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MICHIGAN STATE UNIVERSITY | Extension

A Pocket Guide to IPM Scouting in Highbush Blueberries

Produced by Michigan State University Extension

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Blueberry Scouting Guide Index

Diseases

Diseases (continued)

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Mummy berry

Monilinia vaccinii-corymbosi (fungus)

Mummy berry is an important disease of blueberries throughout the United States and Canada.

Left to right: early, intermediate and late shoot strike symptoms.

Symptoms. The first symptom of shoot infection (shoot strike) is browning along the major leaf veins. Leaves wilt quickly,bending to resemble a shepherd's crook. A light gray powdery layer of spores develops at the leaf base. Flower strikes occur less frequently.

Peter Oudemans, Rutgers Univ.

Flower strike with gray spores on pedicel.

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Mummy berry – *continued*

Infected green berries appear healthy but when cut open reveals white fungal growth in the locules. When berries start to ripen, infected berries appear pinkish tan and slightly ridged. They feel rubbery and contain a gray to black fungal mass inside. Infected berries eventually become faded, shrivel up, and fall to the ground. After the fruit skin has weathered off, the berries look like tiny black pumpkins.

Disease cycle. The fungus overwinters in the mummified fruit on the ground. In early spring, trumpet-shaped apothecia (3 to 10 mm in diameter) produced on the mummies eject windborne ascospores that infect young shoots and flower clusters. The optimum temperature for formation of apothecia and

Mummy berry – *continued*

infection is 50 to 57ºF (10 to 14ºC). At least 12 hours of wetness is required for infection. Frost injury may increase susceptibility of blueberry shoots to infection. Conidia are produced on blighted shoots and flower clusters and are carried to flowers mainly by insects (flies and bees). The fungus then colonizes the ovary of the developing fruit through the stigma and style.

Management. Remove and destroy mummies; cover mummies with soil or mulch – at least 2 inches (5 cm) thick; avoid wet sites or improve drainage; remove escaped or wild blueberries from vicinity; plant resistant cultivars; limit overhead irrigation until petal fall; apply effective fungicides from green tip until petal fall.

Mummified berries with immature (left) and mature apothecia in early spring.

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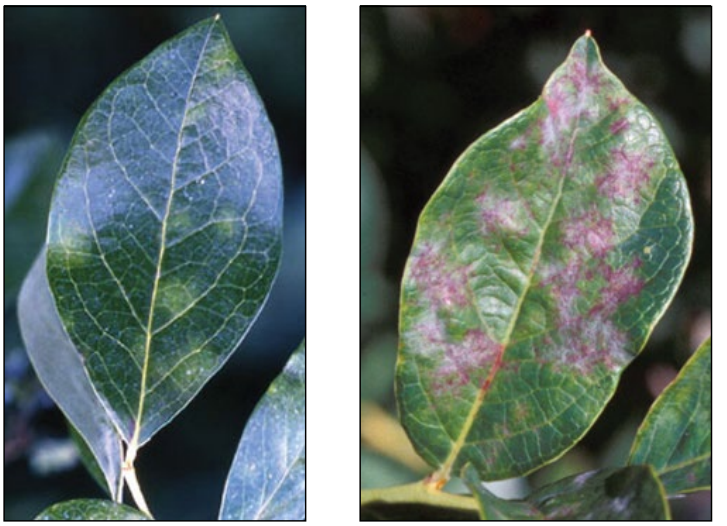
Powdery mildew

Erysiphe vaccinii (fungus)

Powdery mildew can be found in most blueberry plantings, but damage tends to be slight.



Early and late symptoms of powdery mildew on upper leaf surfaces.

Symptoms. Symptoms on blueberry leaves usually do not develop until midsummer. The leaves show light green, yellow or reddish areas and puckering. Water-soaked spotting is visible on leaf undersides. White, powdery growth may develop on the upper leaf surfaces. In severe cases, plants may defoliate.

Disease cycle. At the end of summer, yellow to black fruiting bodies (chasmothecia) form on infected leaves. Airborne spores released by chasmothecia in the spring infect young leaves. The mycelium is superficial and penetrates only the epidermis.

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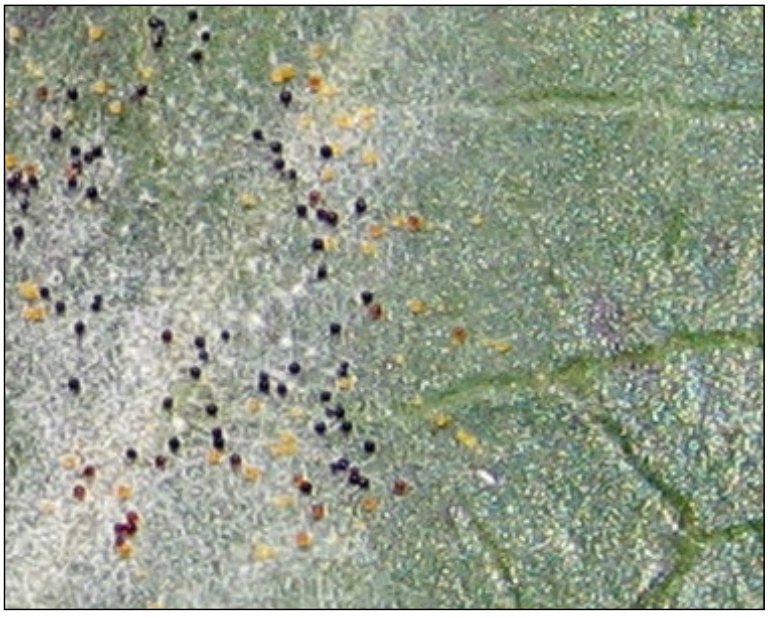
Powdery mildew – *continued*

Water-soaked, radiating spots on underside of leaf.

Secondary spores (conidia) form on the leaves and disperse by wind throughout the summer. Moderate temperatures and high relative humidity promote disease development.

Management. Plant resistant cultivars; reduce humidity in the planting. Fungicides are not recommended unless the disease is severe.



Yellow to black specks on leaves are chasmothecia (overwintering structures). In the spring, chasmothecia release ascospores that cause primary infections.

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Leaf spot diseases

Septoria albopunctata, Gloeosporium minus, Gloeocercospora inconspicua (fungus)

Leaf spot diseases are widespread in blueberries but tend to be more prevalent in the southern United States.

Septoria leaf spot.

Symptoms. Septoria and Gloeocercospora spot are characterized by small to medium brown leaf spots with purplish margins; Gloeosporium causes larger reddish brown, irregular lesions on leaves.

Both *Septoria* and *Gloeosporium* also cause lesions on succulent green stems. Severe leaf spotting can result in premature defoliation of bushes.

Gloeocercospora leaf spot.

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Leaf spot diseases – *continued*

Disease cycle. Leaf spot infections occur on immature leaves; symptoms may take a month or more to become visible. Most leaf spots begin to appear in mid- to late season and are favored by wet weather. The causal fungi all produce rain-splash-dispersed spores and overwinter in infected tissues.

Management. Plant resistant cultivars; limit overhead irrigation; reduce humidity in the canopy; apply effective fungicides before the onset of symptoms.

Septoria stem lesions.

Gloeosporium leaf spot.

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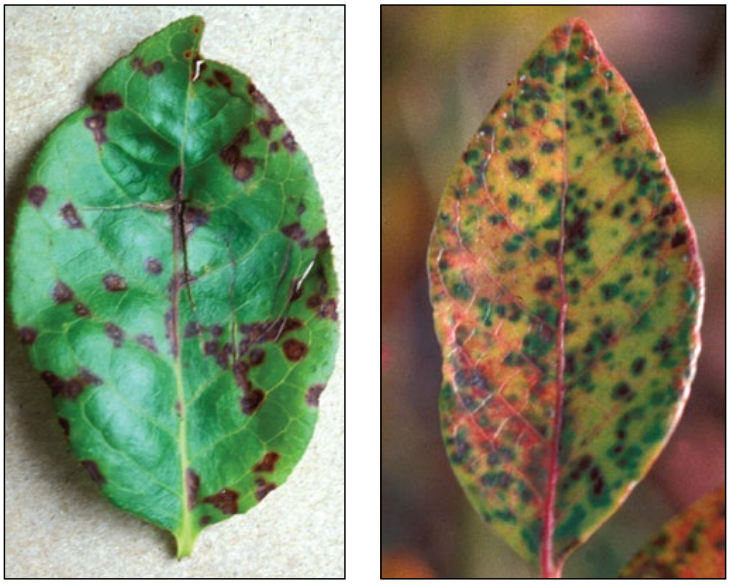
Leaf rust

Thekopsora minima (fungus - eastern US)
Pucciniastrum vaccinii (fungus - western US)

Leaf rust epidemics occur sporadically in the eastern United States. The disease is rare elsewhere.



Early (left) and late (right) symptoms.

Symptoms. Yellow spots appear on leaves by mid-season and soon turn brown. Disease symptoms may increase rapidly. Affected leaves turn yellow and drop prematurely. On the lower leaf surface, yellow to orange spore pustules (uredia) surrounded by dark rings occur. The disease generally has little impact on yield but may cause premature defoliation.

Disease cycle. The alternate host of the rust fungus is hemlock (*Tsuga* spp.), so rust is more

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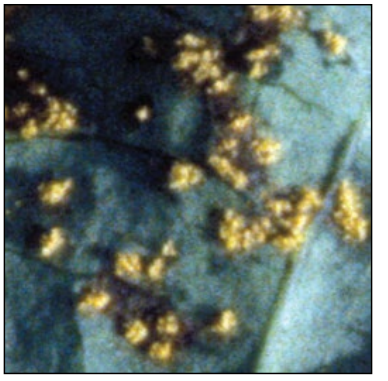
Leaf rust -- *continued*

severe in the vicinity of hemlock trees. The fungus requires both hosts to complete its life cycle in cold climates.

Airborne spores produced on hemlock needles infect blueberry leaves in early summer. Yellow spores then develop in uredia on blueberry leaves and spread the disease among blueberries. The fungus overwinters in infected leaves and reinfects hemlock needles in early spring. In the southeastern United States where hemlocks are not present, the fungus overwinters in uredia on evergreen blueberry leaves.

Management. Remove hemlock trees within a third of a mile (0.5 km); avoid susceptible cultivars; start with rust-free plants; limit overhead irrigation; apply effective fungicides.

Rust pustules (uredia) on underside of leaf.



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Red leaf

Exobasidium vaccinii (fungus)

This disease occurs on lowbush and occasionally on highbush blueberry.

Symptoms. In midsummer, portions of terminal leaves turn red and start to pucker. Affected areas are thickened with a white to cream-colored layer of fungal spores underneath. The affected areas eventually turn black and dry up.

Disease cycle. Bushes are systemically infected and do not recover. Leaves on new growth from previously infected stems usually develop red leaf symptoms. Windborne spores are produced on

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Red leaf – *continued*

leaf lesions in spring and summer and infect healthy leaves. The disease is favored by cool, moist conditions and excessive nitrogen use.

Management. Remove and burn infected bushes; use fungicides to protect healthy plants only if disease incidence is high.

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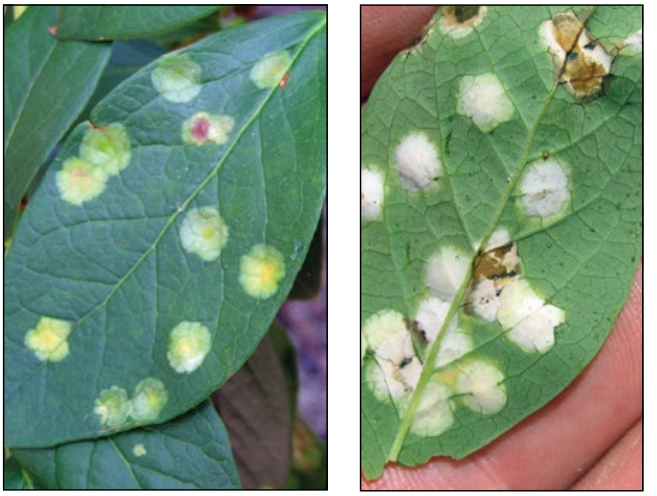
Exobasidium fruit and leaf spot

Exobasidium vaccinii (fungus)

This disease occurs sporadically in North Carolina, Mississippi, and Canada.



Light green spots on upper leaf surface (left) and white spore masses underneath (right).

Symptoms. Small green spots on leaves and fruit appear shortly after bloom and are most severe in the bush interior. Near harvest, a dense white layer of spores develops on the undersides of leaf spots. Spots on fruit fail to ripen, remaining light green and firm.

Disease cycle. Infection occurs in spring; spots do not appear on later flushes of growth. Infection does not appear to be systemic.

Management. Removing bushes is not recommended. Improve air movement; fungicides may have some activity.

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Phyllosticta leaf spot, fruit rot, and berry speckle

Phyllosticta vaccinii, P. elongata (fungus)

This relatively rare disease occurs in the eastern United States.

Fla. Dpt. Ag. Con. Srv., Bugwood.org

Symptoms. Leaf spots are brown and circular with darker margins. Fruit lesions are circular, brown to gray, hard, and slightly depressed. Pycnidia may be visible as small, black pimples in leaf as well as fruit lesions. A hard, dry rot appears on green as well as ripe fruit. Symptomless fruit may become speckled and rot in storage.

Disease cycle. The two fungal species involved in this disease also attack cranberries. Both produce rain-splash dispersed conidia. Not much is known about the life history of these fungi.

Management. Avoid susceptible cultivars; limit overhead irrigation; apply effective fungicides.

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Botrytis blight and fruit rot

Botrytis cinerea (fungus)

Botrytis blight and fruit rot is a minor disease in most years but sometimes causes serious damage. Economic losses are mostly due to blossom blight and fruit rot.

Symptoms. On leaves, brown, irregular lesions develop that sometimes distort leaves. Blighted blossoms turn brown and soon become covered with abundant gray mold. Infected twigs are first brown to black and later become tan to gray. Developing berries can also become infected, but fruit rot usually does not develop until after harvest. Infected berries become covered with a fluffy gray mold.

Leaf lesion (left) and twig blight (right) caused by Botrytis.

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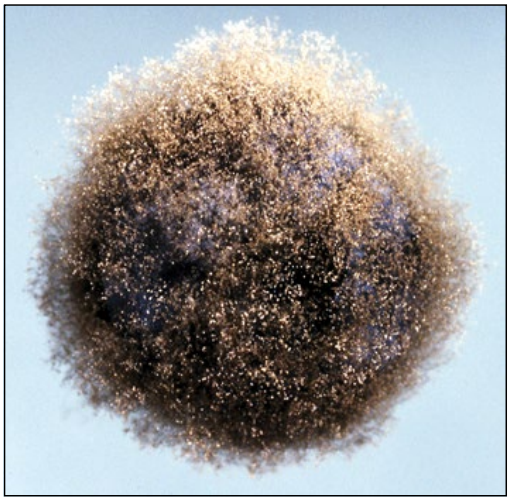
Botrytis blight and fruit rot – *continued*

Disease cycle. The fungus overwinters as mycelium or hard black mycelial masses (sclerotia) on infected plant material. In spring, numerous airborne spores develop on plant debris and sclerotia. The fungus infects tender green twigs, blossoms, leaves, and fruit. Older plant parts are rarely attacked. Moderate temperatures (59-68ºF or 15-20ºC) and frequent rains favor disease development.

