The content of this article was prepared by the Oregon State University Extension Service.

Pacific Northwest blueberry growers must identify and control a number of bacterial and fungal diseases in order to ensure the highest yields possible (profitable yields). Fortunately, only a few of the diseases that occur on highbush blueberry in this region cause significant losses when left unchecked.

You can control fruit and foliar diseases with proper cultivar selection, cultural practices, and fungicides. Stem and root diseases are more difficult to control, but you can reduce their severity by using disease-free planting stock, promoting good plant growth, diligently removing and destroying infected plant parts, and selecting well-drained field sites. Organic growers can use all these tactics except synthetic pesticides. Check with your certifying agency for accepted chemical applications.

Bacterial diseases

Bacterial canker

This disease is caused by the bacterium *Pseudomonas syringae pv. syringae* and is a problem in production areas west of the Cascade Mountains. Bacterial canker can be particularly severe on young plants in new plantings because a high proportion of the wood is succulent and susceptible to disease. Wounded tissues provide entry sites for the pathogen into the plant. Disease severity in the spring is often greater following frost injury the previous fall. Only canes produced the previous season are attacked. It is important to prune out all diseased wood as soon as it is noticed, especially before fall rains. Prune susceptible cultivars during dry weather if possible. Avoid late-summer nitrogen fertilizer applications that can lead to winter injury. Several products can be used for chemical management, but all have copper as an active ingredient. Multiple applications, low rates or both encourage resistance to these products. Spray twice, first before fall rains around the first week in October and again four weeks later.

Crown gall

Crown gall in blueberries is caused by the soilborne bacterium *Agrobacterium tumefacien*s. Agrobacterium infects through wounds on the stems and roots, causing knobby galls to form. The pathogen is spread by splashing rain, irrigation water, infested tools and

equipment, and on contaminated cuttings or grafting stock. Disease control begins with an inspection of incoming nursery stock. Reject any plants that have galls. If possible, avoid planting in fields where Agrobacterium has been a problem. Inoculum in infested fields can be reduced but not completely eliminated by:

- Rotating to grasses or grain crops for at least two to three years.
- Soil solarization.
- Using soil fumigation before replanting to blueberry.

Biological control with Agrobacterium radiobacter strain K84 or K1026 can additionally protect new plants for the first year after planting. In established fields where the pathogen is known to occur, prune only during dry weather and disinfect pruning equipment frequently. Prune off and destroy any galls that develop.

Fungal diseases below ground

Armillaria root rot

Armillaria root rot of blueberry is caused by several species, including *Armillaria mellea* and *Armillaria gallica*. These are soilborne fungi that infect through the roots and have the ability to attack many different plant hosts. They are most commonly found on land that has been recently cleared of native vegetation, so these sites are usually best avoided for new blueberry plantings. The pathogen primarily spreads by producing rhizomorphs, which are black, cord-like structures that grow from plant to plant through the soil.

Symptoms of the disease begin with stunting and leaf discoloration and progress to leaf wilting and cane death. Diagnostic white mycelial fans are produced underneath the bark of affected plants (scrape off bark of dying canes to observe) and occasionally clusters of mushrooms are found in the fall.

Control is best achieved by avoidance. Do not plant on sites recently cleared of native forest vegetation. If a recently cleared site must be used, remove as much woody vegetation as possible, including roots, although it's best to leave the land fallow for several years before planting as buried woody debris serves as a source of inoculum. Soil fumigation can also help reduce inoculum, but all large woody roots need to be removed from the soil beforehand for best efficacy. If the disease develops in already established plantings, infected plants should be uprooted and burned. Remove as much of the root system as possible and do not replant in locations where infected plants were found.

Phytophthora root rot

Phytophthora root rot is caused by the soilborne pathogen *Phytophthora cinnamomi*. This is a warm weather pathogen that does not survive well where soils freeze deeply in winter.

It has a wide host range that can infect many tree and shrub species. *Phytophthora cinnamomi* is spread in contaminated water, soil, and on infected nursery stock. Once in the soil, it can survive for many years. During periods of high soil moisture, spores produced swim towards nearby roots, where infection occurs. Rot can then progress from the fine root system up into the larger roots and, in severe cases, up into the stems.

