf drying. Consider resistant cultivars. Use fungicides if disease becomes severe.



Strawberry leaf scorch in planting (a) and close-up (b).



9. Leather rot (*Phytophthora cactorum*) is caused by a fungus-like water mold. Infected fruit undergo subtle color changes and may appear healthy, but bad flavor and smell easily distinguish diseased fruit. Infected fruit turn brown and become rough and more leathery as disease progresses. Eventually fruit develop into hard, dry mummies. Crowns also may become infected. The pathogen overwinters in mummified fruit or may be introduced on diseased plant material. The soilborne pathogen spreads via soil movement (tools, cultivation, shoes) and runoff water.

Management—Maintain good drainage; divert runoff. Begin with clean plant material. Use proper sanitation; remove infected fruit; avoid soil movement. Mulch to lift fruit from the soil. Use fungicides to suppress disease and reduce spread.



10. Phomopsis fruit rot (*Phomopsis obscurans*) is caused by the same fungus that causes leaf blight (see No. 8). It can affect ripening or ripe fruit. Disease begins as light pink spots and later develops dark centers with black fungal fruiting structures. Pathogen overwinters on old foliage and fallen fruit. Infection may also be introduced on infected plugs or tips.

Management—Use proper sanitation; remove diseased fruit. Mulch to keep fruit clean and dry. Increase air circulation to encourage drying of tissue. Use fungicides to prevent spread from leaf symptoms.



Leather rot (a, b, and c).



Phomopsis fruit rot.

11. Phytophthora crown and root rot (*Phytophthora* spp.) is caused by a soilborne, fungus-like water mold. Initially, young leaves wilt; however, disease development is usually rapid, and entire plants collapse within a few days. If individual crowns become infected, only one portion of the plant may die. When diseased plants are pulled, they often break at the soil surface as a result of rotted crowns. Pathogen buildup can occur in poorly drained sites and during wet seasons. Crowns rot and become brown from the upper portion and then spread downward. Roots become affected later in the disease progression. *Phytophthora* overwinters in plant debris and can persist in soils for many years. Pathogen can build up in poorly drained sites and during wet seasons. Survival structures can develop if infected plants remain in fields.

Management—Provide good internal drainage; manage water runoff. Use proper sanitation; remove infected plants as soon as symptoms develop. Rotate with non-host crops; rotate away from strawberry and solanaceous crops (up to 6 years). Begin with clean plant material. Use fungicides to suppress disease and reduce spread; fungicides do not cure disease.



Phytophthora crown and root rot.

12. Powdery mildew (*Sphaerotheca macularis*) primarily affects leaves; however, petioles, flowers, and fruit may also become affected. White, powdery fungal growth develops on lower leaf surfaces and succulent tissues. Leaf edges roll up as disease becomes more severe. Powdery mil-

dew is more severe in high tunnel plantings than in fields.

Management—Consider resistant cultivars. Increase air circulation by spacing and thinning. Use fungicides if disease becomes severe.



Powdery mildew causing leaf roll (a) and fungal growth on leaf surface (b).

13. Red stele (*Phytophthora fragariae*) is caused by a soilborne, fungus-like water mold. Disease is more severe during wet weather or cool spring seasons. During early stages of root rot, plants may wilt during the heat of the day and then recover at night. As disease progresses, plants become stunted, lose vigor, and shed many older, weaker leaves. Lack of water uptake causes plant collapse and, if left untreated, plant death. Root rot develops from root tips and progresses toward lateral roots and crown. Roots cut lengthwise expose a red-colored stele. Severely rotted root cortex results in sloughing off with stele remaining intact. The pathogen usually enters fields through infected plugs and tips, and can be spread through soil (tools, cultivation, shoes) and runoff water. This water mold can survive in soil for 15 to 20 years.