Management. Remove infected plant material; reduce humidity in the canopy; apply effective fungicides during bloom and fruit ripening; avoid excessive use of nitrogen fertilizer in the spring; cool berries rapidly after harvest.

Flower blight (left) and postharvest rot (below) caused by Botrytis.



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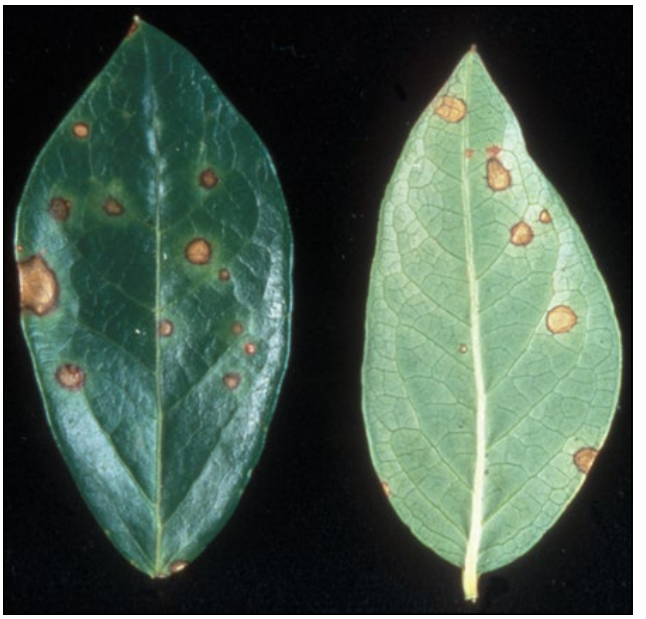
Alternaria leaf spot and fruit rot

Alternaria tenuissima (fungus)



Alternaria leaf spot occurs primarily in North Carolina, but Alternaria fruit rot occurs in most blueberry-growing regions.

Symptoms. Leaf lesions are circular to irregularly shaped, tan to gray, 1 to 5 mm in diameter, and surrounded by a reddish brown border. In most cases only lower leaves are infected, but a severe infection can defoliate the plant. On ripe fruit, sunken areas near the calyx are covered by a dark green, velvety growth. On stored fruit, a grayish-green mold may appear on the stem scar or calyx end and spread over the entire berry. Infected fruit becomes soft and shrivelled.

Disease cycle. The fungus overwinters in old twigs and in plant debris on the ground.

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Alternaria leaf spot and fruit rot – *continued*

Leaf infections occur in the spring during periods of cool, wet weather. Fruit infections occur as berries start to ripen. Disease development is optimal at 68ºF (20ºC).

Management. Plant resistant cultivars; reduce humidity in the planting; apply fungicides from bloom until harvest; harvest in a timely manner; handle berries dry; cool fruit after harvest.

Dark green to black spores on an infected berry in the field.

Fuzzy grayish green mold on stored berry.

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Anthracnose (ripe rot)

Colletotrichum acutatum (fungus)

Anthracnose is a serious pre- and post-harvest fruit rot in most blueberry-growing regions. Cane, twig, and leaf lesions are more sporadic.

Symptoms. The fruit rot manifests itself as sunken areas on ripe fruit with gelatinous, orange spore masses. On young canes, lesions are dark brown with fruiting bodies in concentric circles. On twigs, dark brown lesions may originate from infected buds and kill part of the twig. On the leaves, lesions look reddish brown with distinct borders. Salmon-pink spore masses may appear on infected tissues under humid conditions.

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Anthracnose – *continued*

Disease cycle.

Cane lesions (left) with fruiting bodies in concentric circles. Orange spore masses (right) on a dead twig and bud in spring.

The fungus overwinters in infected twigs, old fruiting spurs and live buds. In spring and summer, spores produced on infected tissues are dispersed by rain and cause new infections. In Michigan, most spores tend to be released between bloom and early fruit development. Prolonged wetness (12 hours or more) and temperatures of 68-77ºF (20-25ºC) promote disease development. Fruit infections remain latent until the fruit starts to ripen or until after harvest.

Management. Prune out old or infected wood; create an open canopy to reduce humidity and increase spray penetration; plant resistant cultivars; limit overhead irrigation; harvest in a timely manner; cool fruit rapidly after harvest; apply effective fungicides from pink bud to harvest.

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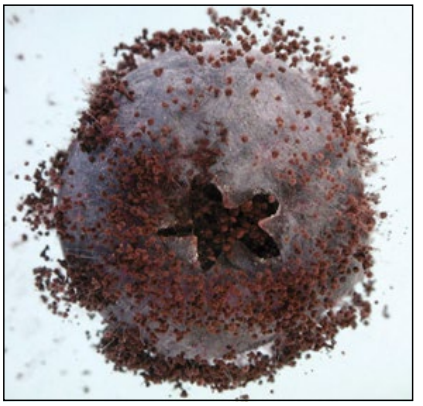
Postharvest rots

Various fungi

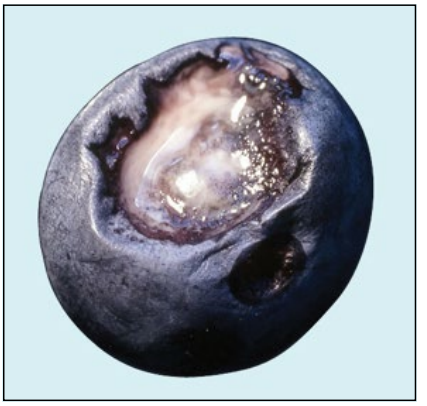
Post-harvest rots caused by various fungi can result in serious losses in stored blueberries.

Symptoms. Berries become covered with fungal growth and/or spores, and may become soft or leaky.

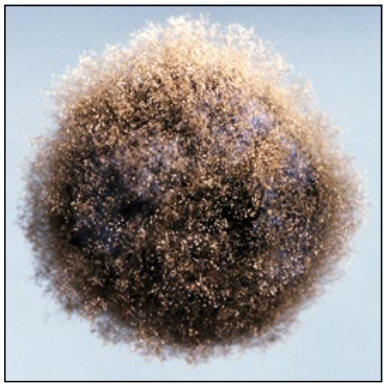
Alternaria



Aspergillus



Aureobasidium



Botrytis

Colletotrichum

Epicoccum

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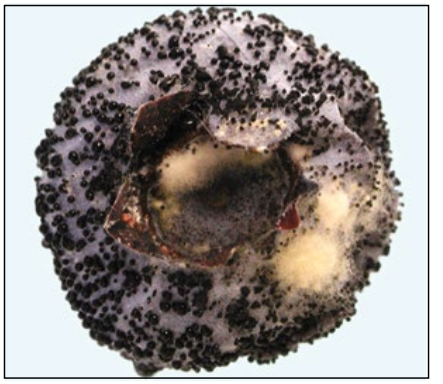
Postharvest rots – *continued*

Disease cycle. Most of these fungi attack only ripe or overripe fruit and are rarely seen in the field. They can spread from infected to healthy berries upon contact.

Management. Harvest in a timely manner; handle berries dry; rapidly cool fruit after harvest; apply fungicides before harvest.

Hainesia

Penicillium



Pestalotia

Phomopsis

Rhizopus

Sphaeropsis

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Phomopsis canker and twig blight

Phomopsis vaccinii (fungus)

Phomopsis canker and twig blight occurs in most blueberry-growing regions.

Symptoms. A typical symptom is sudden wilting and death (flagging) of canes during the growing season. A sunken or flattened area (canker) is often present at the base of the cane.

Brown, spreading lesions develop on green stems and twigs, which are eventually killed. Twig lesions may originate from infected buds. Leaf spots are rare.

Flagging of canes (left); canker (right).

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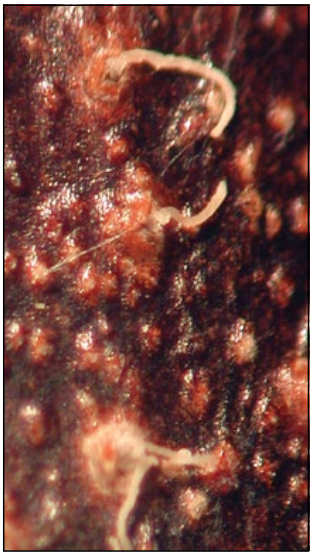
Phomopsis canker and twig blight – *continued*

Disease cycle. The fungus overwinters in infected canes and twigs. In the spring, spores are dispersed from fruiting bodies (pycnidia) by rain. The fungus is active from bud swell until after harvest. Wounding (e.g., by harvesting equipment) and freeze injury may predispose plants to infection.

Young lesions (left) are brown and become bleached (middle) as they age. Fruiting bodies (right) develop in the bleached areas.



Above, spores ooze out of fruiting bodies.

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Phomopsis canker and twig blight – *continued*

Management. Prune out infected canes; avoid wounding the canes; plant resistant cultivars; limit overhead irrigation; apply effective fungicides.

Leaf spots caused by Phomopsis vaccinii.

Fruit cluster collapsing due to twig blight.

Fruit infection leads to white mold growth and soft fruit which split when squeezed.

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Gibbera twig blight

Gibbera vacciniicola (fungus)

Cheryl Smith, Univ. of NH

This disease appears to be limited to the northeastern United States and eastern Canada.

Symptoms. The most characteristic symptom is black, raised, cushion-shaped fruiting bodies (stromata) on twigs and canes. Stromata can occur singly or in clusters and are usually bordered by a distinct red margin. Fruit yield may be reduced, and infected twigs appear to be predisposed to winter injury. Heavily infected twigs are often killed when fruiting bodies form girdling cankers (photo below).

Cheryl Smith, Univ. of NH

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Gibbera twig blight – *continued*

Disease incidence can be as high as 40 percent of the twigs infected. Cultivars Berkeley and Herbert are susceptible and Northland is highly susceptible.

Disease cycle. The fungus overwinters in stromata on infected twigs and canes. Ascospores are released during rainy periods from mid-April to late June, with peak release occurring in May, and infect young twigs and canes. The appearance of tiny, black fruiting bodies on one-year old twigs in early fall is the first evidence of infection.

Management. Remove and destroy infected twigs and canes; avoid susceptible cultivars; apply fungicides starting just prior to bloom.

Fusicoccum canker

Godronia cassandrae (fungus)

Fusicoccum canker occurs in the northern United States and southern Canada.

Symptoms. Small, water-soaked lesions develop on green stems in the fall and expand into sharply delineated, reddish brown cankers during the following spring and summer. The cankers usually center on a leaf scar, are 1 to 10 cm in length, and have a bull's-eye pattern. Most cankers are near ground level, but some occur as high as 3 feet (1 m) above the ground.

Cankers enlarge each year until they girdle and kill the stem. Wilted leaves remain attached. Small, black fruiting bodies of the fungus may be found in cankers.

Dying canes.

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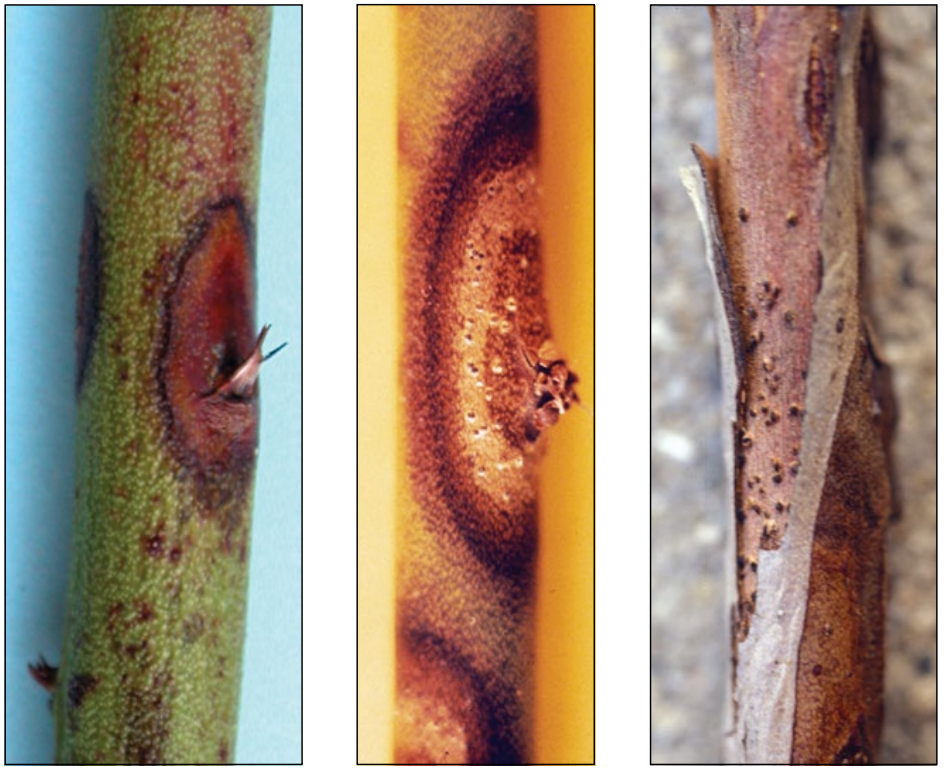
Fusicoccum canker – *continued*

Disease cycle. The fungus overwinters in cankers and produces fruiting bodies (pycnidia) from which spores are released during rain events from bud swell until early leaf drop in the fall. Wounding is not required for infection. On wet canes, infection occurs within 48 hours at 50 to 71ºF (10 to 22ºC). Ascospores are relatively unimportant in the disease cycle.

Management. Remove and destroy stems with cankers; avoid susceptible cultivars; limit overhead irrigation; apply effective fungicides.



Young (left), mid-stage (middle), and old (right) cankers. Pimples (fruiting bodies of the fungus) appear in older cankers.

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Botryosphaeria stem canker

Botryosphaeria corticis (fungus)

Botryosphaeria stem canker is a serious disease of blueberries in the southeastern United States.

Early (left) and late (right) symptoms on blueberry stems. Note swelling and cracking on old stem.

Symptoms. Early symptoms are small red lesions on succulent stems. The lesions become swollen and broadly conical in about 6 months. On susceptible cultivars, large, swollen cankers develop, with deep cracks and numerous fruiting bodies, after 2 to 3 years. Stems may be girdled and killed.

Disease cycle. The fungus overwinters in infected canes. Current-season stems are infected by ascospores or conidia in late spring.

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Botryosphaeria stem canker – *continued*

The optimum temperature for growth and sporulation of the fungus is 77 to 82ºF (25 to 28ºC). Eight races of the fungus are known.

Management. Plant resistant cultivars; use disease-free planting material; remove and destroy infected canes. In general, fungicides are ineffective.

Mature bush with several canes killed by stem canker.

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Botryosphaeria stem blight

Botryosphaeria dothidea and other spp. (fungus)

Botryosphaeria stem blight, commonly referred to as dieback, is a prevalent and destructive disease of blueberries in the southeastern United States.

Symptoms. Early symptoms are yellowing, reddening or drying of leaves on one or more branches. The internal wood of infected stems is discolored brown or tan, frequently on only one side of the stem. The necrotic area may extend just a few centimeters or the entire length of the stem. Twig infections may be confused with winter injury or other twig diseases. Younger plants die rapidly within 1 to 2 years of planting. The mortality rate is highest when infection develops at or near the crown.

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Botryosphaeria stem blight – *continued*

Disease cycle. The stem blight fungus overwinters in infected stems. Most infections occur during the early part of the growing season – May or June; however inoculum is present almost year-round in the southern states. Wounds caused by pruning, mechanical injury, or other stem diseases are the primary sites of infection. Disease development decreases as wounds heal with time.

