

# Highbush Blueberries

## GENERAL INFORMATION

There are two types of blueberries grown in New England. Highbush blueberries (*Vaccinium corymbosum*) are discussed here. For information on lowbush blueberries (*V. angustifolium*, *V. myrtilloides*), contact David Yarborough at the University of Maine Cooperative Extension in Orono, Maine, Sonia Schloemann at the University of Massachusetts Extension in Amherst, Massachusetts, or William Lord at the New Hampshire Cooperative Extension in Durham, New Hampshire.

New England is considered the northern edge of the climatic zone in which highbush blueberries can be grown. As a result, a number of disease problems associated with cold stress, particularly the canker

diseases, are more common here than in other blueberry growing areas. High soil acidity (low pH) and a relatively high organic matter are essential for optimum production. Soils should be well-drained if wet. When these soil conditions are suboptimal, disease increases. Pruning out small twiggy wood and unproductive older canes is generally helpful in controlling fungus diseases on blueberries.

The blueberry has very specific soil requirements, dictated by its unique root structure. The blueberry root system is composed primarily of fine, fibrous roots near the soil surface. These fibrous roots lack root hairs, so the root system has a relatively low absorptive capacity. Blueberry roots are unable to penetrate compacted soils and have limited tolerance to excessively wet or dry soils. The shallow root system is sensitive to both high and low temperature extremes.

The ideal blueberry soil is a well-drained, yet moist sandy loam soil with a pH of 4.5 to 5.2. Soil organic matter levels should be augmented through the use of pre-plant green manuring and the addition of peat moss at planting. In addition, a permanent organic mulch (wood chips, bark, sawdust, pine needles) layer 3 to 4 inches thick is required to protect roots from high temperature injury in summer and cold temperature injury in winter as well as reduce moisture stress.

Fertilizer is generally applied in a split application, reducing the risk of root burn that can accompany a single large application. The first is applied at bloom and the second one month later. Ammonium sulfate (21% N) or urea (45% N) are used as the principal fertilizers.

**Table 24.** Recommended optimal soil characteristics for growing blueberries.

Soil Characteristic	Desirable Range*
pH	4.5 - 5.2
Organic matter	4 to 7%
Phosphorus	20 - 30 ppm
Potassium	100-120 ppm Base Saturation 3.0-5.0
Magnesium	100-120 ppm Base Saturation 2.0-4.0
Calcium	800 - 1000 ppm Base Saturation 20-30

\*Desirable range will vary with soil type (sand, silt, or clay), soil organic matter, and pH.

**Table 25.** Amount of sulfur (in lb/100 sq ft)<sup>a</sup> required to lower soil pH for blueberries.

Present soil pH	DESIRED PH VALUE FOR BLUEBERRIES					
	4.5			5.0		
	Sand	Loam	Clay	Sand	Loam	Clay
4.5	0.0	0.0	0.0			
5.0	0.4	1.2	1.4	0.0	0.0	0.0
5.5	0.8	2.4	2.6	0.4	1.2	1.4
6.0	1.2	3.5	3.7	0.8	2.4	2.6
6.5	1.5	4.6	4.8	1.2	3.5	3.7
7.0	1.9	5.8	6.0	1.5	4.6	4.8
7.5	2.3	6.9	7.1	1.9	5.8	6.0

<sup>a</sup>To convert to lb/A, multiply by 435

**Table 26.** Number of blueberry plants per acre at different spacings.

Feet Between	Spacing Between Rows		
	8 FEET	10 FEET	12 FEET
PLANTS IN ROW			
4	1,361	1,089	908
5	1,089	870	726
6	908	726	605

**Table 27.** Critical nutrient values for blueberry tissue analysis.

Element	Deficient	Below Normal	Normal	Above Normal	Excessive
N (%)	1.65	1.70	1.90	2.10	>2.10
P (%)	0.05	0.06	0.10	0.18	>0.18
K (%)	0.35	0.40	0.55	0.65	>0.65
Ca (%)	0.35	0.40	0.60	0.80	>0.80
Mg (%)	0.18	0.20	0.25	0.30	>0.30
Mn (ppm)	45	50	250	500	>500
Fe (ppm)	65	70	200	300	>300
Cu (ppm)	4	5	11	15	>15
B (ppm)	29	30	40	50	>50
Zn (ppm)	14	15	25	30	>30

Source: PennState University

## DISEASES

### Fruit

**Mummy Berry** (*Monilinia vaccinii-corymbosi*): Mummy berry is increasingly important in some parts of New England, and its severity varies from year to year. It is caused by a fungus which attacks new growth, foliage and fruit, and can cause extensive losses.

The fungus overwinters in mummified fruit on the ground. The mummies form cup or globe-shaped structures called apothecia. Apothecia produce spores that infect young tissue and cause rapid wilting. This is called leaf and twig blight, or bud and twig blight. These symptoms are difficult to distinguish from frost injury. These first infections form more spores, which are spread by rain, wind and bees to blossoms and other young tissue. The fungus infects and invades the developing fruit. The fruit becomes malformed looking like a pumpkin, and turns salmon or grey by midsummer. By fall, these fruit have dropped to the ground where they turn to mummies, ready to produce apothecia the next spring.

**Management:** Cultural controls can be used to reduce inoculum levels in the spring. In very small plantings, mummies can be raked up and burned. On a larger scale, mummies can be buried by cultivating between rows or by covering with a new layer of mulch at least 2" in thickness. Combining cultivation and an application of 50% urea prills in the spring speeds destruction of the mummies. Urea should not be applied to areas where there is standing water, as this may cause fertilizer burn. Apply urea to drier parts of the field and go back to the wet areas later. The cultivation should be done just as apothecia start to emerge in the spring, which usually coincides with bud-break in the blueberry bushes. Cultivars exhibiting resistance to the shoot blighting phase of the disease include Jersey, Elliott, Bluejay, Duke, Stanley and Darrow. Cultivars which appear to be more susceptible are Bluehaven, Bluegold, Northblue, Sierra, Harrison, and Coville.