Management—Provide good internal drainage; manage water runoff. Use proper sanitation; remove infected plants as soon as symptoms develop. Begin with clean plant material. Rotate with non-host crops. Use fungicides to suppress disease and reduce spread; fungicides do not cure disease

14. Viruses are not prevalent in Kentucky strawberry fields. While more than 30 viruses are reported to affect strawberries, only two



Red stele root damage (a) and reddened stele within infected root (b).

have been confirmed as of this publication. Virus symptoms can include chlorosis, leaf distortion, marginal leaf scorch, and red or orange coloration. Some viruses can cause stunting and decline, as well as yield loss. Viruses may

be transmitted through vectors such as aphids, nematodes, thrips, and leafhoppers. **Management**—Begin with clean plant material. Use proper sanitation; destroy infected plants. Manage insect vectors.



Planting infected with strawberry mosaic virus and strawberry mild yellow edge virus (a) and strawberry mottle virus (b).

Insects and Other Arthropod Pests



Pale meadow spittlebug nymphs and spittle produced (a) and adult (b).

Insect Pests

15. Meadow spittlebug (*Philaenus spumarius*) is a nuisance pest, particularly for u-pick growers. Nymph colonies develop in spring and create masses of white, frothy spittle on plant stems. One generation is produced per year with nymphs active during the spring. Although uncommon, heavy populations can stunt plants and reduce berry size.

Management—Manage weeds around plantings. Apply an insecticide if more than one colony is present per square foot (u-pick) or five to six colonies per square foot (other plantings).

16. Root weevil (Family Curculionidae) grubs are legless and feed on young roots and crowns,

creating tunneling damage to underground plant parts. Damaged plants are stunted; leaves darken and become closely bunched. Injured plants may be weakened and may die. Damage is often restricted to circular areas in fields. Adult beetles have small, dark snouts and rows of pits along their backs. Slight variations in size and color occur depending upon root weevil species. Although adults eat notches in leaves, foliar damage is not economically important.

Management—Plow old beds as soon as possible to reduce habitat and prevent spread to new beds. Scout for leaf notching as an indication of adult emergence. Apply recommended post-harvest foliar insecticide sprays at bed renovation to control adults prior to egg laying.



Planting damaged by root weevils (a); plant with root weevil leaf feeding (b); and adult root weevil (c).

17. Sap beetles (Family Nitidulidae) are small, brown, oval beetles approximately $\frac{1}{8}$ inch long. They are attracted to fermenting plant juice smells in association with ripe, damaged, or cracked fruit. Damage may appear as small holes where berries contact the ground. Beetles often escape as fruit is being picked; beetles may not be obvious. Problems often occur after a rainy period when there may be a buildup of overripe fruit.

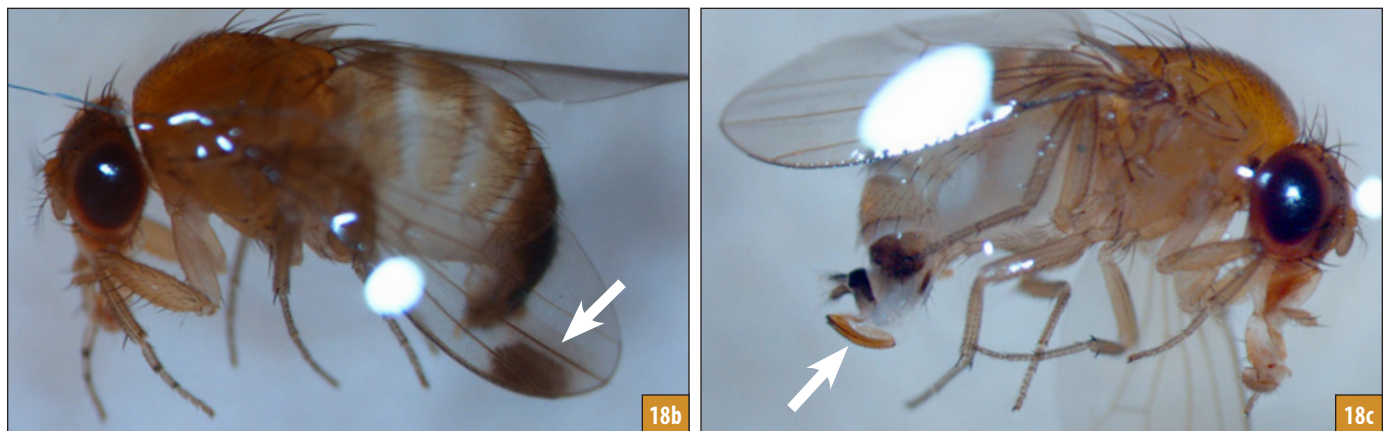
Management—Follow sanitation practices; harvest all ripe fruit and remove damaged, diseased, and overripe fruits in a timely manner. Insecticide sprays can be used during harvest, if necessary.