Management. Plant resistant cultivars; use disease-free planting material; cut off infected canes 15 to 20 cm below any sign of diseased wood and destroy. In general, fungicides are ineffective.

Bark removed to expose brown discoloration in left fork of infected cane.

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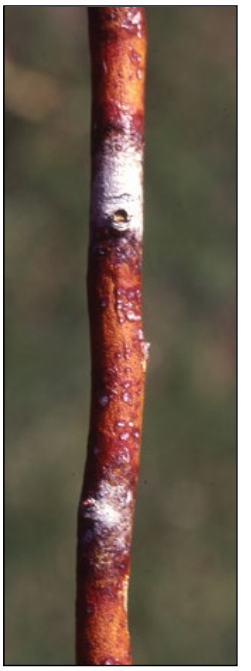
Algal stem blotch

Cephaleuros virescens (plant-parasitic alga)

This disease is known to occur in Florida.

Young, red lesions on canes.



Older lesions with gray centers.

Symptoms. Initial symptoms on green stems are small reddish blotches that expand and may eventually girdle canes. Under humid conditions, the lesions support green to orange tufts or mats of algal growth.

Other symptoms are stunted canes with pale yellow leaves. Cane death may also occur, but it is unclear whether this is a direct symptom or caused by secondary invaders such as *Botryosphaeria* spp. The cultivar Misty is particularly susceptible.

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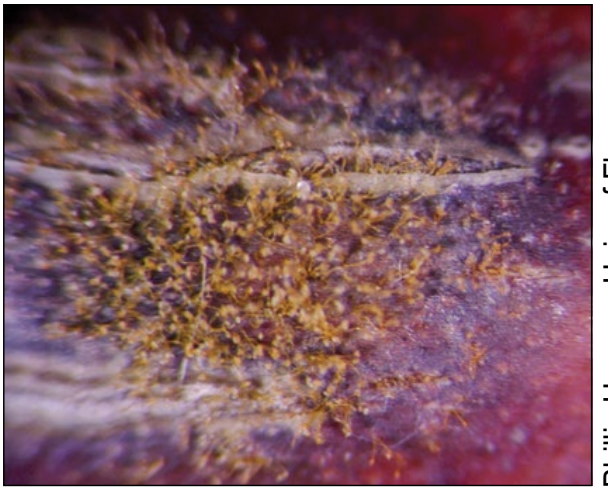
Algal stem blotch – *continued*

Disease cycle. The pathogen has a wide host range and is prevalent in very hot, humid environments. While little is known about this pathogen on blueberries, based on reports on other hosts, it mainly colonizes the cane epidermis. In early to mid-summer, hair-like stalks (sporangiophores) form that produce multiple sporangia, which in turn release zoospores (swimming spores) under wet conditions. Zoospores are spread by rain splash and cause new infections. Due to prolific spore production, the disease can be very aggressive.

Management. Remove and destroy infected canes; create open canopy to improve drying; apply copper fungicides.

Orange fuzz on stem lesions is indicative of sporulation. Magnified view at right.



Phillip Harmon, Univ. of Fla.

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Silver leaf

Chondrostereum purpureum

Silver leaf mainly occurs on blueberries in Chile, but has been sighted in North Carolina.

Andres France, INIA, Chile

Silvery appearance of leaves.

Andres France, INIA, Chile

Brown discolored heartwood.

Symptoms. The first symptoms are leaf surfaces appearing silver-colored in summer. Small pieces of leaf epidermis flake off and underlying areas may later turn dark-red or brown due to sunburn. Symptoms start on one or two branches, which decline and finally die. New branches continue to develop symptoms until the whole plant is affected. Infected plants may die after two or three seasons.

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Silver leaf – *continued*

Andres France, INIA, Chile

Another distinctive symptom is browning of the heartwood. Basidiocarps on dead wood are small (1-25 mm in diameter), purple to pink with a hairy surface and upturned edges. Brigitta, Bluecrop, and Duke are susceptible.

Disease cycle. Basidiospores are released from basidiocarps during rains in fall and winter. Spores can be dispersed several kilometers by wind. The fungus only colonizes fresh wounds. Spores germinate under moist conditions, invade the xylem, and grow into the wood towards the plant crown. The disease may also spread via cuttings from diseased plants.

Management. Use disease-free planting material; prune out and destroy diseased canes as soon as possible; disinfest pruning shears; apply fungicides or *Trichoderma*-based biocontrol agents to pruning wounds.

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Bacterial canker and twig blight

Pseudomonas syringae (bacterium)

Bacterial canker and twig blight is a minor stem disease that occurs mainly in western North America.

Cankers on blueberry stems.

Symptoms. Symptoms first appear in January or early February as water-soaking on 1-year-old stems. The lesions rapidly develop into reddish brown to black, irregularly shaped cankers with definite margins. Cankers can extend the entire length of the stem or girdle stems. Buds in or above the canker area are killed. Shoot tip dieback is the most common symptom on young plants in nurseries or cuttings in propagation beds.

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Bacterial canker, twig blight – *continued*

Disease cycle. The bacteria survive on the buds and bark and enter the plant through wounds caused by frost or pruning. Only 1-year-old stems are attacked. The bacteria can be spread by wind, rain, insects, propagation wood, and pruning tools. Cold weather and moisture favor the disease.

Stems killed by bacterial canker in a young blueberry field.

Bacterial canker, twig blight – *continued*

Management. Prune out diseased stems before the onset of fall rains; avoid late-summer nitrogen applications; apply copper in fall and spring; avoid wounding; protect from freeze injury; sterilize pruning tools.

Bacterial leaf scorch

Xylella fastidiosa (bacterium)

This recently identified disease has the potential to cause major damage to highbush blueberries in the southeastern United States.

Phillip Brannen, Univ. of GA

Symptoms. The initial symptom is marginal leaf scorch (burn), resembling drought symp-toms or fertilizer salt burn. A dark band may be visible between healthy and scorched tissue. Scorching at first is limited to individual stems, but later affects the entire plant. After leaf drop, yellowed stems and twigs are very visible on the skeleton-like bush. Canes and roots appear healthy. Plant death can be relatively rapid, usually in the second season after symptoms appear. Neighboring plants may show symptoms. Plant stress may play a role in disease development.

Bacterial leaf scorch – *continued*

Cultivar FL86-19 has proven to be the most susceptible, although cv. Star is also susceptible.

Phillip Brannen, Univ. of GA

Disease cycle. *Xylella fastidiosa* infects numerous plant species and appears restricted to warm regions. Grasses and herbaceous weeds likely form a reservoir for infection. The bacteria can only survive in plant xylem or insect vectors. In spring to early summer, sharpshooters and spittle bugs transmit bacteria to healthy plants after feeding on infected tissues. Bacteria multiply in and plug up xylem vessels, preventing water and nutrient flow. Bacteria probably also spread through cuttings.

Management. Remove and destroy infected plants; do not take cuttings from infected plants; avoid susceptible cultivars; monitor and manage vectors with foliar or soil-applied insecticides.

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Witches' broom

Pucciniastrum goeppertianum (fungus)

Witches' broom is a relatively highbush blueberries, but it can be severe near balsam fir trees (*Abies*), the alternate host for the rust fungus.

Swollen shoot of witches' broom.

Symptoms. Diseased plants have broom-like masses of swollen, spongy shoots with short inter-nodes and small leaves. Young stems on the brooms are initially yellow or reddish, but later become brown and shiny, and, eventually, dry and cracked.

Heavily infected plants produce no fruit. The brooms can persist for many years, producing infected new growth every year.

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Witches' broom – *continued*

Disease cycle. Airborne spores produced on fir needles infect blueberry leaves and stems in the summer. The fungus becomes locally systemic and perennial in blueberries. Overwintering spores develop in the swollen stems and, in the spring, produce spores that reinfect fir needles.

Management. Because the pathogen is systemic in the blueberry crown, pruning will not eliminate the disease. Remove fir trees within 500 yards (460 m) of planting; eradicate infected plants with a herbicide; 'Rancocas' is a resistant cultivar.

Infected (left) and healthy (right) blueberry stems.

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Cylindrocladium rot

Calonectria ilicicola, C. colhounii (fungus)

This fungal disease of cuttings in propagation beds occurs mostly in the southeastern United States. It is also common in ornamental plant nurseries.

Symptoms. Circular patches of dead cuttings appear in propagation beds as the disease rapidly spreads from an initial infected cutting.

Disease cycle. Infections are thought to originate from nearby infected trees (oak, sweet gum, tulip poplar).

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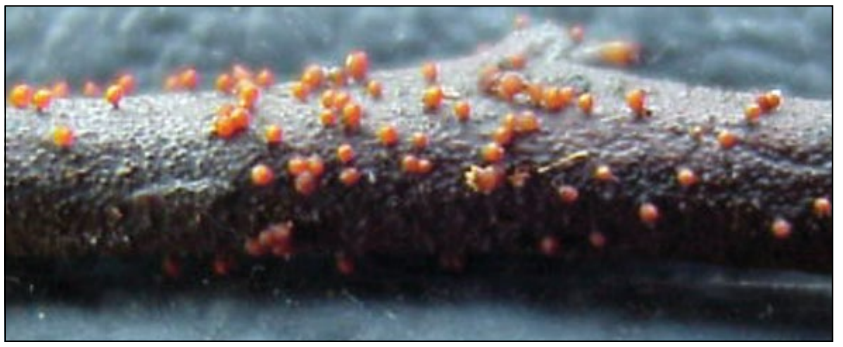
Cylindrocladium rot – *continued*

Initial infection of young shoots may occur in the field or after cuttings are stuck. Spores are splash-dispersed to infect surrounding cuttings. The fungus overwinters in infested rooting media.



Orange fungal fruiting bodies (perithecia) on the surface of a dead stem.

Management. Start with clean rooting media and do not reuse old media; avoid placing propagation beds under trees that may be a source of disease; remove diseased cuttings and treat with fungicides.

Crown gall

Agrobacterium tumefaciens (bacterium)

Crown gall is an occasional problem in propagation beds and new plantings, but is seldom seen in mature plantings.

Crown gall – *continued*

Symptoms. Galls are most common at the bases of canes or on major roots, but they occasionally form on branches higher in the bush. Young galls are cream-colored to light brown; they turn dark brown to black, rough, and hard with age. Infected plants are stunted and weak.

Disease cycle. The soil-borne bacteria enter natural or mechanical wounds on stems and roots and induce gall formation. The disease is less of a problem in acid soils.

Management. Plant disease-free nursery stock in non-infested soils; grow grasses or vegetables in infested fields for at least 2 to 3 years; remove and burn infected plants; minimize wounding; sterilize pruners; dip plants in a suspension of *A. radiobacter* strain K84 before planting.

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Sooty blotch

Various yeast-like fungi

Sooty blotch is not a disease but is common on blueberry stems.

Sooty blotches on stems.

Symptoms. Superficial gray to black blotches form on green stems and twigs, giving them a sooty appearance.

Disease cycle. The causal organism is common in the environment and grows below the cuticle on plant surfaces. It does not appear to harm the plant.

Management. No control measures are necessary.

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Blueberry shoestring

Blueberry shoestring virus (BSSV)

Blueberry shoestring is a widespread disease.

Symptoms. Symptoms appear about 4 years after infection. Elongated reddish streaks (3 to 20 mm long) appear on green stems, especially on the side exposed to the sun. Infected leaves are red or purplish, elongated and straplike. Leaves may become cupped if one side of the leaf fails to develop. Flowers may be reddish and fruit may be reddish purple instead of blue at ripening. Bushes slowly decline.

Oak leaf pattern (left). Streaks on stems (right).

Disease cycle. Blueberry shoestring virus is vectored by the blueberry aphid (*Illinoia pepperi*). Transmission begins when aphids emerge

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Shoestring – *continued*

in the spring and ends just before leaf drop in the fall. Aphids move from infected bushes to neighboring healthy ones as they feed. Aphids carrying the virus may also be transported down the row by mechanical harvesters.

Management. Remove infected bushes; use virus-tested planting stock; apply insecticides when aphids first appear; wash harvester to remove aphids before entering another field; Plant resistant or tolerant varieties.

Straplike leaves on an infected plant.

Pink-tinged blossoms appear on infected plants.

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Blueberry leaf mottle

Blueberry leaf mottle virus (BLMV)

Leaf mottle occurs only in Michigan and can be severe.

Pale, puckered terminal leaves.

Symptoms. Leaves show a mottling pattern and may be malformed or straplike. Severely infected Rubel bushes have dead stems, a small amount of regrowth near the crown area, and little to no crop. Jersey or Blueray plants may be stunted and have small, pale, rosetted terminal leaves.

Disease cycle. The virus spreads via infected pollen carried by honeybees from diseased to healthy bushes up to 1 mile. Symptoms do not become apparent until 3 to 4 years after infection.

Management. Plant virus-tested clean planting stock; test plants showing symptoms; remove and destroy infected plants; use herbicides to prevent regrowth from crown; place beehives as far as possible from infected areas; do not move hives from infected to healthy fields.

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Blueberry mosaic

Blueberry mosaic associated virus (BlMaV)

Mosaic has been observed in the eastern and western growing regions of the United States and Canada.

Symptoms. Leaves on one or more branches show mild to brilliant mottle or mosaic patterns of yellow, pink, or yellow-green. Symptoms are not produced every year and presumably depend on sunlight intensity. Fruit on diseased bushes ripens late and is of poor quality.

Disease cycle. The disease spreads slowly from bush to bush. Diseased planting stocks are responsible for introducing mosaic into commercial plantings. In some cases, mosaic symptoms may be genetic.

Management. Use virus-tested, clean planting stock; remove infected plants from field.

Blueberry necrotic ringspot

Tobacco ringspot virus (TRSV)

Necrotic ringspot occurs sporadically in the northern United States and Canada.

Symptoms. Leaves are misshapen and crumpled with small necrotic spots (2 to 3 mm in diameter) that may cause small holes. Leaves may be dark green and have blunt or lobed tips. Some cultivars show rosetting of leaves or stem dieback. A slow, steady decline in growth and productivity occurs in all cultivars.

Necrotic ringspot – *continued*

Several declining bushes may occur in a row or in a roughly circular pattern in the field. Plants eventually die.

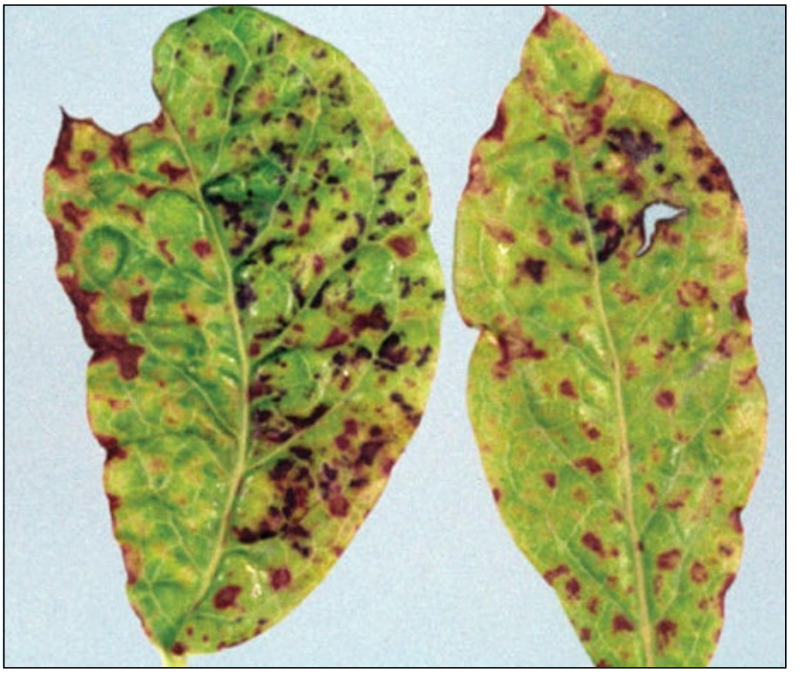
Disease cycle. The virus is vectored by the dagger nematode (*Xiphinema americanum*) and may be introduced by infected planting stock. The disease spreads about 1 m per year. Weeds (dandelion, narrow-leaved plantain, and common chickweed) may serve as a reservoir for the virus.