No fungicides are currently (1998) labeled for use against the primary infection, or shoot blight, phase of this disease. Secondary infections (blossom blight) can be treated with fungicides listed in Table 30. Check

**Table 28.** Highbush blueberry variety descriptions for New England.

Variety	Hardiness	Comments
Berkeley	Fair	Late mid-season; productive, easy to propagate, large, light blue fruit.
Bluecrop	Good	Midseason; med. size, firm berries; some resistance to virus and mummy berry.
Bluegold	Excellent	Late mid-season; very productive, firm, round fruit, sky blue, small scar.
Bluejay	Good	Early to midseason; med. size, firm fruit; some resistance to virus and mummy berry.
Blueray	Excellent	Midseason; large, dark fruit, good flavor, spreading habit, branches may bend to ground with fruit.
Bluetta	Good	Early season; large fruit, good quality; some resistance to mummy berry.
Brigitta Blue	Fair	Late mid-season; Berries medium large, light blue, slightly tart, small dry scar, firm; stores well.
Collins	Excellent	Early mid-season; moderate production, large, firm fruit, with good flavor and small scar.
Coville	Good	Late season; large firm fruit, medium scar, good tart flavor. Erratic production, suitable for mechanical harvest.
Darrow	Good	Late season; very large fruit, light blue, firm, with a large scar, excellent tart flavor.
Duke	Good	Early season; vigorous, very productive. Fruit is large, light blue, firm, mild flavor.
Earliblue	Good	Early ripening; large, firm fruit with fair flavor; upright, vigorous growth.
Elliott	Excellent	Very late-season; heavy producer of medium size, powder blue, very firm, slightly tart fruit; small, dry scar.
Herbert	Excellent	Late season; large fruit, good quality; some resistance to mummy berry.
Jersey	Good	Mid to late season; med. size berries, firm with fair flavor; tall, upright plants.
Lateblue	Excellent	Late season; moderate yield, flavor and scar are good.
Meadar	Excellent	Midseason; large, firm fruit, good flavor; erect, vigorous growth
Nelson	Excellent	Mid to late season; large, firm fruit with good flavor; productive, upright plants.
Northblue	Excellent	Mid-season; semi-dwarf bush, fruit large, dark blue, with a "wild" blueberry flavor.
Northcountry	Excellent	Mid late-season; medium sized fruit, sweet and mild, moderate vigor.
Northland	Excellent	Early mid-season; semi-dwarf bush, fruit medium blue, medium size, very sweet. Bush very productive.
Northsky	Excellent	Mid late-season; fruit sky blue, small to medium in size, stores well.
Patriot	Excellent	Early to midseason; large, firm fruit, good flavor; growth is slow, small plants; some resistance to root rot.
Spartan	Good	Early season; fruit very large, high quality, excellent flavor; well adapted to machine harvest.
St.Cloud	Excellent	Mid late-season; tallest of the half-highs, moderate yields, fruit medium blue, medium sized, well flavored, with a small dry scar. Stores well.
Toro	Good	Mid-season; fruit large, firm, exceptional color and flavor, concentrated ripening.

with your state's Extension Specialist for available fungicides at that time.

**Botrytis Blight/Gray Mold** (*Botrytis cinerea*):

As with other small fruits, *Botrytis* primarily affects blossoms and ripening fruit, although under certain circumstances the fungus can cause stem blight as well. Infection occurs largely during bloom on flowers. The fungus survives the winter on dead twigs and in soil organic matter. It is present every year, but only causes severe damage during cool, wet periods several days in duration. The most critical period for infection is during bloom. Disease is most severe where excessive nitrogen has been used, where air circulation is poor, or where frost has injured blossoms. Rotted berries typically have a gray cast of the mycelium and spore-bearing structures present which gives the disease its

name. Stem symptoms are hard to distinguish from those infected by *Phomopsis*, and the fungus usually must be isolated from the infected tissue in a diagnostic laboratory. Varieties possessing tight fruit clusters (for example, Weymouth, Blueray and Rancocas) are particularly susceptible to the disease.

**Management:** When weather or history indicates that *Botrytis* will be a problem, fungicides should be applied, starting at mid-bloom, with subsequent sprays at 7-10 day intervals through petal fall. See pest management schedule for recommended materials and timing.

**Anthracnose** (*Colletotrichum gloeosporioides*):

This fungus primarily damages fruit but may also infect twigs and spurs. It causes a salmon or rust-colored berry rot which can also ruin fruit quality.

Infested fruit often exhibit a soft, sunken area near the calyx-end of the fruit. Spores spread to “good” fruit during and after harvest, causing significant post-harvest losses. The disease is especially prevalent during hot muggy weather and frequently occurs post-harvest.

The anthracnose fungus, *Colletotrichum gloeosporioides*, overwinters in dead or diseased twigs, fruit spurs, and cankers. Spores are released in spring, and are spread by rain and wind. Blossoms, mature fruit and succulent tissue are infected, and spores may be spread from these infections. Blossom clusters will turn brown or black. Infected fruit shows bright pink spore masses at the blossom end. Stem cankers are rare (but are about 1/8" in diameter, with raised purple margins when they are present). Young girdled stems die back, resulting in a brown withering of the leaves. Berkeley, Coville, Bluecrop, Blueray, and Jersey are particularly susceptible to the disease. Varieties in which the fruit hangs ripe for a long time on the bush prior to picking are especially susceptible. No varieties may be resistant when the weather conditions are favorable for the disease.

**Management:** The disease is controlled primarily through the use of fungicide applications, though pruning small twigs and harvesting frequently are beneficial. Old canes and small twiggy wood should be cleared out in order to increase air circulation around the fruit clusters. See pest management schedule for recommended materials and timing.

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## Stems and Foliage

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### **Fusicoccum Canker** (Godronia Canker):

*Fusicoccum* is a fungus which infects blueberry stems causing dieback and plant decline. Losses from this disease can be serious. The fungus overwinters as mycelium in cankers on living plants. In Massachusetts, spores are released from March to mid-July, and infection probably occurs during this period. Spores are largely disseminated by rainwater. New infections occur following rains throughout the time tender new tissue is present and temperatures are at 50-72½ F. New infections can occur throughout the growing season. Cold stress may play a part in increasing disease damage. Leaves turn reddish-chocolate when dry and often hang-on late into the fall.

Symptoms of *Fusicoccum* canker are similar to *Phomopsis* canker on blueberry. The most unique symptom is a red-maroon-brown lesion centered around a leaf scar. A bulls-eye pattern often results. As

the lesion enlarges, the margin remains red and the center turns gray and dies. On young (1-2 year old) stems, extensive stem infections quickly lead to flagging and dieback of the entire stem. On warm, dry days shoots will suddenly wilt and die due to the stem girdling.

**Management:** Sanitation is essential. A fungicide program should be used where incidence of the disease is high. Apply at 2-week intervals from late dormancy to petal-fall. Varieties differ in their resistance to this disease. See pest management schedule for recommended materials and timing.

### **Phomopsis Twig Blight** (*Phomopsis vaccinii*):

This disease may be the most prevalent of the canker diseases at the present time. The fungus *Phomopsis* causes stem damage similar to that caused by *Fusicoccum*.