Sap beetle damage to strawberry (a) and adult sap beetle (b).

18. Spotted wing drosophila (*Drosophila suzukii*) is a serious invasive pest of soft-skinned fruits. Berries can become infested by legless, white, $\frac{1}{8}$ -inch long larvae. Adult bodies are $\frac{1}{10}$ inch long and amber with red eyes and clear wings. Adult males have a single dark spot near the tip of each wing and two small but distinct dark bands on each front leg. Spots on the wings may not be apparent on newly emerged males. The female has a distinct serrated ovipositor which is used to insert tiny white eggs with two filamentous breathing tubes into the fruit. The female also has unbroken banding of the abdomen.

Management—Sanitation is important to remove infested fruit; collect overripe, damaged, or rotting fruit in clear bags, and leave bags in the sun. Refrigerate berries immediately after harvest. In small plantings, use fine screening to completely seal off plants. Trap for adults as soon as fruit start to form. If adults are caught in traps, begin insecticide sprays and reapply every 5 to 7 days.



Spotted wing drosophila larvae in a blueberry (a); adult male with dark spot on each wing (b); and adult female with distinct ovipositor (c).



Adult tarnished plant bug (a) and catfaced berries caused by plant bugs (b).

19. Tarnished plant bug (*Lygus lineolaris*) is a sap-feeding insect that can cause considerable damage by puncturing young fruits before berries expand. Damaged areas do not develop with the rest of the berry, resulting in misshapen “catfaced” fruit. Most damage takes place just after petal fall. Adult tarnished plant bugs have greenish-brown bodies marked with yellowish and black dashes and a small yellow-tipped triangle behind their head. Nymphs are smaller than adults, slender, and pale green with immature wings called wing buds.

Management—Minimize habitats; manage weeds and eliminate leaf litter around plantings. Tap fruit clusters over a white bowl to identify nymphs; apply insecticides if more than one nymph per fruit cluster is identified.

Other Arthropod Pests

20. Slugs (Class Gastropoda) range in color from yellow to black and may be ¼ to 1 inch or longer. They feed by rasping ragged holes in berries. Tell-tale slimy trails are left on fruit surfaces, making slug damage easy to verify. Slugs require a damp, moist environment to survive, so most injury occurs during rainy spring months.

Management—Remove excess mulch or litter on soil surfaces, manage weeds, and plant at lower crop densities to reduce conditions favoring slugs. Various slug traps (stale beer trap) may be effective for small plantings, but they are not practical for larger plantings. Slug and snail toxicant baits can be used for a higher level of control.



Adult slug with eggs (a); slug damage (b); slug in berry (c).

21. Two-spotted spider mite (*Tetranychus urticae*) occurs on many cultivated and weedy plants. These mites can overwinter on undersides of leaves close to the ground. Mites feed by piercing tissue with their mouthparts and extracting cell contents. Damaged leaves take on a stippled or bronzed appearance. When populations are high, visible webbing may be present on leaf undersides and between leaflets and stems. Mite feeding reduces plant vigor and yield; stunting and/or death may follow.

Management—Minimize mite habitats; manage weeds around plantings. Scout weekly; apply a foliar miticide targeting the underside of the leaves when needed.



Two-spotted spider mite adult female with eggs (a); plant stunting (b); close-up of damage (c); leaf stippling and bronzing (d); and webbing (e).



Weeds



Barnyardgrass growth habit (a) and inflorescence (b).