Management. Do not plant in virus-infested sites without soil fumigation or several years of crop rotation; plant virus-tested planting stock; remove infected plants including crown and major roots; apply nematicides.

Tomato ringspot

Tomato ringspot virus (ToRSV)

Tomato ringspot is a rare but serious disease of highbush blueberries in Oregon, Pennsylvania, and Washington.



Circular spots on infected leaves.

Symptoms. Infected leaves are cupped and malformed with circular spots 2 to 5 mm in diameter. Necrotic spots can also occur on canes. Young leaves may be straplike and mottled. Symptoms are variable within the same plant. Infected plants may be defoliated by mid-harvest and eventually die, often after a severe winter. The disease spreads slowly in the field. Roughly oval-shaped patches of weak or dying plants develop over several years.

Tomato ringspot – *continued*

Disease cycle. The virus is vectored by dagger nematodes (*Xiphinema* spp.) and has a wide host range, including chickweed, dandelion, narrow-leaved plantain, and fruit crops such as apple, grape, peach, and raspberry. It is seed-borne in many of its hosts. These plants can act as a reservoir of virus for nematodes feeding on their roots.

Infected, straplike, mottled leaves.

Management. Before planting, test soil for dagger nematodes and fumigate if nematodes are present; plant virus-tested, clean planting stock; practice good weed control; plant tolerant cultivars; remove and destroy infected plants, including adjacent non-symptomatic plants.

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Red ringspot

Blueberry red ringspot virus (BRRV)

Red ringspot primarily occurs in the eastern United States.

Symptoms. Red ringspots or blotches that are roughly circular and 4 to 6 mm in diameter appear on green stems. Red-to-purple, circular spots 3-5 mm in diameter appear on the upper surfaces of older leaves in mid- to late summer. Symptoms may resemble those of powdery mildew. Circular, light-colored blotches may develop on infected fruit.

Disease cycle. Mealybug is the likely vector of blueberry red ringspot virus. Infections become systemic and plants are infected for life.

Management. Plant virus-tested, clean stock; remove diseased plants from the field.

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Blueberry necrotic ring blotch

Blueberry necrotic ring blotch virus (BNRBV)

Bill Cline, NCSU

Blueberry necrotic ring blotch is a new virus disease of southern highbush blueberries in the southeastern United States. The disease has been confirmed in Florida, Georgia and North Carolina. Affected cultivars include Star, O'Neal and Rebel.

Symptoms. Affected bushes exhibit ring-shaped leaf spots with green centers. Rings are necrotic and visible from both sides of the leaf. In severe cases bushes defoliate prematurely resulting in diminished bud set and a reduced crop the following year.

Disease cycle. The virus appears to cause localized infections on leaves and likely does not persist in the host from year to year. Blueberry bud mites have been suggested as a possible

Necrotic ring blotch – *continued*

vector based on greenhouse observations of disease-spread associated with mite infestations.

Management. Control of vectors may reduce incidence and spread. Do not propagate from infected plants. Maintain bush vigor through good cultural practices to reduce defoliation from this disease.

Bill Cline, NCSU

Stunt

Blueberry stunt phytoplasma

Blueberry stunt is a virus-like disease mainly present in eastern North America.

Short bushy growth at base of infected bush.

Symptoms. Infected bushes are severely stunted and branches appear bushy because of shortened internodes. Leaves are cupped slightly downward and may also have chlorotic areas that turn red in fall.

Disease cycle. The stunt phytoplasma is a microorganism that inhabits the sapwood and is vectored by sharp-nosed leafhoppers (*Scaphytopius* spp.). Infections coincide with peaks in leafhopper activity and become systemic. Plants are infected for life.

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Stunt – *continued*

Leaves showing downward cupping and chlorotic edges are typical of blueberry stunt.

Management. Plant virus-tested, clean planting stock; remove and destroy infected plants; monitor leafhoppers and apply well-timed insecticides.

A stunted bush (left) next to a healthy bush.

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Scorch

Blueberry scorch virus (BIScV)

Scorch is a serious disease of blueberries on both coasts of North America, but it has not been found in the Midwest. In New Jersey, it is also known as Sheep Pen Hill disease, which is caused by a different strain of the same virus.

Blighted flowers are brown at first but later bleach to gray.

Symptoms. In some cultivars, a sudden and complete necrosis of flowers and leaves occurs, while others remain symptomless. Twigs may die back 4 to 10 cm. The scorched blossoms are often retained throughout the summer. Severe infections can kill the bush. Symptoms may be confused with spring frost injury or other blossom blights.

Scorch – *continued*

Disease cycle. The scorch virus is vectored by aphids and spreads quickly in the field in a radial pattern from a point source. Eventually all bushes in a field may become infected. The virus spreads readily to neighboring fields but usually not more than a half-mile. Mechanical harvesters may spread the aphids that carry the virus.

Leaf necrosis (above and below).

In Sheep Pen Hill disease, leaves often show a line pattern in the fall.

Scorch – *continued*

Management. Plant virus-tested, clean planting stock; test bushes showing symptoms to confirm the disease; remove and burn infected bushes; plant tolerant cultivars (these remain a source of infection, however); apply insecticides to control aphids; clean harvesting equipment.

Some cultivars also exhibit marginal leaf chlorosis.

Shock

Blueberry shock virus (BIShV)

Blueberry shock occurs only in western North America.

Symptoms. Symptoms are very similar to those of scorch – sudden, complete flower and leaf necrosis during bloom. However, unlike

Bush with necrotic leaves.

Shock – *continued*

scorch, a second flush of foliage occurs and the plants appear quite normal later in the season except for the lack of fruit. Infected bushes often exhibit symptoms for 1 to 4 years and then become symptomless. Eventually the bushes recover and a good crop is possible in well-managed fields.

Disease cycle. The virus is dispersed by infected pollen carried by bees. The disease spreads rapidly in a radial pattern from the infection focus. Infection occurs only during bloom. Symptomless infected plants remain a source of infection.

R. Michelutti

Sudden leaf necrosis.

Management. Plant virus-tested clean planting stock; do not establish new plantings adjacent to infected fields; do not use planting stock from a field that is in remission; remove and destroy infected bushes before bloom.

Blueberry bronze leaf curl

Cause unknown, a virus suspected

This disease has only been found in Michigan. While it first gained attention in 2010, growers reported seeing similar symptoms for years prior. It was initially thought to be herbicide injury.

Symptoms. Symptoms include bronzing and upward curling of leaves on one or more branches, sometimes accompanied by fine red spotting visible on both sides of the leaf. Leaves may be lobed or malformed. Young leaves show numerous dark brown spots and crinkling. Canes are weak with many skinny twigs. Older fields of Jersey, Bluecrop, Elliott, Rubel, Weymouth and Pemberton are most affected. Symptomatic bushes are scattered throughout the field.

Mark Longstroth, MSUE

Red spotting sometimes occurs.

Bronze leaf curl – *continued*

Yields are reduced and bushes decline and eventually die.

Disease cycle. Little is known about the causal agent or its biology. Mowing off all canes for renewal may result in worse symptoms in new growth, indicating the causal agent is systemic in the plant and survives in the crown or root system.

Management. At this time, the only management options are to remove affected bushes and replant with healthy plant material.

Declining bush.

Blueberry wavy line disease

Cause unknown, a virus suspected

Wavy line disease is more of a curiosity, having been seen only in a few locations in Michigan.

Back of leaf.

Symptoms. Wavy, contour-like lines are visible on both leaf surfaces. Infected bushes appear to show symptoms every year but are easily overlooked because they tend to be smaller than healthy bushes and bear little fruit.

Disease cycle. Nothing is known about the causal agent or its biology. It may be caused by a virus originating in wild plants.

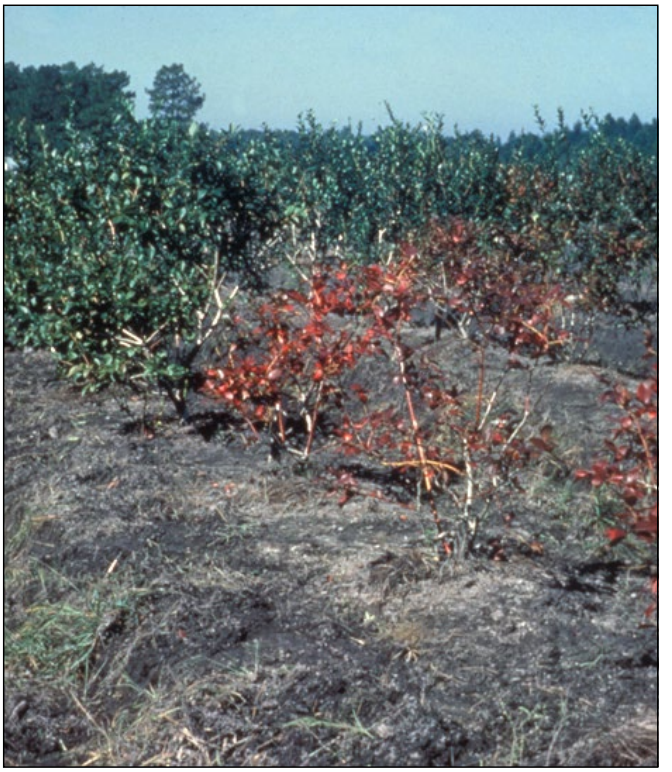
Management. No management is recommended. Remove affected bushes and replant with healthy planting material.

Phytophthora root rot

Phytophthora cinnamomi (oomycete)

Phytophthora root rot may occur at poorly drained sites or in low areas of fields.

Symptoms. Early symptoms are yellowing or reddening of leaves and lack of new growth, followed by leaf drop. Below-ground symptoms vary from slight necrosis of young rootlets to extensive necrosis that turns crowns and main roots reddish brown. Bushes may die eventually.



Bush dying because of root rot.

Disease cycle. The pathogen lives in the soil and produces swimming spores that infect the roots. Hardy chlamydospores (the primary over-wintering structures) are released into the soil as

Phytophthora root rot – *continued*

the affected roots break down. Abundant soil moisture and temperatures between 68 and 90ºF (20 to 32ºC) promote disease development.

Management. Either avoid planting in poorly drained sites or improve drainage; grow rooted cuttings or nursery plants on raised beds; avoid over irrigating when soil temperatures are high; use effective fungides (will not cure severely diseased plants).

Premature leaf coloring and defoliation caused by root rot.

A healthy plant (left) and a diseased plant (right) with a reduced root system.

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Armillaria root rot

Armillaria mellea, A. gallica (fungus)

Armillaria root rot is rare on blueberries in the United States, but can cause serious damage where it occurs.

Dull leaves. Below, mycelial fans are present below the soil line.

Symptoms. Infected plants are low in vigor and may appear to be suffering from a nutrient deficiency. Leaves are small and chlorotic, and branches wilt suddenly. Plants decline slowly over several years or die within a short time. White mycelial fans are present between the bark and the hardwood at or slightly below the soil line. Yellowish brown mushrooms (honey mushrooms) are sometimes produced in clumps at the base of the bush.

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Armillaria root rot – *continued*

Black shoestring-like strands (rhizomorphs) may be attached to the roots or trunk or growing freely in the soil.

Black, string-like rhizomorphs on blueberry crown.

Disease cycle. The fungus attacks more than 500 species of woody plants. The disease is most likely to occur on a sandy, well-drained site where an oak forest was cleared. *Armillaria* survives as mycelium and rhizomorphs on old roots and stumps. The fungus spreads between bushes by root-to-root contact and can also survive on wood chip mulches. Spores disseminated from the mushrooms probably are not important in spread.

Rotted wood in the crown.

Armillaria root rot – *continued*

Management. Disk soil thoroughly if forest (particularly oak) was present at the site and remove as many root fragments as possible; leave the area fallow for at least 3 years; fumigate soil before planting (however, fumigants do not penetrate deeper than 50 cm); remove and burn infected bushes; remove wood chip mulch.

Ganoderma crown rot

Ganoderma spp. (fungus)

Ganoderma is a genus of polypore fungus associated with wood decay on a wide range of host plants. Infection has been observed in North Carolina on the cultivar O'Neal, and may occur elsewhere, as this fungus is distributed worldwide.

Bill Cline, NCSU, all Ganoderma images

Symptoms. Affected bushes lose vigor and gradually die. In advanced stages, shelf-like fruiting bodies (conks) develop at the base of the bush. These conks are woody and persistent, with off-center, glossy, reddish-brown stalks and smooth white undersides.

Disease cycle. The fungus spreads via spores released from the conks or by root-to-root contact from infected plants to adjacent healthy bushes.

Ganoderma crown rot – *continued*

Management. Remove infected plants and root pieces, and monitor the planting for signs of the fungus indicating spread to nearby bushes. Infections have most often been observed on older bushes, and widespread infection may indicate a planting is aging out and due for renovation.

Nematodes – Stubby-root, root-lesion, sheath, root-knot, dagger, etc.

Nematodes are tiny roundworms that live in the soil. Most feed on bacteria and fungi and are essential for mineralizing nutrients that are taken up by plants. Plant-parasitic nematodes feed on plant roots, but are generally not a serious problem in blueberries. The types listed above may cause diseases of blueberries when present at high population densities. Nematodes have also been observed to cause stunting and poor rooting in hardwood propagation beds. In addition, dagger and stubby-root nematodes are vectors of certain plant viruses such as tobacco ringspot virus.

Nematode galls on roots.

Symptoms.

Heavily infected plants are stunted and slow-growing with reduced yields. Roots may show necrotic lesions, stunting, or galls.

Nematodes – *continued*

Disease cycle. Plant-parasitic nematodes reproduce by eggs and have four juvenile stages. Juveniles and adults feed on living plant roots. Most nematodes are migratory, but some become sedentary in roots.

Management. Avoid replanting into an infested field; have soil tested the year before planting so remedial action can be taken if nematodes that vector viruses are present; apply organic amendments such as mulch, compost, or manure; apply nematicides; fumigate soil before planting; avoid reuse or fumigate rooting media.

Dodder

Cuscuta spp. (flowering plant)

Dodder is a parasitic flowering plant that attacks many crops, including blueberry.

Symptoms. Blueberry bushes are covered with the yellow to orange vinelike

Dodder flowers curled around blueberry stem.

Dodder – *continued*

strands that are the leafless stems of the dodder plant. Heavily infected blueberry bushes are stunted with reddish leaves and reduced yields.

Disease cycle. Dodder reproduces by small, brown seeds that can remain viable in soil for 30 years. Upon germination early in the spring, the seedling coils itself around the host plant, penetrates the epidermis, and obtains nutrients via embedded haustoria (feeding structures). A single dodder plant can spread 4.5 to 7.5 meters per year.