Spores from old cankers are released in spring and, to a limited extent, in summer. Most spores are released from bud swell to petal fall, and none are released after September 1. Rain is necessary for spore release, and temperatures ranging from 70-80½ F encourage infections. The disease is most severe after winters in which mild spells are interspersed with cold weather. Periods of hot, dry weather during the growing season probably also predispose the plants to a certain degree. The fungus overwinters in infected plant parts.

Symptoms first appear on smaller twigs, and the disease spreads into larger branches and may affect the crown. It is possible for *Phomopsis* to spread downward in injured canes to the crown and then progress upward on new canes. This rarely occurs, usually only where the crown itself has been injured after a particularly severe winter, or in highly susceptible varieties. Younger tissue may show no symptoms at first, then exhibit rapid wilting and dieback. Lesions, somewhat similar to those caused by *Fusicoccum* but generally lacking the bull's-eye pattern, may appear on the stems. Leafspots have also been observed where disease is particularly severe. The disease will cause premature ripening of the berries. Earliblue, Coville, Bluecrop, Blueray, Jersey and Berkeley are susceptible to the disease. Weymouth may be the most susceptible variety.

**Management:** Since mechanical damage and cold stress seem to be necessary for *Phomopsis* infection, avoid careless pruning and cultivating, and do not fertilize late in the summer. Pruning the weakest canes to the ground is best for the long-term production of

the bush. Keep the plants well-watered through prolonged periods of dry weather in the summer. Avoiding any stresses will help prevent this disease. Cultivars which appear to be more resistant include Bluejay, Jersey, Duke, Pioneer, Darrow, Elliott, Stanley, Bluetta, Wareham, Rubel, Cabot, Rancocas and Pemberton. Benlate applied at 1 lb/A every three weeks from bud break until early August is effective at reducing disease incidence. Dormant sprays of lime sulfur also help to reduce inoculum of the pathogen. A fall application can be made when most of the leaves have dropped. Spring applications should not be delayed until warm weather occurs, or injury may result. See pest management schedule for recommended materials and timing.

**Coryneum Canker** (*Coryneum microstictum*): This canker disease appears to be uniquely situated in the southeast part of New England. No estimates of loss from the disease are available; it is not regular in occurrence and the fungus often occurs in conjunction with other canker fungi.

The symptoms are similar to other canker diseases. The cankers are commonly seen on sun-scalded or cold-stressed bushes where the fungus produces spores in specialized structures. Wounds are apparently necessary for infection.

**Management:** Cultural practices which maintain vigorous growth without stimulating too much succulent growth are recommended for this canker disease as well as the others. (See the *Phomopsis* section). No chemical controls are specifically recommended.

**Powdery Mildew** (*Microsphaera vaccinii*): This disease affecting primarily the leaves is uncommon in New England, although localized outbreaks of the disease may occur in certain fields when weather conditions are favorable for infection by the fungus. The symptoms include a white fungal growth on the upper leaf surface, puckering of the leaves, and reddish spots on the leaf. When severe infection occurs, defoliation may occur.

**Management:** Some cultivars are more resistant than other cultivars. Well-timed fungicides will also control the disease.

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## Roots

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**Phytophthora Root Rot** (*Phytophthora cinnamomi*): This disease is usually associated with poorly drained areas of a field. Symptoms are noted on the roots and on the above-ground portions of the plant. The very fine absorbing roots turn brown to black; larger diameter roots may also be discolored. In severely infected bushes, the entire root system is reduced in stature and is totally black. Above-ground symptoms include chlorosis and reddening of the leaves, smaller leaves, defoliation, branch dieback, death of entire canes, stunting, and death of the entire bush. The disease may be present in a few infected plants scattered throughout the planting or localized in group of plants in a low lying area of the field. The disease is worst where plants are growing in heavy clay soils.

*Phytophthora cinnamomi*, in addition to attacking blueberry, attacks a number of additional susceptible Ericaceous hosts, including rhododendron, azalea, and cranberry. Lowbush blueberry appears to be immune. This species of *Phytophthora* is not an important pathogen on any other small fruit covered in this guide. The fungus thrives in wet soils and can survive for a long period of time.

**Management:** The disease is avoided through careful site selection before planting. Heavy soil which becomes waterlogged or suffers from a high water table should be avoided when selecting a site. Internal and surface water drainage should be improved. Plants can be grown on raised beds if desired. Most varieties are susceptible to the disease, although some varieties may better tolerate heavy infections. Bluecrop and Weymouth are two varieties which have shown promise. Metalaxyl (Ridomil) should be used at planting if problems with *Phytophthora* root rot are anticipated. In both new and established plantings, it should be applied twice per growing season to remedy infection.

**Armillaria Root Rot** (*Armillaria mellea* and *A. ostoyae*): Although this disease is uncommon, it can cause serious injury to plants in fields where the fungus is present in the soil. To date, the disease has only been found in fields which were originally pine/oak forests.

Infected bushes usually decline over several growing seasons, and their symptoms can be confused with those caused by winter injury, *Phomopsis* twig blight, or a nutritional imbalance. Affected plants will

**Table 29.** Fungicides registered for use on blueberries and their primary uses.

Fungicide	Anthrachnose	Botrytis	Phomopsis	Mummy Berry***	Phytophthora	Powdery Mildew
Aliette	+	-	-	-	+	-
Benlate	-	+	+	+	-	-
Captan	+	+	-	-	-	-
Lime sulfur*	-	-	+	-	-	-
Orbit**	-	-	-	+	-	-
Ridomil	-	-	-	-	+	-
Sulfur	-	-	-	-	-	+
Ziram	+	-	-	+	-	-

\*Use lime sulfur only on late dormant or dormant bushes. Do not mix with oil.

\*\*Orbit is allowed in blueberries under Section 18 Emergency Exemptions on a state by state basis. Check with your Extension Specialist.

\*\*\*Orbit is effective for the shoot blight phase; Benlate and Ziram are effective for the blossom blight phase.

be chlorotic, have smaller-than-usual leaves, and be more susceptible to other stresses than healthy-appearing plants. Branches may suddenly wilt, followed by plant mortality in some instances. The disease may be found throughout an entire field, or it may be confined to one or a few area(s). The most important diagnostic characteristics are the presence of the fungus: white mycelial fans underneath the outer bark or the crown of the plant, black rhizomorphs (resembling shoestrings) attached to the roots or the trunk, and yellowish-brown mushrooms produced at the base of the plant in late summer or early autumn.

Two species of the fungus, *Armillaria mellea* and *A. ostoyae*, are probably causal agents of the disease. The fungus survives in the soil on root pieces of susceptible hosts (pine, oak, etc.). The fungus can infect bushes through root grafts and it can survive on wood chip mulches.