Grasses and Other Narrow-leaf Weeds

22. Barnyardgrass (*Echinochloa crus-galli*) is a clump-forming summer annual commonly found on fertile, damp soil. Leaves are 1 to 2 inches wide and 4 to 8 inches long. A distinct vein in the center of leaf blades is characteristic. Plants tend to be shallow-rooted, but roots can

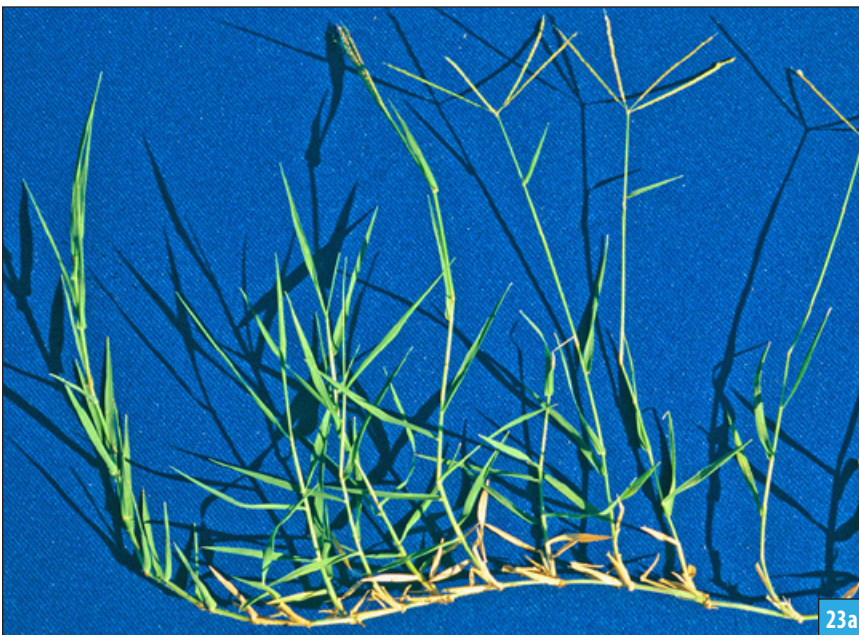
develop at the nodes when they contact the soil. Plants are very frost susceptible.

Management—Cultivate beds when plants are young. Apply a grass-specific post-emergent herbicide (graminicide).

23. Bermudagrass (*Cynodon dactylon*) is a drought tolerant, warm-season, perennial grass that actively spreads vegetatively by both rhizomes and stolons. It also has the ability to

spread by seed. Spikelets on seed heads (typically 3 to 6) are similar to crabgrass and are present from mid-summer through autumn. While extremely vigorous, bermudagrass is favored by warm weather, so it does not become a problem until later in the season.

Management—Avoid cultivation, which spreads rhizomes and stolons. Chemical control is recommended and must be repeated as plants readily regrow from rhizomes and stolons.



Bermudagrass underground stolon (a) and stems and foliage (b).



Goosegrass

24. Goosegrass (*Eleusine indica*) is a summer annual that grows in a flat rosette; centers appear white. Plants, which have fibrous root systems, are typically found in dry, compacted soils. Plants are frost sensitive. Seed will not germinate until soil temperatures are over 65° F. **Management**—Cultivate when plants are young. Apply a grass-specific post-emergent herbicide (graminicide).

25. Johnsongrass (*Sorghum halepense*) is an aggressive perennial common in agronomic fields, along roadways and waterways, and in low lying areas prone to flooding. Mature leaf blades are 5 to 20 inches long with an obvious white rib down the middle. Plants reproduce by seed and

perennial rhizomes, making control difficult. Rhizomes are stout compared to other grasses.

Management—Apply pre-emergent herbicides to help prevent seedling establishment. Post-emergent herbicides selective for grasses can be applied when plants are seedlings, but these are less effective once rhizomes have formed. Avoid cultivation, which spreads plants.

26. Quackgrass (*Agropyron repens*) is a perennial grass that spreads by seeds and rhizomes. Seed heads are 2- to 7-inch long spikes. Leaves are 4 to 8 inches long and about 3/4 inch wide. Narrow projections (auricles) from leaf blades encircle stems. Quackgrass tolerates mowing and usually remains green even when dormant.



Johnsongrass foliage and stems (a) and growth habit (b).