Management. Physically remove and burn dodder before it sets seed; scout fields next to irrigation ponds for infestation (seeds can spread via irrigation water); practice good weed control to remove other hosts; use preemergence herbicides; wipe with glyphosate.

Blueberry Scouting Guide Index

Insect and mite pests

Insect and mite pests (continued)

Mite pests of buds

Blueberry bud mite

Blueberry bud mites are microscopic and white, living on the inner bud scales of blueberry from the fall to spring. Females lay clear, spherical eggs, and multiple generations occur each year. Mites can reproduce rapidly, and if populations build to high levels, feeding injury to buds may be seen in spring.

Blueberry bud mite on a blueberry scale.

To detect infestation, sample current-season growth after harvest and dissect floral buds nearest to shoot tips using a microscope to see the tiny mites.

Viewed under a microscope, white mites are visible against a red bud scale.

Blueberry bud mite – *continued*

Some varieties, particularly Rubel, are sensitive to the mite's feeding; others show few symptoms. Symptoms are seen in the spring as blistering on the outside of bud scales and poor flower set. In the summer, poor plant growth and fruit set, particularly in the tops of plants, may indicate bud mite infestation.

Low fruit set on infested cluster.

Infested plants (on left in the photo) have poor growth and low yields.

Insect pests of buds

Cutworms

Cutworms damage plants by feeding on young tissues. They spend the day time in leaf litter or in upper soil layers under bushes, and they tend to be more of a problem in weedy fields. Larvae are active at night and crawl up onto bushes after the first warm spring days. For this reason, inspect bushes for injured buds during delayed-dormant to budbreak. Buds may be partly or entirely consumed, and multiple buds may be damaged during one night of feeding. Cutworm larvae are typically 1 inch long (25 mm) and dark colored. When disturbed, they curl into a C-shape.

25 mm

Left, cutworm larva found under leaf litter. Right, cutworm damage.

Mississippi State Univ Archives

Insect pests of buds

Spanworms

Several species of spanworm (inchworm) larvae feed on blueberry, where they chew holes through the sides or tops of buds. These insects have thin bodies with large fleshy legs only at the front and rear ends of the body. Their coloration makes them well camouflaged in blueberry bushes. They loop as they walk and may remain completely still when disturbed, mimicking a branch to avoid predators. Detect spanworms by shaking branches over a beating tray. Inspect buds for feeding during bud swell.

Spanworms can look like twigs.

30 mm

Insect pests of flowers

Blueberry blossom weevil

2 mm

This is a dark reddish beetle 2 mm long with white flecks on the wing covers and a snout nose. It overwinters in wooded areas near fields and moves to blueberry bushes as early as bud swell. There is typically one generation per year in blueberry fields. This pest is most common in eastern North America.

Beetles drop to the ground when disturbed and move off plants if temperatures drop. Beetles can be scouted for on warm spring days using a white beating tray.

Feeding can occur as buds expand, but most injury occurs as flower buds open. The female

Blueberry blossom weevil – *continued*

drills a hole into the flower buds, lays an egg into each drilled flower, and may also clip the pedicel. A small, legless, yellow-white grub with a brown head develops and feeds inside the flower bud, preventing flowering. The injured buds drop to the ground, where the larvae grow and then pupate. Adults develop in late spring and may feed on foliage, leaving small puncture marks.

Back to insect/mite pests index

Insect pests of flowers

Flower thrips

Thrips can feed on flowers, leaves, and fruit. In blueberry, a few different species cause injury. These insects are active before, during, and after bloom. When they feed on flowers, the damage can cause reduced pollination and poor fruit set. Damaged leaves may become curled and red. Scout for thrips during bloom by tapping flowers onto a white sheet. Split flowers open to look for feeding damage.

Jerry A. Payne, USDA ARS

Thrips feeding damage affects pollination and yields.

Thrips are elongated with feathery wings. At left, damage to leaves. **2 mm**

Jack T. Reed, Mississippi State Univ.

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Insect pests of leaves and shoots

Aphids

Adult blueberry aphid.

Several species of aphids colonize blueberry bushes. The most damaging species transmit viruses that cause poor plant growth. Blueberry aphid (*Illinoia pepperi*) is the vector of blueberry shoestring virus and blueberry scorch, which is also transmitted by *Ericaphis* species aphids. (See the disease section for symptoms of these viral diseases.) Aphids overwinter as tiny eggs on blueberry bushes. In spring, young aphids hatch and colonize new leaf growth, living on the undersides of leaves. Populations grow during the summer and can cause sooty mold on fruit if populations are very high. Parasitic wasps and other natural enemies feed on aphids, suppressing their abundance. Scout for aphids on the undersides of leaves, focusing on young shoots at the bases of bushes.

Aphid colony on underside of leaf.

Jerry A. Payne, USDA ARS

Insect pests of leaves and shoots

Obliquebanded leafroller

Various species of leafroller can be found in blueberry. Obliquebanded leafroller is one of the most damaging leafroller pests of blueberry in eastern North America and can feed directly on fruit.

First-generation larvae are active before and during bloom. Focus scouting on flower buds and look for webbed flowers and leaves. The summer generation larvae are active during fruit ripening, feeding on fruit and foliage. Larvae are green with a dark head and about 25 mm long when fully grown. They feed on flower clusters, leaves, and green fruit. Larvae feed inside webbing used to pull together plant tissues into a protective shelter and may be hard to find.

25 mm

Obliquebanded leafroller larva on a leaf.

Obliquebanded leafroller – *continued*

Pheromone traps can be used to determine adult emergence. This information can be combined with growing degree days to predict egg hatch, larval development, and optimal timing for control. Timing of treatment may depend on the type of insecticide.

18 mm

Moth wings are banded with tan to brown scales. Moths are about 18 mm long.

Left, leaf feeding injury by oblique-banded leafroller. Right, a larva crawls up a leaf where tip injury is evident.

Obliquebanded leafroller growing degree day table

GDD° Base 42 (Postbiofix)	Event	Action
Early bloom	Majority of larvae have emerged from shelters	Examine fruit buds for larval activity
0 GDD° = biofix (~900 GDD° after Jan 1)	1st sustained moth captures	Set GDD° = 0
220-250 GDD°	Peak moth flight - overwintering generation	
400-450 GDD°	Start of egg hatch	Timing for treatment
1000 GDD°	End of egg hatch	
2300 GDD°	Peak moth flight - 2nd generation	
2750 GDD°	Start of 2nd generation egg hatch	Timing for treatment

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Insect pests of leaves and shoots

Other leafrollers

Blueberry is a host plant for other leafroller species, though their injury is typically minimal. Redbanded leafroller larvae may be present as soon as green foliage appears, and this first generation can injure leaves and young clusters. The later generation rarely causes injury. RBLR and other leafrollers are usually controlled by sprays for other pests or by natural enemies.

Redbanded leafroller larvae are green-yellow with a similar colored head capsule and grow to 16 mm long.

Redbanded leafroller moths have distinct red bands on the fore-wings in a V-shape when at rest. Wingspans range from 12 to 18 mm.

Insect pests of leaves and shoots

Sharpnosed leafhopper

This insect is a vector of blueberry stunt disease. Adults are small and brown, about 5 mm long, with a pointed head and cream-colored flecks on the body and wings.

Adults have a distinctive anvil-shaped head. **5 mm**

The wingless nymphs are yellow-white with red to brown coloration that develops an hourglass pattern. This species overwinters as an egg inside fallen leaves, and eggs hatch as leaf buds open in the spring. There are typically two generations per year with adults in mid and late summer. The timing of these generations can be monitored with yellow sticky traps. Second-generation adults deposit the overwintering eggs.

Insect pests of leaves and shoots

White-marked tussock moth

Tussock moth larvae are brightly colored.

30 mm

Mature tussock moth larvae are large (30 mm) with distinctive coloration and hairs, which can irritate the skin of pickers. Female moths are flightless and lay large batches of eggs in a hairy mass, which overwinter wrapped inside blueberry leaves. These can be seen during pruning. Small, brown larvae hatch from the egg mass in the spring and disperse into the lower branches of bushes. There can be two generations per year. Scouting in the inside and bottom of bushes can help detect larvae before they reach full size. This pest is usually more common near woods. Controlling weeds and ensuring good spray coverage improves control.

Tussock moth egg masses are laid in blueberry branches.

Insect pests of leaves and shoots

Winter moth

Winter moth is a new pest of blueberries in the northeastern United States. It can destroy flower buds and defoliate bushes during the spring when caterpillars are active. The caterpillars can be up to 1 inch (about 25 mm) and are pale green with a white stripe running down both sides of the body. They have a looping style of

Heather Faubert, Univ. of Rhode Island

Winter moth caterpillar.

25 mm

Winter moth – *continued*

movement. After feeding through the spring, they pupate in the soil.

Moths start emerging from the soil in late November and continue to late December, mating and laying eggs. The males are about the size of a quarter and have light brown wings with faint brown patterns. The female is gray with tiny wings so she cannot fly. Eggs are laid on host plants including many trees and blueberry bushes during winter. They hatch in early spring around mid-April, just before bud break. Caterpillars wriggle into buds and feed on developing flower parts. As caterpillars grow, they continue to feed on surrounding buds and leaves until they drop to the ground. Over 90 percent of flower buds can be destroyed.

Insect pests of leaves and shoots

Gypsy moth

John H. Ghent, USDA Forest Serv.

Gypsy moth larvae are brown-black with white and yellow hairs and can be up to 50 mm long. They are typically present during bloom, feeding on foliage and flower clusters. The youngest larvae (3 mm long) can “balloon” through the air on silken threads and can be carried from woods into nearby blueberry fields.

Scouting during and after bloom can detect small larvae on bushes when they are easiest to control.

Insect pests of leaves and shoots

Blueberry gall midge

Adults of this Cecidomyiid fly are only 3 mm long and difficult to see. This pest is also called cranberry tipworm. Females can lay up to 20 eggs in swelling buds, and white larvae develop inside, damaging young flower and leaf buds. Larvae are yellow-orange and reach only 1 mm when mature. Multiple generations occur each year. Infected buds dry up and disintegrate. Later egg laying occurs on vegetative shoot tips.

Monitor by collecting buds and holding them at room temperature in plastic bags until larvae emerge.

Gall midge damage.

Insect pests of leaves and shoots

Blueberry stem gall wasp

Stem gall wasps cause kidney-shaped or spherical growths (2 to 4 cm in diameter) on blueberry stems. The adult wasps emerge from galls during or after bloom and lay several eggs in young stems. The galls develop around these stems during the year, turning from green to brown.

Pruning the galls out of the fields is the most effective control for this insect.

Old gall showing wasp emergence holes.

Below, a newly formed gall.

Back to insect/mite pests index

Insect pests of leaves and shoots

Scales

Various species of scale attack blueberry. Scales typically occur in older fields on old wood, so regular pruning is the most effective control. Scale infestation can cause loss of bush vigor, sooty mold, and blemished fruit. Each scale is a small, waxy dot 2 to 3 mm in diameter, which covers an immobile yellow insect. The crawler stage is most susceptible to control and can be monitored using double-sided sticky tape placed around branches.

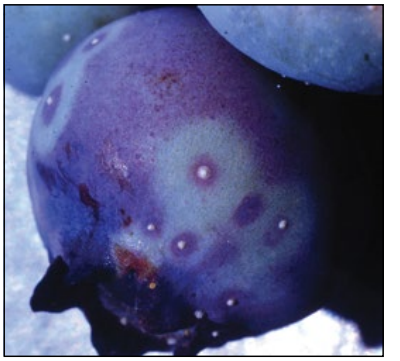
Jerry A. Payne, USDA ARS

3 mm

Putnam scale on cane.

Jerry A. Payne, USDA ARS

Terrapin scale on leaves and petioles.



Putnam scale on fruit.

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Insect pests of leaves and shoots

Blueberry tip borer

Adult moths of this sporadic pest emerge after bloom and lay single, translucent eggs on succulent shoots. The young larvae tunnel into the shoot near the eggs, and feed inside. A small pinhole can be seen where the larva entered the stem. The internal feeding causes the stem to wilt and the leaves to dry up from the tips.

Drying terminal leaves indicate tip borer injury.

Monitoring for the start of this symptom can be used to identify the egg laying period. Larvae continue developing into the fall and pupate inside the stem. Standard fruitworm controls usually prevent tip borer infestation; pruning infested shoots can help suppress populations.

Insect pests of leaves and shoots
Blueberry flea beetle

Eggs overwinter in leaf litter in spring and feed on developing buds and foliage. Larvae are dark brown, grow to 6 mm long, and take 2-3 weeks to develop. The adult beetle is oval, 5 mm long, with a shiny bronze color. It causes notching damage to leaves during summer and may also chew holes in the leaves. The beetles have a distinctive jumping behavior when disturbed.

Insect pests of fruit
About fruitworms

Two species of fruitworm infest blueberry, and because their timing usually overlaps, they are often managed together. Knowing how to scout for both can help with making appropriate IPM decisions. Just after petal fall is the best time to examine developing fruit to look for egg laying and early infestations.

Insect pests of fruit
Cranberry fruitworm

Adult moths emerge during bloom, and monitoring traps can indicate timing and abundance of male moths. Females begin to lay white, oval eggs in the calyx of the berry soon after petal fall.

Cranberry fruitworm moths have distinctive white patches on their wings. 13 mm

Larvae enter fruit where the stem meets the berry making a hole with frass around it.

CBFW eggs are oval and irregular, changing from white to yellow with age. The egg on the left (above) has hatched. 1 mm

Larvae are green with a dark head and move between multiple berries as they develop. Berries are webbed together, and frass is often deposited, looking like sawdust trapped in the webbing.

Jerry Payne, USDA ARS.

Insect pests of fruit
Cherry fruitworm

Cherry fruitworm moths f earlier than cranberry fruitworm, and egg laying begins immediately after petal fall. Eggs are round, flat, and shiny and are laid in the calyx.

Cherry fruitworm moth on monitoring trap. 5 mm

Larvae often enter berries in the calyx or on the berry side. The larva resembles cranberry fruitworm but has a dark head capsule and a reddish body, reaching 9 mm in length.

Cherry fruitworm larva. 9 mm

Because they develop inside a single berry, cherry fruitworms cause little webbing, and infested fruit often drop off before harvest.

Insect pests of fruit
Plum curculio

Adult beetles have a rough-surfaced brown body and distinctive snout. There is one generation per year in northern regions. Adult beetles overwinter in leaf litter and become active during late bloom, laying eggs in young berries.

Adult plum curculio **6 mm**

A white maggot develops under the crescent-shaped scar they left when the egg is laid. Scouting for this scar indicates the level of infestation, typically greatest near woods and at field borders. Injured berries color prematurely and may drop off bushes before harvest. In early varieties, larvae may be harvested with berries.

Curculio maggot. **5 mm**

Left, half-moon scar from curculio injury.

Insect pests of fruit
Blueberry maggot

Adult flies are dark and approximately 5 mm in length. The most characteristic feature is the dark pattern on their wings, which can be used to distinguish it from other fruit flies. Flies also have a white spot on the back of the thorax and three (male) or four (female) white bands across the top of the abdomen.

Blueberry maggot flies have a distinctive M shape on each wing.