**Management:** The disease is best avoided by thoroughly discing the soil where blueberries are to be planted, and removing as many of the root fragments as is possible. If possible, leave the field fallow three years after the trees have been removed. Soil sterilants or fumigants are effective at killing the fungal inoculum. The disease is very difficult to control once it is present in a field. Dead or dying plants should be removed, and adjacent plants should be inspected at the soil-line for mycelial fans or rhizomorphs. Remove any plants which have these signs of the pathogen. Wood chip mulch should be removed from infection "hot spots." Although spot fumigation might be effective, chemical controls are usually not feasible in fields where the disease is present. Most varieties are probably susceptible to the disease.

## Viruses and MLOs

**Blueberry Shoestring Disease:** This viral disease was originally described in New Jersey. In Michigan, the disease has been found in 0.5% of the bushes; an assessment has not been done for potential losses due to the virus.

The most common symptom is an elongated reddish streak along the new stems. The leaves may also show red banding or a red-purple oak-leaf pattern. Diseased leaves are narrow, wavy and somewhat sickle-shaped. Flowers may be red-streaked, and berries turn purple prematurely. Within a few years, berry production drops dramatically.

**Management:** Other than buying disease-free plants, destroying wild plants near the planting, and removing diseased plants, controls do not exist. As with most virus diseases, the best controls are preventing disease introduction, and detecting the disease when it is localized in a small portion of the field. The virus has been observed most often in Burlington, Jersey, June, Cabot, and Rancocas. Other varieties may possess field resistance to the disease.

**Blueberry Stunt:** This disease was originally thought to be caused by a virus but it is now known to be caused by a mycoplasma-like organism or phytoplasma. The only known carrier is the sharp-nosed leafhopper, though other vectors probably exist.

Symptoms vary with the stage of growth, time of year, age of infection and the variety. Symptoms are most noticeable during mid-June and late September. Affected plants are dwarfed with shortened internodes,

excessively branched, low in vigor with small downward cupped leaves which turn yellow along the margins and between the lateral veins giving a green and yellow mottled appearance. These mottled areas will turn brilliant red prematurely in the late summer, although the midrib remains a dark bluish-green. Fruits on infected bushes are small, hard, lack flavor, ripen late if at all, and remain attached to the plant much longer than they would on healthy plants.

**Management:** Diseased bushes cannot be cured; these must be removed from the field as soon as a diagnosis has been made. The removal process may facilitate in the further spread of the disease in the field. Agitation of the bush will dislodge the leafhoppers, causing them to hop to a neighboring healthy bush. Infected bushes should be sprayed with malathion or another appropriate insecticide before the bush is removed. Using virus indexed plants is also helpful. Bluetta, Jersey, and Weymouth are particularly susceptible, whereas Rancocas is resistant.

**Red Ringspot:** This is the most widespread viral disease in New Jersey at the present time. The symptoms are very distinctive, including red spots, rings and oak-leaf patterns which usually appear on the older leaves in late June or July. Production of the bush is seriously reduced and the berries become pockmarked and unattractive. Bluetta, Coville and Darrow are susceptible, while Bluecrop, Collins, Jersey, Rancocas and Weymouth are resistant or tolerant to the disease. Infected bushes must be rogued out.

**Mosaic:** Like some of the previously described viruses, this virus is probably indigenous in wild blueberry plants. Infected plants become unproductive. Leaves are brilliantly mottled with yellow, yellow-green and pink areas. Not all leaves will show the symptoms and some branches on an affected bush may be symptomless as well. It may take several years for a bush to show symptoms. The disease appears most commonly in Herbert and Stanley; most varieties appear to have field resistance to the virus. Infected bushes cannot be cured and must be removed promptly.

**Blueberry Scorch (formerly Sheep Pen Hill Disease):** This disease has not been reported in New England, but a description is provided here so that growers will be on the lookout for it. It is localized to fields in New Jersey (it was originally found in a field in the Sheep Pen Hill area), although a similar disease

termed blueberry scorch has been found in Oregon and Washington. These two diseases are related but not identical to each other. Symptoms fluctuate greatly from year to year, and disease has been worst during excessively wet years.

The disease is characterized by dieback of blossoms and young vegetative shoots in the spring followed by a flush of growth in the summer and the development of a necrotic line pattern in the fall foliage. The roots suffer injury, and production of the bushes can be greatly impacted. Weymouth and Bluecrop are known to be susceptible, and Blueray may also be affected.

**Management:** The causal agent appears to be a flexuous rod-shaped particle (probably a virus), and it may be vectored by a leafhopper, although this is merely conjecture at this point. The sole control strategy is to remove affected bushes.

**Witches'-Broom:** Witches'-broom is a relatively minor disease of highbush and lowbush blueberries and other *Vaccinium* spp. in North America. Although heavily infected plants produce no fruit, disease incidence is usually so low that crop losses are negligible. However, nearly 100% of blueberry plants may be infected in fields located near fir (*Abies* spp.) trees, the alternate host of the rust fungus that causes witches'-broom.

Diseased blueberry plants have broomlike masses of swollen, spongy shoots with shortened internodes and leaves reduced in size. The brooms usually begin to develop during the year following infection and then persist for many years, producing infected new growth each spring. Young stems on the broom are initially reddish or yellow, but as the season progresses they become brown and shiny, then dull, and eventually dry and cracked. Heavily infected plants produce no fruit.

**Management:** Because the pathogen is perennial and systemic in blueberry crowns and rhizomes, burning and other pruning methods do not eliminate witches'-broom. The best control strategy is to eradicate the alternate host (fir trees) within 1200 feet of the blueberry plants; this may not be practical, however, in areas where balsam fir is abundant in natural stands or in Christmas tree plantings. Eradication of diseased blueberry plants with a recommended herbicide effectively eliminates the disease from an affected field.

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## Bacteria

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**Crown Gall** (*Agrobacterium tumefaciens*): There is only one bacterial disease which is a significant problem in the Northeast at present: crown gall. The disease is caused by the bacterium *Agrobacterium tumefaciens*. Since blueberries are grown on acid soils, and the crown gall bacterium does not grow well in an acid situation, the disease occurs infrequently.

Globose, pea-size to large galls occur on low branches, twigs, and at the base of canes near the ground. Injured tissue is more likely to produce galls.

**Management:** Sanitation, purchasing healthy nursery plants and maintaining proper soil conditions are the most reliable controls. An antibiotic called Agrocin is available for either soil treatment or for dipping the root systems of bushes prior to planting.