Management—Avoid cultivation, which spreads rhizomes. Chemical control is difficult because rhizome buds may remain dormant so they are unaffected by systemic herbicides. Repeat applications are often necessary.

27. Yellow nutsedge (*Cyperus esculentus*) is a perennial sedge often mistaken for a grass. Leaves arise from a central triangular stem to form a clump that grows 1 to 3 feet high. Yellow-green leaves are up to ½ inch wide, smooth, and shiny on upper surfaces. It can reproduce from seed; however underground tubers forming at the end of each rootlet are the primary means for reproduction.

Management—Tubers can be spread by cultivation; work infested areas of fields last to avoid spread. Grass-specific herbicides are ineffective due to this plant's different physiology. Apply non-selective contact herbicides to suppress nutsedge. Rotate with tall, thick-canopied plants for suppression. A few pre-emergent herbicides are effective.



Quackgrass growth habit (a) and close-up of auricle (b).



Yellow nutsedge in bloom (a); tubers (b); and stem cross section (notice the triangular shape) (c).



Canada thistle (a and b).

Broadleaf Weeds

28. Canada thistle (*Cirsium arvense*) is a difficult to manage perennial that spreads by seeds and rhizomes. Leaves are deeply lobed with spines; leaf margins and bases surround stems making stems look spiny as well. Flower heads are usually purple to pink. Root systems may extend more than 10 feet deep.

Management—Avoid cultivation and spread. Cut or mow plants to help reduce root reserves and starve plants. Apply spot applications of herbicides when shoots are at least 10 inches tall and before flowers open when plants are most susceptible to herbicides.

29. Common blue violet (*Viola sororia*) is a short perennial weed (less than 6 inches tall) with heart-shaped leaves on long stems growing from a crown. Plants, which grow in clumps, are spread by seed and short, thick rhizomes. While common in moist areas, plants also tolerate dry sites once established.

Management—Managing with herbicides is difficult. Cultivation spreads rhizomes. In small plantings, dig up individual clumps. Crop rotation is effective if rotational crop has more herbicide options.



Common blue violet in bloom (a) and underground rhizome (b).

30. Common chickweed (*Stellaria media*) is a winter annual that germinates in autumn and produces small, white flowers in spring. Leaves are small ($\frac{1}{4}$ to $\frac{1}{2}$ inch long), pointed at tips, and arranged opposite along stems. Plants are easily separated from their shallow fibrous root systems. Other closely related chickweeds (*Cerastium* spp.) may occasionally be found in plantings.

Management—Apply a pre-emergent herbicide in autumn. Hand weed in spring when stems are fragile. Avoid cultivation after seed set to prevent spread.

31. Dandelion (*Taraxacum officinale*) is a common yellow-flowered perennial weed that grows as a rosette from a deep taproot. Oval leaves have wavy margins.

Management—Cultivate or dig individual plants; however, new shoots can grow from dormant buds on root pieces remaining in the ground. Apply herbicides as spot applications.

32. Hemp dogbane (*Apocynum cannabinum*) is a perennial weed spread by seed and rhizome. It can be confused with milkweed because stems exude milky sap when broken. Small leaves (2 to 5 inches long and 1 to 2 inches wide) are thick



Chickweed in bloom

and have white veins on their upper surfaces. Leaves are paired on opposite sides of stems, and they may be attached directly to stems or have short petioles.

Management—Cut repeatedly and/or cultivate at renovation.



Dandelion in bloom



Hemp dogbane



33a



33b

Horsenettle in bloom (a) and foliage (b).

33. Horsenettle (*Solanum carolinense*) is a coarse perennial weed spread by seeds and rhizomes. Stems and leaves have scattered ¼- to ½-inch spines. White and yellow flowers produce green berries that turn yellow as they ripen.

Management—Cut repeatedly and spot-treat with a systemic herbicide. Do not allow plants to go to seed; a single plant can produce up to 5,000 seeds.

34. Lambsquarters (*Chenopodium album*) is a rapidly growing summer annual that can reach 6 feet in height. Erect stems branch freely and are often reddish or striped with pink, purple, or yellow. It is adaptable to most environmental conditions.