5 mm

Fly emergence typically starts as midseason varieties (e.g., Bluecrop) start turning blue. Flies feed and mate for 7 to 10 days before females are ready to lay eggs. This insect can be monitored using yellow traps baited with ammonium acetate. Traps should be hung in the top third of bushes without foliage touching them. Traps placed at the field border and interior can identify immigrating and resident fly populations, respectively. Keep traps effective by changing bait regularly.

Blueberry maggot – *continued*

It is critical to monitor traps to detect and accurately time controls. Fly species identification is important because other flies with similar wing patterns may be caught.

Place monitoring traps in the top third of the bush to identify the start of fly emergence.

If flies are detected, man-agement is typically required within 7 to 10 days to prevent egg laying in fruit. Eggs are 1 mm long, oval and white, and are laid singly in fruit. Maggots hatch in about 5 days and grow to about 7 mm long inside one berry. Infested berries soon become soft, and shrivelled. Mature larvae drop to the ground, where they burrow into the soil to pupate.

Infested fruit contains a white, legless maggot. **7 mm**

Back to insect/mite pests index

Insect pests of fruit
Spotted wing Drosophila (SWD)

This small fly (1/16 to 1/8 inches long) is a major pest of blueberries, having recently invaded many production regions. SWD overwinters as an adult fly, with first captures in early June and low populations during July. The males have a small, dark mark on each wing, while the female has no wing spots. Both have red eyes and a tan body. Female flies lay tiny, white eggs just under the skin of berries. Identification requires a hand lens or microscope to distinguish from other similar flies.

SWD eggs hatch in a few days and develop into white larvae up to 1/8 inches in length, which

Martin Hauser

Female flies cut into fruit with a serrated ovipositor.

Kurt Stepnitz, MSU

Male spotted wing Drosophila. Note spots on wings.

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Spotted wing Drosophila – *continued*

can destroy fruit quality and marketability. At optimal temperatures (typical summer conditions), a generation can take as little as two weeks, so SWD populations can grow quickly. During blueberry ripening season, lower abundance has been observed during harvest of Duke and Bluecrop, but increasing rapidly through harvest of Jersey and Elliott varieties.

To monitor the flies, use a baited trap such as a plastic container with holes on the side and a fermenting yeast-sugar mix or one of the commercial lures with a drowning solution. SWD infestation can be assessed by sampling blueberries weekly and immersing them in a strong salt solution for 30 minutes and then looking for larvae in the liquid.

Steve VanTimmeren, MSU

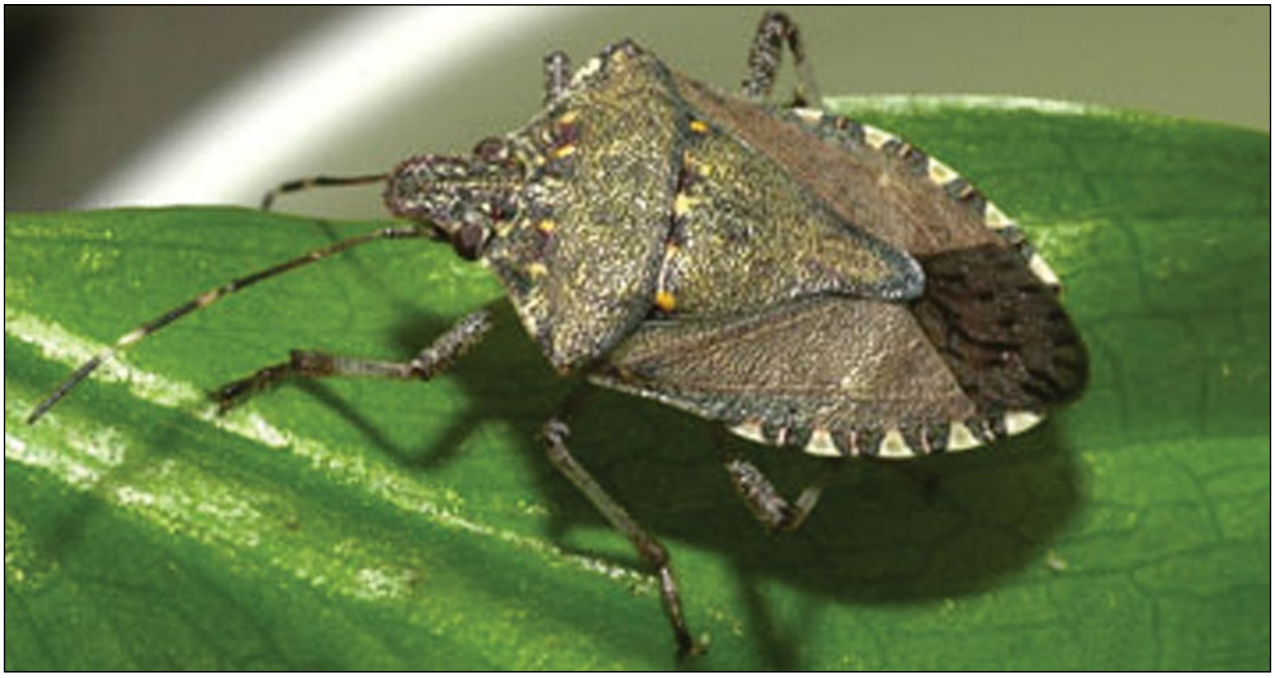
Hang traps in the shade to increase catch.

Insect pests of fruit

Brown marmorated stink bug (BMSB)

Feeding by this stink bug has potential to cause damage to ripe blueberries, though it is not yet a primary pest in most production regions. BMSB has recently invaded regions of the eastern and western United States, and is still spreading.

Adult BMSB have the typical shield shape of stink bugs and are 5/8 inches long and 3/8 inches wide. Males and females have light bands on each antenna and have a smooth pronotum, which distinguishes it from some beneficial predatory stink bugs.



David R. Lance, USDA APHIS PPQ

Adult.

Brown marmorated stink bug – *continued*

Gary Bernon, USDA APHIS, Bugwood.org

Newly-hatched egg mass.

Eggs are light yellow-green and laid on the undersides of leaves in clusters of 20-30. Emerging nymphs are yellowish brown with black and red, while older nymphs are darker and more like adults. All nymphs have red eyes.

In the fall, adult BMSB seek overwintering sites such as houses and other protected places. They emerge in the spring and mate. Females that develop during the summer lay up to 400 eggs which hatch in three to seven days. During the first stage, nymphs stay close to the egg cluster but disperse as they get older. Nymphs have five stages with a molt in between, each about a week long. The number of generations depends on temperature, with one typical in northern parts of the North Central Region and two possible in the southern parts.

Insect pests of fruit
Japanese beetle

Adult beetles feed on ripe fruit and foliage.

13 mm

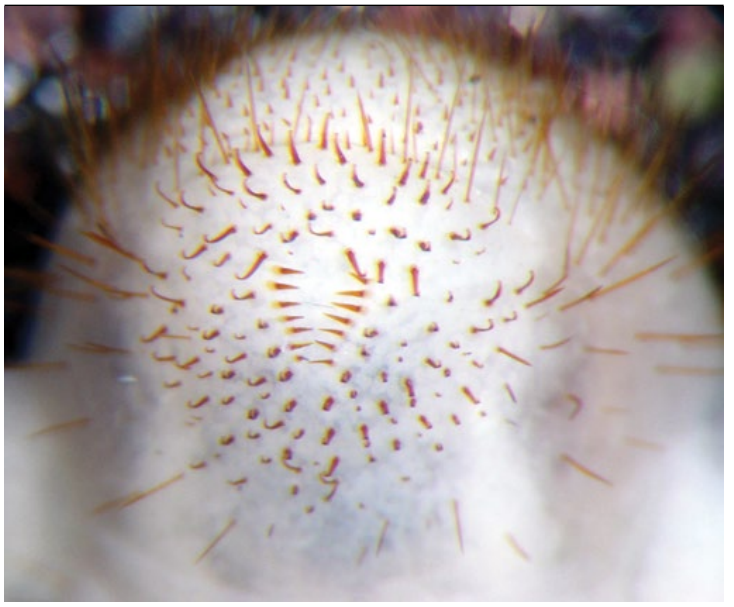
Adult beetles are about 13 mm long with a metallic green thorax and shiny, brown wing coverings. Rows of white tufts are distinctive on the undersides of the abdomen. Male and female beetles congregate on the tops of plants in sunlight, where they feed and mate. Adult beetle emergence begins in early June in North Carolina and early July in Michigan.

Mating occurs as soon as females emerge from the ground. Then they seek grassy areas with moist soil to lay eggs. Eggs are 1 to 2 mm in diameter, spherical and white, and are laid 5 to 10 cm deep in the soil in batches throughout the female beetle's month-long life. C-shaped, cream-colored grubs with brown heads and three pairs of legs develop in the soil, becoming 3 cm long when fully grown.

Japanese beetle – *continued*

C-shaped grubs are found in soil under grassy areas

Japanese beetle grubs can be distinguished from similar grubs by two rows of seven hairs in a V shape on the inside of the posterior segment. Beetles are best detected on blueberry bushes during calm, hot, cloudless afternoons. Traps for monitor-ing Japanese beetle are highly attractive but can increase the number of beetles flying into an area. In small plantings, beetles can be removed from bushes. Control of attractive weed hosts and removal of grassy areas in and around fields during July and August can reduce field suitability for Japanese beetle. Biological control agents suppress populations in areas where the beetle is established.



Japanese beetle grubs have hairs in a distinctive V pattern.

Insect pests of fruit
Three lined flower beetle

10 mm

This beetle emerges in spring, feeding on young buds and flowers. The beetles are about 1/4 inch long, with females being gray and males more tan-colored. Both sexes have wing coverings with patches of more dense hairs on them, making a lined pattern across the body.

These beetles leave ragged feeding marks on flowers or buds and tend to be most abundant at field perimeters. There is one generation per year, and the adult activity period can last from bud swell through bloom. They are also attracted to white monitoring traps and may be first detected there.

Feeding damage on flower buds.

Insect pests of roots

Oriental beetle

This pest is established in the eastern United States and is spreading slowly into the Midwest. Adult Oriental beetles vary from light brown to black with mottling on the wing covers. They are active from late June through August; slightly earlier than Japanese beetle. They are active at night and can be monitored using a pheromone-baited trap placed on the ground.

The females lay eggs in the ground at the bases of bushes, and larvae feed directly on blueberry roots.

Adult Oriental beetles.

10 mm

Oriental beetle – *continued*

Larvae are very similar to those of Japanese beetle (page 92), but the pattern of hairs on the posterior segment differs, with two parallel rows of 10 to 16 hairs per row.

Roots damaged by Oriental beetle.

Insect pests of roots

Blueberry mealybug

Adult mealybugs are 3 to 4 mm long and white to light pink with a waxy covering. They are found on the roots of bushes, usually in association with ant colonies. Adult female mealybugs lay light brown, oval eggs in a white, fluffy material near roots. High populations can lead to poor plant growth and decline. Plants must be unearthed to find infestations.

Adult mealybugs are white with hairs on the posterior.

3 mm

Blueberry Scouting Guide Index

Beneficial insects

About natural enemies

Natural enemies are beneficial organisms that can enhance pest control, often providing suppression of many indirect pests, such as mites and leafrollers. The best ways to conserve beneficial insects are to use caution when selecting pesticides and timing applications, and to restrict use of predator-toxic products, particularly later in the season.

Natural enemies
Predatory mites and spiders

Predatory mites can be distinguished from pest mites by observing their movement. When disturbed, predators generally move more quickly than pest mites. A ratio of one predator to 10 pest mites is often sufficient for effective biological control. 0.5 mm

Predatory mites are white, orange, or clear.

Spiders live in bushes and can eat small pest insects.

Natural enemies

Lacewings

12 mm

Green lace-wing adults (10 to 12 mm) have net-veined wings and gold-colored eyes. They feed on nectar, pollen, and aphid honeydew. Some lacewing species are brown and smaller.

Lacewing eggs are suspended at the tips of long, erect stalks.

A lacewing larva.

15 mm

Lacewing larvae are alligator-shaped with long, piercing mandibles. They are active predators of aphids and other small insects.

In rare cases, lacewings have pupated inside the calyx cup of ripe fruit.

Natural enemies
Beetles

Several species of **lady-beetles** are active in blueberry fields. They are generally oval and red to orange with varying numbers of dark spots. Both adults and larvae are predators, eating aphids and other small insects.

8 mm

1 mm

Ladybeetle eggs are yellow and barrel-shaped and laid in clusters.

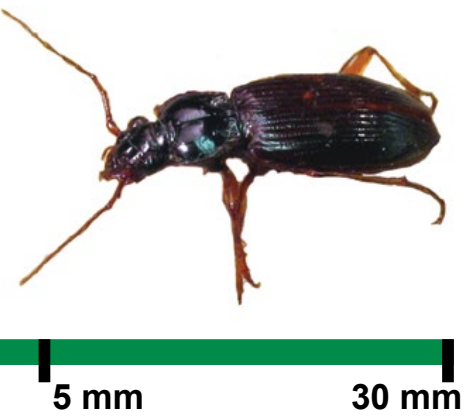
Larvae have dark, elongated bodies with orange markings and well-developed legs. 5 mm

The **multicolored Asian ladybeetle**, an introduced species, feeds on pests during summer. They may be many colors with several or no spots.

Beetles – *continued*

The Asian ladybeetle can be distinguished from other ladybugs by the black M or W (depending on the viewing direction) between the head and abdomen (see photo).

Ground beetles eat insects and weed seeds. They can feed on insect eggs, larvae, and pupae that are found on the ground, and some may search in the bush canopy for food.



Natural enemies
Flies

Syrphid fly adults resemble bees but have only one pair of wings and much shorter antennae. They can be seen hovering in the air near plants. Their larvae are predators.

Flies – *continued*

Syrphid fly larvae are usually light green, legless maggots, rounded at the rear and tapering to a point at the head. When the maggot is crawling, the head moves from side to side.

Syrphid fly larva 3-4 mm

The larvae eat aphids and other soft-bodied insects.

Tachinid fly adults are hairy and bristly. Their larvae feed on moth, beetle, and stinkbug larvae.

Tachinid fly larvae emerging from a caterpillar.

3-4 mm

Robber flies are general predators that eat aphids, moths, beetles, and many other pests.

15 mm

Back to natural enemies index

Natural enemies
True bugs

Damsel bugs have long bodies that narrow slightly toward the head. They have stout beaks and large front legs for grasping prey. 8 mm

Adult **minute pirate bugs** are black with white markings. 5 mm

Adult **assassin bugs** are medium to large insects, and their color ranges from brown to green. They have long heads with a groove between the eyes and curved beaks. The nymphs are also important predators.

12 mm 36 mm

12 mm

Many **shield bugs** (at left), pentatomids, are predatory and can attack beetles and caterpillars.

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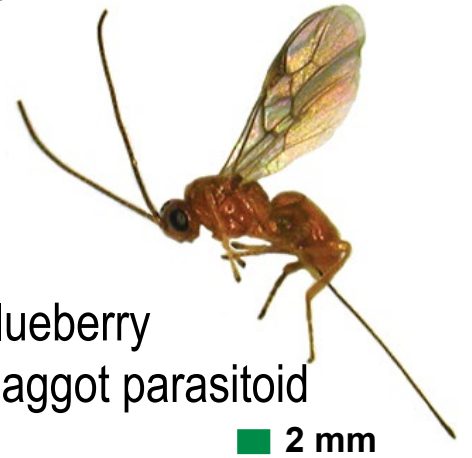
Natural enemies

Parasitic wasps

Most **parasitic wasps** are tiny, and they often develop inside their hosts, so detecting them can be difficult. Some recognizable signs of parasitism include unusual host (pest) behavior, host body darkening, and the presence of emergence holes or cocoons on the pest.