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## Post-Harvest Diseases

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As with most soft fruit, blueberries have particular post-harvest disease problems. There are three fungi which can cause major post-harvest losses in the crop: *Colletotrichum gloeosporioides* (anthracnose), *Botrytis cinerea* (gray mold), and *Alternaria* spp. The diseases can cause up to 30% rot within 7 days of harvest even when refrigeration is used. Without refrigeration, berries can show 15% rot in 3 days.

**Management:** In New England, where virtually all highbush blueberries are sold fresh, well-ventilated containers and refrigeration should be combined with careful picking and handling.

## INSECTS

**Scale Insects** (*Aspidiotus ancyclus* and *Lecanium nigrofasciatum*): These insects appear mound-shaped, of varied colors, and usually measuring 1/8" or less in length. They are found on rough, loose bark of older stems and sometimes on fruit. Infestations can result in reduced vigor and yield of bushes by feeding on the plant's sap.

**Management:** Good pruning is the first step in control of scales on blueberries. Prune out weakened canes. During dormancy or delayed dormancy, apply superior-type oil of 60- or 70-second viscosity at 3 gallons per 100 gallons of water. To avoid injury, apply when there is no danger of freezing temperatures for at least 24 hours after treatment.

**Gypsy Moth** (*Porthetria dispar*): Gypsy moth larvae (caterpillars) are hairy, dark brown to black in color and marked with red and blue spots. They are large in size, from 1/4 to 2" in length, depending on their age. They are found on leaves, buds and stems of bushes. Feeding by the larvae can result in partial to full defoliation and partial to full bud (and fruit) loss.

**Management:** If possible, remove larvae by hand. Remove egg masses when found. If plantings are surrounded by wooded areas known to be infested, apply protectant sprays. Bt-type materials are effective only if eaten by the caterpillars and work best on young larvae. Forestry experts feel that gypsy moth outbreaks should be rare in New England now due to the presence of an introduced natural enemy *Entomophaga maimaiga*.

**Blueberry Blossom Weevil; Cranberry Weevil** (*Anthonomus musculus*): This is a dark reddish brown snout beetle, 1/8" long, with a curved snout. It emerges in spring and feeds and lays eggs in expanding flower and leaf buds. The weevils hide between the clustered buds, and in small infestations they may be difficult to find. Damage results when punctured flowers do not open. Damaged leaf buds produce an abnormal cluster of dwarfed leaves. Adults of the second generation sometimes feed on blueberry leaves.

**Management:** No insecticides are labeled for use against this pest. Disking between rows and raking/hoeing under plants is helpful. Eradication of wild blueberries or other ericaceous plants in the vicinity of the blueberry planting is advised.

**Plum Curculio** (*Conotrachelus nenuphar*): This dark brown snout beetle is about 1/4" long with 4 humps on its wing covers. It is found on developing flower buds and later on developing berries. The larva (caterpillar) bores into the fruit and eats its contents. As a result, a prematurely ripened fruit drops off the bush. This feeding activity on buds and fruit reduces yield.

**Management:** Plum curculio are more abundant where blueberries are located near tree fruit. If possible, plant blueberries away from tree fruit. Spray applications made at petal fall to control cranberry or cherry fruitworm are also likely to control Plum Curculio.

**Cranberry Fruitworm** (*Acrobasis vaccinii*): The cranberry fruitworm larva (caterpillar) is mainly green with some brownish-red coloration on its top surface and measures about 1/2" long at maturity. It is found

within developing and ripening berries. Feeding reduces the crop and spoils marketability of the berries. Eggs are laid in the calyx cup (blossom end) of unripe fruit. Hatching larvae move to the stem end of the fruit, enter, and consume inner flesh entirely. Larvae will consume from 3-6 berries, filling them with brown frass, and web together fruit with silk.

**Management:** When damage is severe, treat in the following year with insecticide. See pest management schedule for recommended materials. Cranberry fruitworm was effectively controlled formerly by picking off infested berries, which were easily detected because of the webbing and their early ripening. This method is still practical in small plantations with light infestations. Elimination of weeds and trash around plants cuts down on overwintering protection for cocoons.

**Cherry Fruitworm** (*Grapholita packardii*): The cherry fruitworm larva (caterpillar) at maturity is orange-red and about 1/4-1/2" long. It is found within developing and ripening berries. Feeding reduces the crop and spoils marketability of the berries. Hatching larvae bore into the calyx cup (blossom end) of the berry, feed until about half-grown, and then move to a second fruit. (This is distinct from the cranberry fruitworm described below.) The two infested berries are usually joined by silk.

**Management:** When damage is severe, treat in the following year with insecticide. See pest management schedule for recommended materials.

**Blueberry Maggot** (*Rhagoletis mendax*): The adult is a black fly about 1/5" long with a pattern of dark and clear bands on its wings. The maggots are white, legless, and about 1/4" long when full grown. Flies alight on fruit to lay eggs under the fruit skin just as the fruit begins to turn blue. Maggots are later found in ripening and harvested fruit. Maggots feeding within developing fruits renders fruit unmarketable. Berries become soft and mushy. Undetected infested berries contaminate pack-out.

**Management:** Red sticky spheres or yellow sticky rectangle traps (available from suppliers listed in appendix) can be used to monitor blueberry maggot populations in the planting. In large bushes, sticky traps should be hung in upper half of the canopy, suspended from wires and about 1-1/2 feet from the outer foliage. All fruit and foliage within 8 inches from the trap should be cleared away, and all traps positioned so that there is as much foliage and fruit surrounding them at this distance as possible. In small

plantings, it may be possible to trap this insect out with sufficient trap density. Consult with your state's regional fruit specialist for further information. Spray recommendations are found in the blueberry pest management schedule.

**Blueberry Tip Borer** (*Hendecaneura shawiana*): In June, before new growth has begun to harden, some blueberry shoots may begin to wilt, arch over, and become discolored, the leaves turning yellowish with red veins and the stems purplish. This injury, which may be mistaken for primary mummyberry infection, is caused by the tip borer. The newly hatched worm, tiny and pink, enters the soft stem and bores channels that may extend for 8 or 10" by autumn and result in the destruction of the stem's fruit-production potential in the following year.

**Management:** Prune out damaged tips as observed and burn infected canes. The standard spray program used for other insect pests normally keeps this pest under control.

**Blueberry Bud Mite** (*Acalitus vaccinii*): Blueberry bud mites are whitish in color and tiny. Unlike other mites, they are elongate and conical, with eight legs bunched near the head at the broad end of the mite. Heavily infested buds have a definite reddish coloration and characteristic rough bumps on the outer bud scales. Eggs and immature and adult mites are present throughout the year. They are generally confined to the buds and blossoms. During the fall and winter, many mites may be found between the scales of a single fruit bud.