Symptoms are usually most severe on young plants and include stunting, chlorosis and scorch. When soil moisture is abundant and temperatures are warm, wilting and cane death may occur. However, older plants with larger root reserves can survive the disease for years.

Once the pathogen is in a field, it is almost impossible to eradicate. Inspect all incoming nursery stock for infection and reject any plants that appear diseased.
Because *Phytophthora* is mostly a problem of wet sites, select fields with good drainage, avoid heavy soils with high clay content, use sprinkler or microspray irrigation systems instead of drip, and do not overwater. Raised beds, drainage tiles, and compost amendment can also improve soil aeration.

Systemic fungicides help protect new plantings from infection when the pathogen is present. However, once application stops, the pathogen can resume growth and cause damage. In organic production systems, gypsum soil amendment at 1-10 tons/acre can reduce infection but not to the same extent as fungicide application.

Cultivars with some resistance to the pathogen are also available. Mulching with composted sawdust or bark mulch instead of black weed mat may reduce infection by keeping the soils cooler. Black weed mat maintains higher soil temperatures that are favorable to the pathogen. Finally, inspect fields periodically and dig out and destroy plants with more than 50% mortality.

Fungal diseases above ground

Alternaria fruit rot

The fungus *Alternaria tenuissima* has caused severe losses in some Pacific Northwest fields,

although it is not as common as ripe rot. The fungus overwinters as mycelium and spores in old, dried-up berries, dead twigs from the previous season's crop and on other plant debris. Infections can occur any time between late bloom through fruit maturity.

Infections remain quiescent (latent) until fruit ripens. The disease often develops in storage or in transit to market. Damaged fruit may be covered with a blackish or dark greenish mass of spores that gives the surface of the berry a dull cast. Although berries may be dry in the field, the rot can become watery when harvested fruit is stored.

- Harvest promptly to prevent overripe fruit.
- Do not pick or handle fruit when it is wet.
- Hand harvesting results in less rot than machine harvesting.
- Avoid wounding or bruising fruit during harvest.
- Cool berries rapidly after harvest.
- Clean plant debris from picking buckets, packing lines and inspection belts frequently.

A wide variety of synthetic fungicides are registered for use after full bloom when berries are developing. Bloom applications have not been very effective.

Botrytis blight

The fungus *Botrytis cinerea* survives as sclerotia (resistant survival structure) and dormant mycelia on dead twigs of bushes and prunings. Spores spread primarily by wind but also by splashing water.

Susceptibility is highest during bloom and again near harvest. Cultivars that tend to retain floral structures over a long period are more susceptible. Also, branch tips killed by low winter temperatures are easily infected. Blueberry blossoms take on a brown, water-soaked appearance and die. Blossoms may be covered with dense grayish powdery masses of *Botrytis* spores. Infections may move through the blossoms rapidly and often destroy the entire floral structure. The disease also can move from blossoms back into fruit-producing wood.

Infected succulent twigs are at first brown to black and later bleach to tan or gray. Symptoms can be seen after winter injury or before floral bud break. When planting a new field, space plants for good air circulation and quick drying. Annually prune to remove infected twigs and to open the canopy for good air circulation. Adjust timing or frequency of overhead irrigation to keep aboveground portions of the plant dry. Drip irrigation will also keep flowers and above-ground portions of the plant dry. Pick fruit at correct stage of

maturity and move harvested fruit to cold storage as soon as possible.

A wide variety of synthetic and some organic fungicides are registered for use from prebloom through the end of bloom. A preharvest application is useful to control fruit rot after harvest.

Fusicoccum canker (or sometimes still called Godronia canker)

The fungus, *Fusicoccum putrefaciens*, can interfere with new plantings in British Columbia and Washington. It is less serious in established fields because only new wood can be infected. However, disease incidence has been increasing in older fields since the late 1980s.