Management—Mulch and apply pre-emergent herbicides to prevent seed germination. Till and apply post-emergent herbicides to destroy plants.

35. Maretail/horseweed (*Conyza canadensis*) is a biennial weed that can reach heights of 3 to 6 feet. Seeds germinate throughout spring and early summer; plants mature and set seed the same year. Late-season plants overwinter in the rosette stage. One plant may release 200,000 seeds that disperse easily by wind.

Management—Cultivate at renovation. Apply pre-emergent herbicides to prevent seed germi-



34a



34b

Lambsquarter growth habit (a) and close-up of foliage (b).



Marestalk growth habit (a, b) and flowers (c).

nation. Burn-down herbicides during seedling or rosette stages destroy young plants. Glyphosate-resistant marestalk is becoming more common.

36. Palmer amaranth (*Amaranthus palmeri*) is an extremely competitive invasive annual weed that is highly adaptive. One plant can produce up to 500,000 seeds that may remain viable in soils for 5 years. Under ideal conditions, amaranth can set seed as early as 4 weeks after germination. Petioles on older leaves are as long as or longer than leaf blades; this differentiates it

from other amaranth species. Some plants have distinct patterns on leaves.

Management—Cultivate when plants are small. Apply a combination of pre- and post-emergent herbicides. Use contact herbicides before plants reach 4 inches in height.

37. Pigweeds (*Amaranthus* spp.) are native annual plants that are associated with disturbed sites. Leaves are simple and oval- to lance-shaped with an alternate leaf arrangement. Pigweeds germinate readily from late spring

through early autumn, produce numerous seeds, and grow quickly. Seeds of weedy species are small and black. Plants have a primary taproot.

Management—Cultivate when weeds are less than 4 inches tall; cultivation is not effective with larger plants. Apply pre-emergent herbicides and spot spray with post-emergent herbicides; however, some pigweed populations have herbicide resistance. Herbicide-resistant populations should be confirmed by a county Extension agent or the Weed Science Society of America.



Palmer amaranth (a and b)



Pigweed



Common ragweed



Red deadnettle lacking the typical reddish color.

38. Ragweed (*Ambrosia artemisiifolia*) is a broadleaved, branched annual with compound leaves (divided into leaflets on a single leaf). Leaves are arranged alternately in plant tops, but lower leaves have an opposite arrangement. This weed typically will not germinate after renovation as soil temperatures tend to be too high during July and August

Management—Early control is important. Cultivate early in the season and at renovation. Apply pre-emergent herbicides.

39. Red dead nettle or purple deadnettle (*Lamium purpureum*) and **henbit** (*Lamium amplexicaule*) are members of the mint family. They are winter annuals that produce flowers in early spring. Plants have square stems and shallow roots. Upper leaves of *L. purpureum* are often reddish in color.

Management—A limited number of pre-emergent herbicides are effective.

40. Violet (*Viola arvensis*) is a winter annual that germinates in late summer to early autumn. Other common names include: field violet, wild pansy, field pansy, hearts-ease, and European field-pansy. Leaves are arranged alternately on stems. Flowers range in color from light yellow to yellow with purple petals.

Management—A limited number of pre-emergent herbicides are effective. Apply a labeled pre-emergence herbicide in August.



40a



40b

Violet growth habit (a) and flower (b).

Wildlife

41. Birds of various species can cause issues with strawberries, and almost all occur after fruit begins to appear. Blackbirds, robins, and other bird species cause injury when they peck into fruit. Bird droppings can also be a nuisance.

Management—Employ multiple methods of bird management right before or after fruit is present. Fake snakes, hawks, or owl decoys placed around plants may help over short periods of time, but for longer effectiveness, place netting over plants.

42. Vole, mice, and other small mammals can cause damage either by tunneling into beds or by feeding on plants, and occasional-

ly fruit. Vole damage is common during winter and severely injures plants and reduces yields in plasticulture production systems. These small mammals can also damage irrigation lines and make holes in plastic mulch. Other small mammals, such as raccoons, rabbits, and squirrels, can also damage plants or consume fruit; however, they may be more of an issue for backyard gardeners than for commercial growers.