Bud mites feed on the surface of the bud tissues and bud scales. Injured buds desiccate and usually produce distorted flowers. These flowers may fail to set fruit, or develop into fruit with rough skins. The potential for damage differs with variety.

**Management:** Plants should be inspected for bud mites in September, before the new buds are well formed. Look for them under bud scales and between bud parts. Economic threshold levels have not been determined for bud mites. Thorough pruning of infested canes provides good control of bud mites. Limited chemical control measures are available.

**Blueberry Stem Gall Wasp** (*Hemadas nubilipennis*): The adult blueberry stem gall wasp is a small (less than 1/8") shiny black insect with delicate wings. It lays its eggs in succulent shoots. Several grub-like larvae develop in closely associated chambers inside the shoot; the larvae release a chemical sub-

stance which induces the shoot to grow abnormally, resulting in a pithy, kidney-shaped gall 3/4 to 1-1/4" long. Pupation occurs within the larval chambers; the new adults bore an exit hole through the gall. Early in the season galls are greenish and spongy to the touch. By fall the galls turn brownish-red and become quite hard. Shoot growth is reduced and the shoot may be diverted at severe angles.

Unchecked, the blueberry stem gall wasp can cause severe reduction in shoot growth and stem vigor. Hundreds of galls can develop on a single bush. Heavy infestations reduce fruit production and result in dense, stemmy growth. Susceptibility to galls may depend on variety. This insect is rarely encountered in fields managed with standard chemical pesticide programs, but it can be a major pest or organically managed fields.

**Management:** Chemical treatments directed toward other pests are generally sufficient to keep stem gall in check. Removal and destruction of gall during normal pruning operations will also control this pest.

**White Grubs Japanese Beetle** (*Popillia japonica*), **Rose Chafer** (*Macrodactylus subspinosus*), **Asiatic Garden Beetle** (*Maladera castanea*), **and others:** White Grubs are the larvae of a variety of beetle species some of which are listed above. The larvae are generally white or cream colored with brown heads and legs, and they hold their bodies in a distinct hooked or C-shape. Stretched out, larger species may be over one inch in length. Many of the species can be determined as larvae by distinctive patterns of stiff hairs on the undersurface of the tip of the abdomen. Some species feed on the roots of plants for more than one year before completing development. Most species overwinter as grubs deep in the soil. Pupae are white to cream colored and have many features of the adult insect. The time of pupation and the emergence of adults varies with species.

Adults of white grubs are known generically as May Beetles, June bugs, chafers, or scarab beetles. The adults of most species feed on the foliage, flowers and fruits of many plants. Japanese beetle and rose chafer adults can be significant pests of blueberry during harvest when they contaminate the berries.

For many years white grubs were a rare problem in blueberry fields, but recently they have become serious pests in some fields, with populations as high as 30 grubs per bush. The grubs consume feeder roots and may also girdle or clip off larger roots. Infested plants may not show any outward signs of injury until a period of drought stress, when the reduced root system

cannot provide enough water to the plant. Damaged bushes show low vigor and reduced production. Adults, especially the Japanese beetle and rose chafer, sometimes become serious pests by consuming leaves and scarring the berries.

**Management:** Unfortunately, sampling for white grubs damages the roots of blueberry bushes. Growers should check new sites for white grubs before establishing a field, and take actions against grubs before planting. Currently, there are no insecticides registered for soil application against white grubs on blueberries. There is great interest in the use of pathogenic nematodes as biological control agents for the grubs. Adults are generally easy to control with foliar sprays, but timing is difficult since these are highly mobile insects that may suddenly appear in the field.

## VERTEBRATE PESTS

**Birds:** Birds are a major pest problem in highbush blueberries. Left unchecked, they can destroy enough of the crop to ruin the profitability of a planting. The loss of chemical deterrents has made bird control a more difficult task in recent times, but effective means are still available.

**Management:** Netting is the most effective way to keep birds out of the planting. Although initial costs can be high, most netting will last for many years if cared for properly. Netting should be hung over some sort of support structure built around the planting. Usually posts are set nine feet above the ground around the perimeter of the planting, and wire is run from pole to pole to form a grid over the planting. The netting is hung over this grid when the fruit begins to turn color. Some temporary nine foot poles may be placed within the planting at intersections of the grid to keep the netting from drooping. Bury the edges of the netting or anchor it to the ground to keep birds from crawling underneath. Remove the netting when the harvest is complete, and store in a cool, dry place.

Visual scare devices have variable effectiveness on birds. Scarecrows, balloons, kites, or stuffed owls may work on certain bird species in certain areas, but none seem to have widespread dependability. When using scarecrows, "scare eye" balloons, stuffed owls, or snakes, put them in the planting only when the fruit begins to ripen, and move them regularly, at least once a day. Six scare-eye balloons per acre are recommended. Take them out of the field as soon as harvest is over. This will reduce the chance of birds becoming accustomed to the devices, and increase the longevity

of their effectiveness. Kites and helium-filled balloons positioned high above the planting with a silhouette of a hawk hanging from them have provided good results in some areas.

Noise deterrents, such as propane cannons, alarms and recorded distress calls seem to have the least effect on birds in blueberries, but may greatly annoy neighbors. A combination of noise and visuals may be effective, however. Several operations have hired people to regularly drive motorcycles and/or ATVs through the plantings when the fruit is ripe, and this seems to keep birds away quite well. Be sure to make drivers aware of where pickers are however, to avoid possible accidents.

Bird Shield™, a new repellent formulated from methyl anthranilate, is currently being registered for use on blueberries, cherries, and grapes. Methyl anthranilate is commonly used as a grape flavoring in human food preparations. Bird avoidance is based on odor quality and irritation. To humans, this chemical has a grape-like or fruit odor and a slightly bitter, pungent taste. Unfortunately efficacy data does not support recommending the use of this material at this time.

**Voles:** Voles can be a serious problem in blueberry plantings. They feed on the bark of the stems or on the roots depending on which species of vole is present. In the Northeast, two species are found: the meadow vole (*Microtus pennsylvanicus*) and the pine vole (*Microtus pinetorum*). They may both be present in a blueberry planting. It is important to determine which species is present in order to make management decisions.

Size and appearance of the two species differ although it is somewhat rare to actually see them. The

meadow vole has a long body (150-195 cm) and long tail, prominent eyes and ears, coarse fur, and is dull gray to chestnut in color with a gray belly. The pine vole has a short body (110-135 cm) and short tail, sunken eyes and ears, fine velvety fur, and is bright chestnut in color with a slate gray belly.