Trichogramma wasps are egg parasites of many insects, including cranberry fruitworm and leafrollers. Parasitized eggs are dark black rather than the yellow-cream of healthy eggs.

Braconids and **ichneumonids** are small black, orange, or yellow wasps that prey on immature insects such as cranberry fruitworm larvae. Adults are less than 10 mm long, and many species are found in blueberry fields.



Blueberry maggot parasitoid

Blueberry Scouting Guide Index

Physiological/chemical

Physiological/chemical (continued)

Nutrient deficiency

Nitrogen (N) deficiency

Nitrogen shortages are common in blueberries. Symptoms include reduced shoot growth, fewer new canes, and pale green (chlorotic) leaves. Chlorosis is uniform across leaves with no mottling or pattern. Leaves of deficient plants often develop fall colors and drop off early. Yield is usually reduced.

At left, Bluecrop with normal N and right, Bluecrop with low N.

Nutrient deficiency

Phosphorus (P) deficiency

Symptoms of P deficiency occur occasionally. Plants may be stunted, with small leaves tinted dark green to purple, particularly on the tips and margins. Leaves may lie unusually flat against the stems. Twigs are narrow and may be reddish-purple. Symptoms sometimes appear briefly in the spring following periods of cold weather.

Darker green to purplish color characteristic of P-deficient leaves.

Nutrient deficiency

Potassium (K) deficiency

Symptoms of K deficiency occur periodically and include tip dieback of shoots, scorching along the leaf margins, leaf cupping or curling, and necrotic spots. Symptoms are similar to those caused by acute drought stress. Younger leaves near shoot tips may develop interveinal chlorosis similar to that caused by iron deficiency.

Early stages of burning along leaf margins (left) and advanced marginal burning caused by K deficiency.

Nutrient deficiency
Magnesium (Mg) deficiency

Symptoms of Mg deficiency are seen periodically, particularly on sandy sites. A distinctive pattern of chlorosis develops between the main veins of leaves. These regions may turn yellow to bright red while tissues adjacent to the main veins remain green. Older leaves at the bases of canes and shoots show symptoms first. Young leaves at the tips of shoots are seldom affected.

Symptoms of Mg deficiency may vary in color and usually develop later in the summer.

Nutrient deficiency
Iron (Fe) deficiency

Iron chlorosis is common when soil pH is above 5.5. High pH prevents the plants from using Fe normally. Symptoms appear first at the shoot tips on young leaves. Tissue between veins is a light yellow or bronze-gold color. The leaf veins stay green. In severe cases, all leaves are affected and leaf margins turn brown and die. Shoot growth and leaf size are reduced. Symptoms are increased if soils are poorly drained or compacted.

Chemical injury
About postemergent herbicides

These herbicides are applied directly to weeds. Blueberry bushes can also be injured if chemicals come into contact with plants.

Chemical injury
Glyphosate (Roundup®) injury

Glyphosate is absorbed by green plant tissue (bark, leaves) and then moves within the plant. Branches or canes exposed early in the year usually stop growing and eventually die. When branches are exposed later in the season, absorbed glyphosate can move throughout the plant.

Mottled chlorotic appearance of leaves 2 weeks after exposure to glyphosate.

Glyphosate – *continued*

Severe injury or plant death may occur the next spring. Branches exposed the previous year produce stunted growth with small, narrow, chlorotic leaves. Symptoms may persist for 1 to 3 years.

Mark Longstroth, MSU

Small, narrow blueberry leaves resulting from glyphosate exposure during the previous summer.

Chemical injury

Paraquat (Gramoxone®) injury

Paraquat is a contact herbicide that injures any green plant tissue. It does not move in plants, so injury is confined to treated parts. Sprayed leaves develop brown spots within 2 to 3 days and may drop, depending on the amount of exposure. When young canes are sprayed, reddish-brown spots develop on the green bark. Canes may be stunted or killed if much of the bark surface is injured.

Young injured canes may be more susceptible to Phomopsis infection and winter injury.

Chemical injury
2,4-D injury

2,4-D severely injures blueberries if bushes or branches are sprayed or if volatile formulations (esters) are applied near blueberries. Symptoms vary, depending on circumstances, but they usually include stem twisting and downward bending, yellow to red mottling on leaves, and branch or bush death in severe cases.

Chemical injury

Clopyralid (Stinger®) injury

Clopyralid is a growth regulator-type herbicide used to control certain broadleaf weeds. The mode of action is similar to 2,4-D. It causes distorted growth if blueberries are sprayed directly when new shoots are growing. Symptoms include twisting of new shoots and narrowing and twisting of leaves. Branches exposed to clopyralid after shoot growth has ceased may show no symptoms.

Claudia Arkesteyn, Crop Production Services

Chemical injury

About preemergent herbicides

Preemergent herbicides are applied to the soil and absorbed by plants. Even those labeled for blueberries can injure bushes if high rates are used. The potential for injury is greatest on sandy soils or soils low in organic matter. Young or weak bushes are especially vulnerable. Injury can also occur if the spray application is not uniform over the soil surface or if rains move herbicides concentrating them in low areas.

Chemical injury

Simazine (Princep®) injury

Simazine is one of the safest preemengent herbicides, but excessive rates can cause injury. Symptoms are similar to those of iron chlorosis. Symptoms appear irregularly in the bush and include yellowing between the leaf veins and eventually browning and death starting along leaf edges. Bushes with mild to moderate symptoms survive but grow poorly for several years.

Chemical injury

Diuron (Karmex, Direx) injury

Injury is most likely if young or weak plants are treated with excessive rates. The first apparent symptom is a pale green color along the main veins of leaves. Eventually, brown areas develop between the main veins in the middle of leaves. These often do not extend to the leaf margins.

Chemical injury

Hexazinone (Velpar®) injury

The risk of hexazinone injury is relative high. Excessive rates result in irregular yellow patches on leaves, which later turn dark brown and die. Affected areas are not confined to certain parts of the leaves or consistently shaped. Darkening along some leaf veins is sometimes seen. In severe cases, bushes may drop nearly all leaves. Bushes are typically dead the following spring.

Velpar injury symptoms usually appear in the middle of the summer. Leaves may eventually fall off.

Chemical injury
Terbacil (Sinbar) injury

Blueberries are relatively sensitive to terbacil. The first injury symptom is irregular yellow or light green patches on leaves. Chlorotic patches later turn brown and die. The ends of leaves often turn brown and dry. Leaves curl and eventually drop from bushes. Severely affected bushes may drop all leaves and die by the following spring.

Terbacil injury is most common on small plants growing in soils low in organic matter.

Chemical injury

Norflurazon (Solicam®) injury

Blueberries are relatively tolerant of norflurazon. Excessive rates cause distinct leaf symptoms. Veins turn white or pinkish white. Current-season shoots may turn white. One-year-old bark turns pinkish. Symptoms usually appear first on lower branches. Norflurazon is persistent in the soil, so excessive rates may not result in symptoms until late in the season or the following year.

Chemical injury

Clomazone (Command®) injury

Clomazone (Command) is a preemergent herbicide used on soybeans and selected vegetables in Michigan. Command may drift from treated fields onto nearby sensitive plants, including blueberries. Exposed leaves turn a distinctive white color due to lack of chlorophyll. Symptoms may persist for several weeks before plants regain normal color.

Abiotic condition

Drought injury

Drought in early summer causes wilting of young shoots and reduced growth of shoots and berries. When drought occurs later in the season, berries may shrivel, and the margins of leaves turn brown and die starting toward the tip of the leaf. Drought in the autumn reduces flower bud initiation and yields for the following year.

Abiotic condition

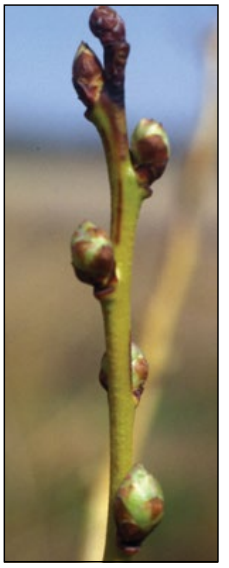
Edema

Edema (oedema) appears as numerous small bumps (0.5 to 2 mm) on the undersides of leaves. Under magnification, the bumps first appear raised and water-soaked; later they become sunken and necrotic. Affected bushes develop a rusty color on older leaves, but leaves do not display any signs of pathogenic infection (mold or spores). Edema appears to be caused by excess moisture and is most common under cloudy, humid conditions or in low, humid areas in the field.

Abiotic condition

Winter injury

Damage from winter cold can be hard to diagnose. Winter cold hardiness varies between varieties, and is influenced by growing stresses from the previous year, as well as conditions before a cold event. Winter cold can damage different parts of the plant and show different symptoms in spring. Flower buds at the shoot tips are often damaged before older wood and canes. Injury to flower buds can be assessed by dissecting buds: dead flower primordia are dark brown and live primordia are light green. Flowers in the bud are killed individually, not all at once, and there will be differences between buds on a shoot. Buds killed in winter appear brown and dead as spring growth begins. Partially injured buds develop



Cross-section of bud showing dead flowers (left) and twig dieback (right) due to winter injury.

Winter injury – *continued*

Carlos Garcia-Salazar, MSUE

Cut flower buds showing live and injured flower primordia.

fewer normal flowers. Damage to leaf buds may be more severe than damage to flower buds. Shoots may bloom normally, but few leaf buds grow and shoot growth is reduced. In severe cases, whole canes may fail to leaf out or break bud normally, then cease growth and die with warmer weather. Often, some canes are severely damaged, while others on the same bush show little damage. Winter injury may be localized to the colder portions of the field or widespread across a growing region. It resembles salt injury, which is usually found close to major roads.

Mark Longstroth, MSUE

Winter-injured bushes after bloom. Note poor growth and lack of leaves in the upper portions of the bush and vigorous shoot growth from the bush's base.

Abiotic condition

Road salt damage and dieback

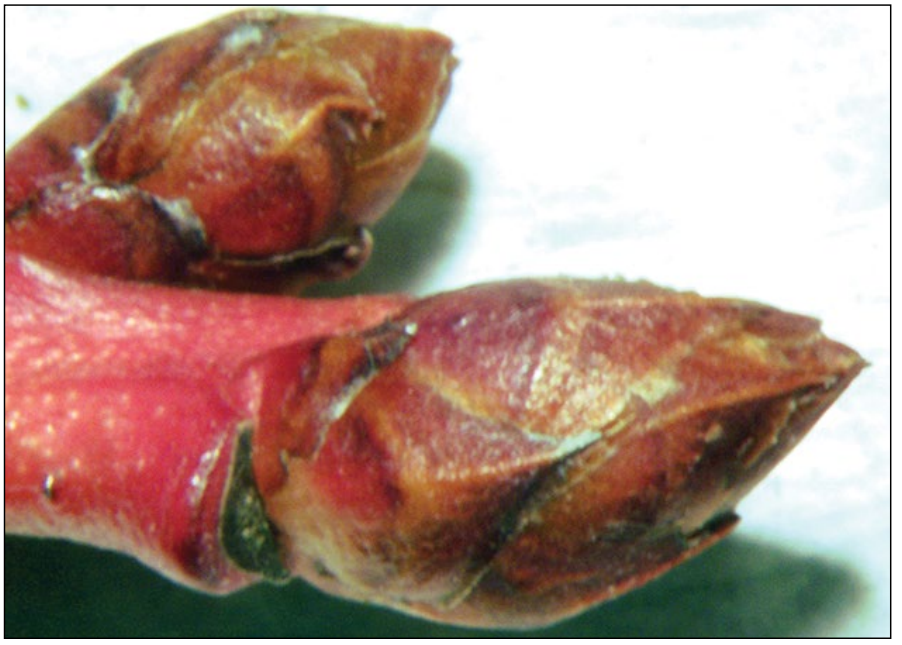
Intense use of de-icing road salt causes crop losses and diminished productivity in fields next to major highways in snowy regions. In western Michigan, blueberry fields along major roadways are severely affected.

Carlos Garcia, MSU

Damage (top right) occurred 30 meters from the road.

Road salt – *continued*

Symptoms of road salt damage are similar to winter damage, but appear only in fields facing roads that receive de-icing salt during winter. Symptoms include flower bud kill and extensive cane dieback that extends from the field edge up to 30 meters (100 feet) into affected fields.



Carlos Garcia, MSU

Damaged buds.

Carlos Garcia, MSU

Buds cut open to expose the damage within.

Abiotic condition

Spring freeze injury

Damage to flowers

Water-soaked, dark, freeze-injured flowers.

Cutaway of healthy flowers.

Injury to ovules

Brown, freeze-injured ovules in berry.

Healthy, white ovules in developing berry.

Spring freeze injury – *continued*

Damage to fruit - internal

Hollow, corky berries and internal injury caused by freeze injury at the berry stage.

Damage to fruit - external

“Frost rings” at the calyx can cause scarring and cracking.

48 hours after injury.

One month after injury.

Abiotic condition

Pimples on fruit

During fruit sizing, berries may be covered with small black bumps that are very obvious during scouting. While the cause of these has not been fully determined, these bumps are not visible once the berries ripen and turn darker.

Miscellaneous fruit defects

Hail damage

Hail injury to ripening fruit.

Hail dents and bruising on green fruit.

Bird damage

Bird feeding damage.

Rain cracking

Fruit cracking caused by rain shortly before harvest.

Miscellaneous fruit defects – *continued*

Shriveling of Elliott fruit

Berries of the Elliott variety occasionally soften and shrivel before they are fully ripe. No cause has been identified.

Shriveled Elliott fruit.

Spray injury

Various chemical sprays can injure blueberries.

Bravo injury to fruit.

Fruit injury resulting from surfactant burned flowers.

Using this scouting guide

This guide was developed as a pocket reference book for easy use in scouting blueberry fields. It provides information on biology of common pest and beneficial insects, diseases, weather-related disorders, and symptoms of pesticide damage and nutritional disorders. Use this guide to learn what to look for while scouting and to guide timing of scouting activities. The guide focuses on highbush blueberries in the United States. But many of the diseases, insects, and disorders also occur in other regions.

Introduction to scouting

Why scout blueberry fields?

Scouting for pests and diseases means looking for them in the planting at critical times in their development and recording their incidence. Regular scouting is the foundation of effective pest management and ensures early detection of insect and disease problems before they reach damaging levels. Regular scouting also helps optimize timing of control measures.

Strategies for scouting

- Various insects and diseases require monitoring at different times. See the scouting calendars on pages 7 and 8.
- Know and understand basic pest biology (life cycles). This will give you the best information on when pests and diseases, and their damage, can be found in the planting.
- Learn to identify disease and insect life stages and the damage they cause.

- Know where on the bush insect pests and disease symptoms are most likely to be found.
- Scout with the sun behind you, and look under the canopy at interior leaves and fruit.
- Look carefully for disease symptoms after prolonged wet periods.
- Develop field history maps with locations of areas most affected by pest and disease outbreaks, and monitor more intensively in these areas.
- Keep track of the weather and pesticide applications to help distinguish pest damage and disease symptoms from physiological disorders and pesticide injury.