Management—Keep areas around beds, buildings, ditch banks, and nearby fields mowed closely to limit suitable habitat. If pests are already present, use snap traps baited with peanut butter or plunger style mole traps over active tunnels; trapping is difficult to do on large fields.



Bird damage to berry



Vole tunnels (a, b), vole injury to plants (c), and small mammal damage to fruit (d).



43. White-tailed deer can consume or crush plants and may also damage any plastic mulch covering beds. Deer damage is easily identified by tracks on the ground or through the plastic. Deer feeding appears as rough cuts on plant tissue.

Management—Install fencing for the most effective means of limiting deer damage. Fencing should be either 8 feet high or electric. If severe problems persist, contact a local Kentucky Department of Fish and Wildlife Resources private lands biologist to obtain nuisance permits.



Deer damage to plastic mulch (a) and plants (b).

Abiotic Disorders



Freeze injury prior to bloom (flower with the darkened dead area, a); freeze injury (b) (bottom) compared to uninjured flower (top); frost damage to fruit (c, d).

44. Frost injury results when cold temperatures damage flower pistils and/or kill ovaries. Injury may occur anytime during blossom development. Spring frosts often cause entire flowers or fruit to abort. Developing fruit occasionally survive and may become disfigured; these symptoms are easily confused with poor pollination
Management—Monitor air temperatures at crop level in spring. Protect plants from frost with floating row covers or use overhead sprinkling beginning at 34°F; turn off sprinklers once ice has mostly melted. Straw can be raked up over matted row strawberries.

45. Herbicide injury to fruit occurs when chemicals drift or are applied at the wrong time of year. Growth regulator herbicides, such as 2,4-D, may result in fruit malformation, especially when applied in late spring or fall.



2,4-D injury to fruit due to a late spring application.



Severe iron deficiency in planting (a) and close-up of foliar symptoms (b).

Management—Apply herbicides according to the label (early in spring or immediately after the last harvest). Avoid spray drift by applying products only on calm days and using shielded sprayers.

46. Iron deficiency occurs when soil pH is too high, generally above 7.4. Initially it is characterized by yellowing of the youngest leaves; leaf veins remain green. Symptoms progress to older leaves. Iron is not mobile within plants, so it is not moved into the newest leaves from the older leaves. Symptoms may be evident only in certain areas within the same field.

Management—Select planting sites with soil pH of 6.5 or below. Adjust high pH by incorporating sulfur into soil at least 6 months prior to planting. A tissue analysis can detect deficiency in its early stages. Apply iron chelate to foliage or soil to allow plants to take up iron at a high soil pH. Iron chelate applied close to harvest may not be effective.

47. Nitrogen deficiency is characterized by the development of smaller than normal, yellowish-green leaves that become increasingly yellow. Older leaves turn reddish in color.



Nitrogen-deficient (right) versus healthy (left) plants.

Management—Apply nitrogen to soil at planting; do not over-fertilize. *Plasticulture:* Begin fertigation when blooms appear (approximately April 1). Submit foliar analysis samples between March 15 and April 15. *Matted row:* If

leaves show deficiency symptoms, make a light nitrogen application in August. Apply nitrogen at renovation. Submit foliar analysis samples between July 15 and August 15.

48. Poor pollination results in the development of small misshapen fruit. Low fruit set, small berry size, misshapen fruit, and low yields result from poor pollination. A high level of pollination is achieved through a combination of self-, wind, and insect pollination.

Management—Remove row covers during warm days while plants are in bloom to provide access by bees. Avoid insecticide applications during bloom. If insecticides are necessary, spray in the evening after bees return to hives. One hive of bees will sufficiently pollinate one acre of strawberries.



Misshappen fruit as a result of a lack of achene (seed) development when pollination did not occur (a and b). Note fruit expansion around achenes that were pollinated (a).

49. Sunburn occurs on fruit that initially develop under cloudy or rainy conditions and are exposed to sudden direct sun and heat. Symptoms occur on portions of fruit exposed to the sun.

Management—Maintain a good plant canopy over fruit by promoting plant vigor and by using

good cultural practices. Irrigate when soil is dry to reduce fruit stress.



Sunburned fruit.

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