The fungus overwinters in cankers on stems and crowns of infected plants. Conidia are released from pycnidia in wet weather and disperse by splashing rain. Conidia infect stems primarily at leaf scars from March through June. Natural openings in the bark also may serve as infection sites. Infections appear on current-year stems at bud sites or wounded areas as small reddish-brown lesions in early spring. As these cankers enlarge, the centers usually become gray and the margins turn reddish brown or dark brown, giving the canker a bulls-eye appearance.

Small, dark, pimple-like pycnidia can frequently be found in the canker. Purchase healthy, certified planting material and do not use plants with injured branches. Sanitation is critical for successful management. If cankers are found, prune out and destroy cankered branches. Avoid overhead irrigation, using drip if possible. No fungicides are registered for control. Research in British Columbia indicates that broad-spectrum fungicides with multi-site modes of action used for control of other diseases are effective. Management of other diseases in the spring may indirectly be controlling this disease.

Mummy berry

The fungus *Monilinia vaccinii-corymbosi* overwinters in mummified fruit (sclerotia) on the ground. In early spring, about the time buds begin to break, fungal fruiting cups (apothecia) grow from overwintering mummies in or near the soil surface. Ascospores from apothecia infect leaves and flowers shortly after buds open.

Infected flowers turn brown and wither as if they had been frosted. Leaf and shoot growth expanding from newly opened leaf buds are blackened in the center and eventually wilt and die. About three weeks after primary infection, a brownish gray mass of spores develops on

blighted flower stalks and leaves. These spores are spread by wind, rain, and various insect pollinators to healthy flowers.

Flowers are most susceptible just as they open. During early berry development, diseased fruits look like healthy ones; if cut open, however, the spongy white fungal growth can be seen within the carpels. As berries approach maturity, infected berries become a reddish buff or tan color in contrast to the waxy green of healthy fruits. Many of the diseased berries fall before healthy berries are harvested. Mature mummified berries are gray, shriveled, and hard.

Plant resistant cultivars and remove susceptible cultivars such as ‘Berkeley’ from mixed plantings. Disruption of the developing apothecia with physical or chemical tactics can help the overall management of mummy berry. In fall, before leaf drop, shallowly cultivate to bury mummies. In early spring between bud break and bloom, destroy developing apothecia by disrupting the soil under plants or in alleyways by raking or cultivating the soil. Some growers drag chains along the ground to disrupt the developing apothecia.

Harvest and destroy mummified fruit from bushes before they drop to the ground. This practice may take several years before a benefit can be realized but has been effectively used by some organic growers. Before moving to a new field, remove and destroy plant debris that accumulates on harvester machines. Also in spring, destroy any cull piles near packing houses. A wide variety of synthetic and some organic fungicides are registered for use to protect blossoms and foliage from bud break to end of flowering.

Ripe rot (sometimes still called anthracnose)

The fungus *Colletotrichum acutatum* can appear on fruit before harvest (ripe rot), but more often appears as a post-harvest fruit rot. Warm, wet conditions favor disease spread and buildup. Spores are dispersed by splashing rain or irrigation.

Infection can occur at any time during bloom and berry development. Berry infections remain quiescent (latent) until fruit is nearly mature. Blighting of shoot tips may be observed first. Then, a few flowers turn brown or black.

As infected berries ripen, the flower end may soften and pucker. Under warm and rainy conditions, salmon-colored spore masses form on infected berries. However, there may also be no indication of disease prior to harvest. After harvest, spore masses form rapidly on infected fruit when in cellophane-covered baskets or in plastic clamshell packs.

A combination of cultural and chemical practices combats losses from this disease. Prune bushes for adequate airflow and to reduce drying time after becoming wet. Avoid overhead irrigation or apply such that plants are not wet for extended periods of time. Lower the temperature of harvested fruit as soon as possible after picking. A variety of synthetic fungicides are registered for use during bloom. Applications may be needed after bloom in, especially wet years.

Silver leaf

Silver leaf was confirmed for the first time in 2014 on ‘Draper’ and ‘Liberty’ blueberry, although samples with these symptoms had been noted since 2009. The fungus (*Chondrostereum purpureum*) invades cut or wounded stems and limbs of a wide variety of plants including blueberry.