Tools for scouting

- Monitoring traps to track insect development.
- A 20X hand lens to help identify insects and pathogens.
- Collection bags or vials to hold samples for identification.
- Waterproof notebook and pencil.
- Field maps to document locations of pest outbreaks and locations of scouting efforts over the growing season.
- Clipboard with scouting forms - include a “time in” and “time out” section to record the

amount of time spent scouting a planting. This is particularly important when determining the economics of scouting activities.

- Colored tape or tags to mark bushes of interest.
- Water-insoluble marker to write on tags/tape or on leaves.

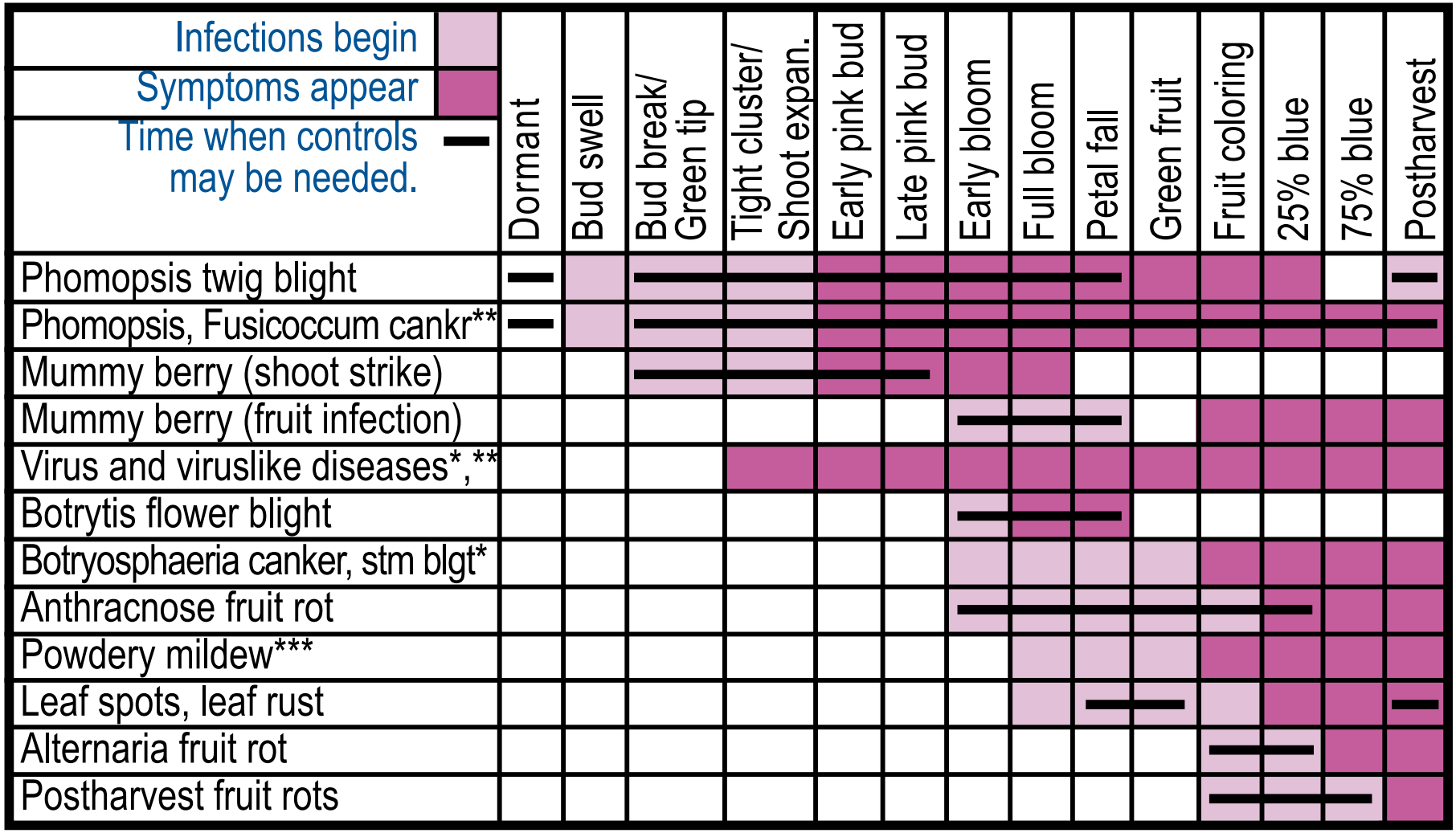
Where to monitor

- Check border and interior areas of the field separately.
- Include adjacent habitat that may harbor pests.
- Monitor at least 100 bushes (25 bushes along the length of four different rows).
- Look in hotspots with a history of insect pest or disease problems.
- Inspect and sample both sides of the bush.
- Walk different rows each time you scout.

Weather monitoring

- Weather information may be used to predict crop growth stages, appearance of specific insect pest life stages, and infection periods of the major diseases affecting blueberries.
- Weather information can also help explain weather-related disorders such as cold injury. Minimum weather parameters to monitor include daily high and low temperatures and rainfall.

Blueberry Disease Scouting Calendar



*Fungicides ineffective. **Infections may have occurred in previous years.
***No control usually needed.

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Blueberry Insect Pest Scouting Calendar

	Dormant	Bud swell	Bud break/ Green tip	Tight cluster/ Shoot expan.	Early pink bud	Late pink bud	Early bloom	Full bloom	Petal fall	Green fruit	Fruit coloring	25% blue	75% blue	Postharvest
Blueberry bud mite	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cutworms and spanworms		+	+	+										
Blossom weevil		+	+	+	+	+	+							
Obliquebanded leafroller			+	+	+	+	+			+	+	+	+	
Thrips					+	+	+	+	+	+	+			
Cherry fruitworm								+	+	+	+	+		
Cranberry fruitworm								+	+	+	+	+		
Plum curculio								+	+	+	+			
Sharpnosed leafhopper									+	+	+	+	+	+
Blueberry aphid								+	+	+	+	+	+	
Oriental beetle										+	+	+		
Japanese beetle											+	+	+	+
Blueberry maggot											+	+	+	+
Spotted wing Drosophila										+	+	+	+	+

Usual time for monitoring and control

Less risk, monitoring or control may be required

Potential pest activity +

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Monitoring blueberry nutrition

Routine monitoring with leaf analysis

Sample every 1 to 3 years:

1. Divide farm into sampling units with same variety (ideally), uniform soil types and past fertilization or management practices. Unit size: 1 to 10 acres.
2. Collect 50 to 100 leaves per sampling unit in late July or early August. Collect healthy leaves from the middle of current-season shoots from different plants throughout the sampling unit.
3. Wash leaves by swirling them in a diluted detergent solution for several seconds. Rinse briefly in tap water. Let leaves air-dry on a table top.
4. Package leaves in paper bags. Send to a reputable lab for analysis of nutrient elements.

Diagnosing problems with leaf analysis

To diagnose a suspected nutritional problem, collect one sample from plants beginning to develop the symptoms and a second from nearby healthy plants. Sample leaves anytime.

Interpreting leaf analyses

Deficient, normal and excessive levels for blueberries are well defined for some nutrients (N, P, K), but these ranges for other nutrients (most micronutrients) are not well defined because deficiencies and excesses have not been documented in fields.

Nutrient	Deficient	Normal	Excessive
Macronutrients (%)			
Nitrogen (N)	< 1.7	1.7 to 2.1	> 2.3
Phosphorus (P)	< 0.08	0.1 to 0.4	??*
Potassium (K)	< 0.35	0.35 to 0.65	> 0.8
Calcium (Ca)	< 0.13	0.2 to 0.6	> 0.8
Magnesium (Mg)	< 0.1	0.15 to 0.3	??
Micronutrients (ppm)			
Boron (B)	< 15	20-60	> 80
Copper (Cu)	??	5 to 20	??
Iron (Fe)	??	60 to 200	??
Manganese (Mn)	??	50 to 350	??
Zinc (Zn)	??	8 to 30	??

* Inadequate information to determine.

Soil testing

Use soil testing to monitor soil pH and estimate nutrient supplies. Sample all blueberry soils before planting and sample established plantings every 2 to 4 years.

Divide the farm into sampling units or areas that have uniform soil types, management history and variety. Farms with variable soils or history will require more sampling units to provide an accurate picture of the nutritional health over the farm. If the soil and history are similar, divide the farm into 10-15 acre blocks.

Sample soils anytime of the year. Use a soil probe or auger to sample from at least 20 locations throughout the sampling unit. Sample beneath the plants to a depth of 8 inches. Combine the soil from the unit in a bucket, mix and remove about a pound of soil. Package in bags or soil sample boxes. Send samples to a reputable lab.

Interpreting soil test results

Soil test nutrient levels are a crude estimate of nutrient supply and do not accurately predict

the nutrient status of bushes. General target soil test levels for Michigan blueberries are about 50 ppm P, 60 ppm K, 40 ppm Mg and 250 ppm Ca. Since nutrient concentrations are much higher in heavier soils than sandy soils, the relative proportions of nutrients are an important measure of status. A suitable balance of soil K, Ca and Mg, expressed as percent of exchangeable bases, would be 60-80% Ca, 15-30 % Mg, and 10-15% K.

Estimating Wind Speed (continues on next page)

Description	Observed effects	Notes	Approximate wind speed
Calm	Smoke rises vertically	Avoid fine sprays on warm days	Less than 1 mph
Light air	Smoke drift indicates wind direction; weather vanes do not move	Avoid fine sprays on warm sunny days	1 to 3 mph
Light breeze	Leaves rustle; wind felt on face; weather vanes begin moving	Ideal spraying	3 to 7 mph
Gentle breeze	Leaves and twigs in constant motion	Good spraying	7 to 11 mph

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Estimating Wind Speed (continued)

Description	Observed effects	Notes	Approx. wind speed
Moderate	Small branches moved; raises dust, leaves and loose paper	Avoid pesticides with finer sprays	12 to 15 mph
Fresh breeze	Small trees sway	**Do not spray** – Drift regulations prohibit spraying when wind speed is over 15 mph	
Strong breeze	Large branches sway	Off-target movement very likely	
Moderate gale	Whole trees in motion		

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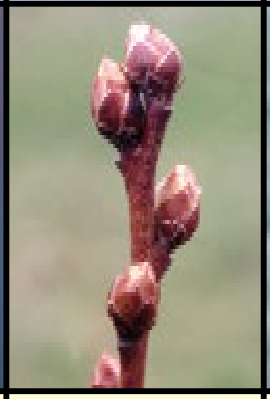
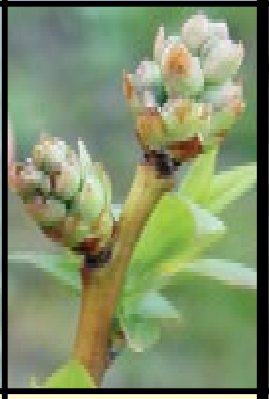
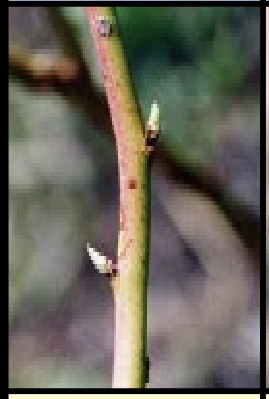
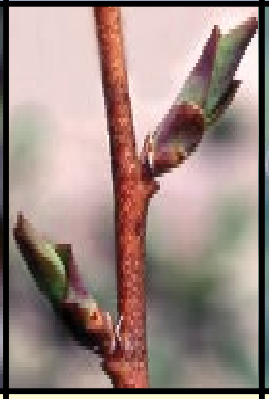
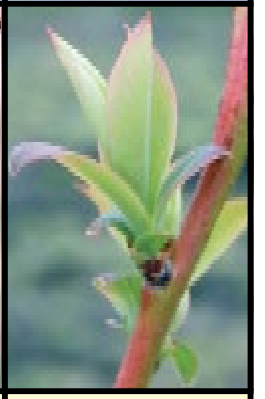
Blueberry growth stages (continues on next page)

Flower bud development				Leaf bud development		
Tight bud	Bud swell	Bud break	Tight cluster	Early green tip	Late green tip	Shoot expansion
						
No visible swelling; bud scales completely closed.	Visible swelling of buds; scales separated. Can tolerate 10 to 15ºF (-12 to -9ºC).	Bud scales separated, tips of flowers visible. Can tolerate 15 to 20ºF (-9 to -6ºC).	Individual flowers distinguish-able. Can tolerate 20 to 25ºF (-6 to -4ºC).	1/16 to 3/16 inch (1 to 5 mm) of green leaf tissue visible; leaves still rolled up.	1/4 to 1/2 inch (6 to 13 mm) of green leaf tissue visible; leaves starting to unfold.	Shoots expanding and leaves enlarging.

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Blueberry growth stages (continues on next page)

Flower development				
Early pink bud	Late pink bud	Early bloom	Full bloom	Petal fall
				
Partly expanded flowers are readily visible and have separated; corolla tubes (petals) short and closed. Can tolerate 23 to 25ºF (-5 to -4ºC).	Individual flowers fully developed and separated; corollas expanded but still closed. Can tolerate 24 to 27ºF (-4 to -3ºC).	Some corollas completely expanded and open; many flowers still closed. Can tolerate 25 to 28ºF (-4 to -2ºC).	Most flowers on the bush have opened and can tolerate 28ºF (-2ºC).	Corollas are falling off, revealing small green fruit; this is the stage most vulnerable to frost damage, which can occur at 32ºF (0ºC).

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Blueberry growth stages

Fruit development and postharvest				
Green fruit	Fruit coloring	~25% blue	~75% blue	Bud set for following year
				
Berries are expanding; fruit may vary from small to large pea-size in the same cluster.	Berries are changing from green to pink to blue.	First crop of berries is ripe and ready for harvest.	Berries are picked several times as they ripen. There may be 2 to 5 pickings. Berries may be hand- or machine harvested.	After harvest, the blueberry plant stores reserves and sets buds for next year's growth until leaf fall.

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Blueberry growth and black tips

Some growers become concerned when they notice a small, black leaf at the shoot tip. This is a normal occurrence in shoot growth, indicating the end of a shoot growth flush. In blueberries, shoot growth stops with the death of the shoot tip and often a small leaf coming from the apex of the shoot dies as well. After shoot growth stops, the next bud below the shoot apex becomes the terminal bud. This bud will either form a flower bud or remain a leaf bud capable of an-

Black tip formed by death of the shoot tip soon after the small leaf on the left was formed. The bud in the small leaf's axil will become the shoot's new terminal bud.

Mark Longstroth, MSUE

The dead leaf formed by the death of the shoot tip is clearly visible at the shoot tip in this photo.

Blueberry growth, black tips – *continued*

other growth flush. One or more flushes of shoot growth occur every year. During active shoot growth, new leaves are formed at the shoot tip. Full-sized leaves to the shoot tip, with no new leaves at the shoot tip, means shoot growth has stopped.

Blueberry gall midges cause shoot branching by killing the shoot tip, but there is usually damage to associated leaves as well. Winter or spring cold injury and herbicide injury can kill the shoot tip resulting in short shoots of one to two leaves.

Mark Longstroth, MSUE

Several actively growing shoots with new leaves emerging from the shoot tips.

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A Pocket Guide to IPM Scouting in Highbush Blueberries

2020 PDF

Produced by Tim Miles, MSU Plant, Soil and Microbial Sciences; Rufus Isaacs, MSU Entomology; Joy Landis and Mallory Marienfeld, MSU IPM Program.

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Get more information about growing blueberries at this Michigan State University website:

www.blueberries.msu.edu

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