Evidence of their activity is more diagnostic. Meadow voles are active on the surface of the ground, feeding on the bark of the bushes and making shallow trails in the grass or mulch around the plants. Food caches and droppings can be found in these surface trails. Pine voles are active below ground, feeding on roots. Subsurface trails can be found by digging around the bushes. These trails come to the surface where mounds of dirt can be seen. Holes leading into these trails are about 1" in diameter.

Simply finding evidence of voles does not indicate a serious problem. To determine whether the voles are causing serious injury to the bushes, it is necessary to estimate the population of voles present. This requires some specialized sampling. It is best to contact your Extension Specialist for help with this sampling procedure.

**Management:** In some cases, the removal of mulch material around the bushes can help in reducing the meadow vole population. However, this is risky for bushes susceptible to drought stress. In those cases, choosing a mulch material that does not support tunnelling (caves in easily) is recommended. In some New England States, any application of toxicants or poisons for the purpose of killing any mammal or bird is prohibited. However, some toxicants may be allowed under certain situations with the proper permits. Call your Extension Specialist for recommendations.

**Table 30.** Highbush blueberry pest management schedule†.

Dormant and Delayed Dormant			
Pest	Spray Material, Rate/A (pre-harvest interval)	Cultural Practices and Scouting Notes	Comments
Scale Insects	Superior oil, 3% (0) SunSpray Ultra-fine Oil, 3% (0)	Prune out old, weakened canes.	Treat from March 1 to first bloom using 250 to 300 gallons of spray (at 300 to 400 psi) per acre. Apply oil only when no danger of freezing temperatures within 24 hours.
Blueberry Blossom (aka Cranberry) weevil	No insecticides labeled against this pest.	Disking between rows and raking /hoeing under plants helpful.	Eradication of wild blueberries in the vicinity of the blueberry planting is advised.

**Table 30 continued.** Highbush blueberry pest management schedule<sup>†</sup>.

Dormant and Delayed Dormant			
Pest	Spray Material, Rate/A (pre-harvest interval)	Cultural Practices and Scouting Notes	Comments
Mummy Berry	Individual New England States may have Section 18 Emergency Exemption labels for early season fungicides to control Mummyberry. Check with your state's Extension Specialist.	Before mummy cups appear (about March 20), disk between rows and rake, sweep, and hoe under plants.  As first mummy cups appear, apply 200 lbs of 50% Urea prills.	Cultivation and Urea application are most effective when both are used.
Phomopsis twig blight	Lime Sulfur, 5 gal (0)	Prune out affected canes.	Use Lime Sulfur only once in Spring. May be used again in autumn where Phomopsis is a problem.
Fusicoccum canker	Benlate 50W, 1 lb (21) Ziram 76DF, 1.5 lb (*)	Weymouth, Berkeley, Coville, and Jersey cultivars are particularly susceptible to Phomopsis twig blight.  Avoid practices such as late season fertilization that make bushes more vulnerable to winter injury. Winter-injured bushes are more susceptible to Phomopsis and Fusicoccum infections.	Do not use Lime Sulfur within 14 days of an oil spray or when temperatures are above 75½F.  Benlate: The current Benlate label specifically states that Benlate is "not for use in home plantings nor once any commercial crop is turned into U-pick, Pick Your Own, or similar operation." Consult with your state's pesticide office for the relevant interpretation of this restriction.  *Apply Ziram at loose bud scale stage, followed 7 days later. Do not apply later than 3 weeks after full bloom.
Phytophthora root rot	Ridomil Gold EC (45)*  New Plantings, 3.6 pt broadcast at or before time of planting (repeat once)  Established Plantings, 1/4 pt/1000 ft of row, (repeat once)  Ridomil Gold WSP (45)*  New Plantings, 4 lb broadcast at or before time of planting (repeat once)  Established Plantings, 1/4 lb/1000 ft of row, (repeat once)  Aliette WDG, 5 lb (12 hrs)	Do not plant blueberries on wet soils.	Phytophthora damage symptoms may mimic nutritional deficiency symptoms.  Ridomil: Apply only as an emergency use, not as a routine or preventative treatment.  Apply in spring before growth begins in established plantings. In new plantings, apply at or just after planting.  *In new plantings, do not exceed 3.6 gallons/A within 12 months of harvest or illegal residues may result. Read the label.  Alliette: Apply as a 5 ft. band. Do not tank mix Alliette with copper compounds or apply to foliage with copper residues or phytotoxicity may occur. See label for other restrictions

## Pre-bloom

Pest	Spray Material, Rate/A (pre-harvest interval)	Cultural Practices and Scouting Notes	Comments
Blueberry Blossom (aka Cranberry) weevil	No insecticides labeled against this pest.	Disking between rows and raking /hoeing under plants helpful.	Eradication of wild blueberries in the vicinity of the blueberry planting is advised.

## Early to mid-bloom

Anthracnose Botrytis Mummy berry	Combine: Captan 50WP, 5 lb (0) plus Benlate 50WP, 1 lb (21) or Rovral 4F, 1-2 pt (0)  or  Use alone: Ziram 76DF, 3 lb (*) Captan 50WP, 5 lb (0) Captec 4L, 2.5 qt (0)	This treatment will cover for all three diseases (plus Phomopsis for Ziram).  For mummyberry, this spray is designed to prevent flower infections. It is necessary only if primary infections (shoot blight) were not adequately controlled earlier.  Apply Benlate and/or Captan at mid-bloom and repeat at 7-10 day intervals if rain occurs.  Captan has a 0 day phi, but the REI of 24 hrs requires that PPE be worn during this period. See label or section on Worker Protection Standards for details.  Benlate: The current Benlate label specifically states that Benlate is “not for use in home plantings nor once any commercial crop is turned into U-pick, Pick Your Own, or similar operation.” Consult with your state’s pesticide office for the relevant interpretation of this restriction.  Rovral is only labeled for control of Botrytis. Additional applications can be made at 14 day intervals. Do not make more than 4 applications per year.  *Apply Ziram at loose bud scale stage followed 7 days later. Do not apply later than 3 weeks after full bloom.  DO NOT combine (tank mix) diazinon and captan formulations together because berries and leaves will be injured.	
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## Petal Fall (remove honey bees before spraying)

Cherry fruitworm Cranberry fruitworm	Guthion Solupak 50W, 1-1.5 lb (7)  Imidan 70W, 1 1/3 lb (3) °Lannate 90, 0.5 - 1 lb (3) Malathion 57 EC, 1.6 pt (1) Sevin 50WP, 3-4 lb (0) Pyrenone Crop Spray 0.5EC, 2-12 oz (0) *Biobit 1.6 FC 1-2 pt (0) *DiPel 1.9 ES-NT 1-2.5 pt (0)	Disking between rows and raking and hoeing under plants is helpful for fruitworm management.  Remove and destroy infested fruit (which can be identified because it turns prematurely blue)	Fruitworms are active for about five weeks and they cannot be controlled with only one post-pollination spray.  * Bacterial biological insecticides containing <i>Bacillus thuringiensis</i> . Must be ingested to be effective. Apply when newly hatched larvae (1st or 2nd instar) begin feeding. Larvae cease feeding in hours and die in 2-5 days.  Guthion has 48 hr REI for mowing, irrigating, and scouting; and 4 day REI for all other activities.
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**Table 30 continued.** Highbush blueberry pest management schedule<sup>†</sup>.