Small bracket-like fruiting bodies are produced in the fall and winter during moist weather. Spores are blown for miles, germinate and enter fresh surface wounds such as pruning cuts, mechanical injury, winter injury or insect damage. Pruning cuts are most susceptible within a week of wounding.

After infection, fungus growth is systemic into the root crown of the bush. During the summer the top surface of young leaves turns silvery. Symptoms may start on one of two branches, which show reduced growth and die in two or three seasons. New branches on the same plant continue to develop symptoms until the whole bush is affected.

The heartwood of infected stems may turn brown or exhibit purple to brown concentric rings of discoloration. This discoloration is more accentuated at the base of bushes and branches. Rogue out and destroy symptomatic plants. Destroy all dead wood removed from 'Draper' fields. Burn prunings because the fungus will fruit only on dead wood and pruning piles are often the source of reinfection in other fruit systems.

Twig blight

The fungus *Phomopsis vaccinii* overwinters in infected plant debris. In the spring, spores are dispersed from fruiting bodies (pycnidia) embedded in diseased tissue by rain splash and irrigation water. Infection occurs through flower buds from bud break to bloom.

The disease spreads from flowers into shoots and twigs. The fungus can also infect through injuries such as wounds from pruning, harvest equipment, frost cracks, and herbicide injury and produces girdling cankers. Cankers may be present at the base of infected canes.

Cankers are seen as elongated, flattened areas that become covered with small, pinpoint-sized fruiting bodies (pycnidia) that produce spores.

Infected stems wilt during the summer and the leaves turn color earlier, causing a red flagging. Purchase healthy planting material and do not use plants with injured branches. Provide adequate plant spacing and manage canopy size to promote good air circulation. Prune out, remove, and destroy infected and dead branches. Avoid wounding or injuring plants. Encourage plants to harden off in winter to avoid frost damage. A variety of synthetic fungicides are registered for use during bloom. The fungus may be active anytime it rains in the spring from bud break to harvest but focus applications during bloom.

Minor fungal diseases

These are not generally a problem but be aware that these diseases can be troublesome in certain situations:

Double spot

The fungus *Dothichiza caroliniana* will cause roughly circular leaf spots in early summer that are light brown to gray and are outlined by a dark brown ring. No control is recommended unless disease incidence is high. Fungicides applied to control fruit rot also should aid in reducing double spot.

Leaf rust

The disease is caused by the fungus *Pucciniastrum vaccinii*, and it can attack all Vaccinium species. The alternate host for the rust fungus in this region is hemlock (western or Pacific hemlock, *Tsuga heterophylla*, and the mountain or black hemlock, T. mertensiana).

Spores form on the lower surface of the leaf in yellowish-orange pustules that become rusty red with age.

Powdery mildew

Powdery mildew is caused by *Microsphaera alni*. Because this disease usually develops after most of the fruit is harvested, it has little impact on production except when both disease incidence and severity are very high.

Stem canker

The disease, caused by *Botryosphaeria corticis*, has not been a problem in the Pacific Northwest, but has been found in Oregon. Reddish conical swellings appear in summer and fall on current-year canes. The lesions enlarge and become fissured in the second year, giving the cane a rough, blistered appearance. Prune out and destroy infected branches.

Twig canker

The fungus *Sporocadus lichenicola* can infect blueberry plants suffering from winter injury, sunscald, or damage from other sources. The fungus has been found sporadically in the Willamette and Hood River valleys of Oregon. Twigs have multiple grey-white cankers with reddish margins associated with nodes and range from 1 cm to the entire length of the twig. Tactics that minimize winter or other injury to plants are encouraged.

Witches' broom

This disease is caused by a rust fungus *Pucciniastrum geoppertianum*. Stems swell, and there is excessive branching, giving the witches' broom effect. True firs (*Abies* sp.) are the alternate hosts. Both hosts are required for the fungus to complete its life cycle. Because the fungus becomes systemic and perennial, the only method of control is to remove and destroy infected plants.