Petal Fall (remove honey bees before spraying)			
Pest	Spray Material, Rate/A (pre-harvest interval)	Cultural Practices and Scouting Notes	Comments
Mummy berry Botrytis Anthracnose	Combine: Captan 50WP, 5 lb (0) plus Benlate 50WP, 0.5 lb (21)  Or  Use alone: Aliette WDG, 5 lb (12 hrs) Captan 4L, 2.5 qt (0)	For mummyberry - this spray is designed to control flower infections and should only be used if primary shoot blight infections were not controlled.  For botrytis - Repeat at 7-10 day intervals during bloom if long rainy periods predicted.  For anthracnose - Occurs only sporadically and especially during seasons with frequent rain and warm temperatures. Spray for control in such seasons if a history of this disease has been noted recently.  Captan has a 0 day phi, but the REI of 24 hrs requires that PPE be worn during this period.  Benlate: The current Benlate label specifically states that Benlate is "not for use in home plantings nor once any commercial crop is turned into U-pick, Pick Your Own, or similar operation." Consult with your state's pesticide office for the relevant interpretation of this restriction.	
First cover (about 10 days after Petal Fall; some berries begin to color)			
Anthracnose	Aliette WDG, 5 lb (12 hrs) Captan 4L, 2.5 qt (0) Captan 50WP, 5 lb (0)		See comments above.
Cherry fruitworm	Same as petal fall		Apply 7 to 12 days after petal fall
Cranberry fruitworm			
Blueberry Maggot	Malathion 25WP, 4 lb (1) Guthion Solupak, 1-1.5 lb (7) Imidan 70 W, 1 1/3 lb (3) Pyrenone Crop Spray 0.5EC, 2-12 oz (0)	Use sticky traps (red spheres or yellow rectangles; See source listing in appendix) to monitor population and activity.  Apply insecticide when one fly is captured.  Check traps twice each week	Apply sprays when berries begin to turn blue or when flies begin to lay eggs, usually late June. Repeat every 10 days through harvest.  Be aware of pre-harvest intervals and other restrictions with repeated sprays.  Guthion has 48 hr REI for mowing, irrigating, and scouting; and 4 day REI for all other activities. Second and additional covers - (10 days from previous cover, repeat as needed)
Second and additional covers (10 days from previous cover, repeat as needed)			
Blueberry maggot	Same as first cover above	See comments above for Blueberry maggot	
Japanese Beetle and other scarab beetles	Sevin 50WP, 3 lb (0) Imidan 70W 1.3 lbs (3)	Remove webbed twigs and webworm caterpillars. Remove beetles.	The use of Sevin may result in the build up of aphids due to the elimination of natural predators.
Anthracnose	Aliette WDG, 5 lb (12 hrs) Captan 4L, 2.5 qt (0) Captan 50WP, 5 lb (0)		Captan has a 0 day phi, but the REI of 24 hrs requires that PPE be worn during this period.

Post-harvest			
Pest	Spray Material, Rate/A (pre-harvest interval)	Cultural Practices and Scouting Notes	Comments
Sharp-nosed leafhopper	°Lannate 90, 0.5 lb (3) °Lannate LV, 1.5 pt (3) Malathion 57 EC, 2.8-3.2 pt (1) Sevin 50W, 2-4 lb (0)	Rogue out plants affected with blueberry stunt.  Monitor insects with yellow sticky traps and control when found.	Each of these sprays will control sharp-nosed leafhopper, the only known carrier of the blueberry stunt mycoplasma.
Crown girdler		Cut plants at ground level. Apply 1/2 oz. paradichlorobenzene (PDB) in a trench 1 1/2 inches deep and 1 1/2 inches from the base of the plant. Mound and compact soil.	
Blueberry bud mite	Thiodan 3EC, 2 qt (*) Thiodan/Cottonseed oil, 3 qt (*) Phaser 3EC, 2 qt (*)		Apply immediately after harvest is complete and repeat according to label instructions.  * Do not apply Thiodan or Phaser after buds are well formed; do not apply more than 2 times per year; do not exceed 3.0 lbs active ingredient per acre per year.
Phomopsis twig blight	Benlate 50WP, 1 lb (21) Lime Sulfur, 5 gal (0)		Apply in late October or when 2/3 of leaves drop on Weymouth and Berkeley.  Benlate: The current Benlate label specifically states that Benlate is “not for use in home plantings nor once any commercial crop is turned into U-pick, Pick Your Own, or similar operation.” Consult with your state’s pesticide office for the relevant interpretation of this restriction.

†Where brand names for chemicals are used, it is for the reader’s information. No endorsement is implied, nor is discrimination intended against products with similar ingredients. Please consult pesticide product labels for rates, application instructions and safety precautions. Users of these products assume all associated risks.

° Restricted use.

## WEED MANAGEMENT

The primary goal of weed management is to optimize yields by minimizing competition between the weeds and the crop. Weeds reduce yields by competing with the crop for water, light, and nutrients. Weeds also harbor insects and diseases and encourage vertebrate pests. Timely cultivation, wise use of herbicides, and never permitting weeds to go to seed are integral parts of a good weed management system. Many of the weeds found in these fields are difficult-to-control perennial weeds that are not common in annual crop culture. New plantings usually have fewer perennial weed problems than older plantings. Annual and biennial weeds can also exist in these fields. Fields

should be scouted at least twice a year (spring and fall) to determine specific weed problems. The selection of a weed management tool should be based on specific weeds present in each field. Several herbicides are labeled for use in this crop. A list of herbicides and their recommended uses is presented in Table 31 below.

Herbicides can be broadcast or applied as a directed spray to the base of the crop. With a band treatment, only 1 to 2 feet on either side of the row is treated. The areas between the crop row is usually maintained with a mowed cover of sod, clover, weeds, or a combination of these. This cover is used primarily for erosion control and to improve trafficability in the field. With banding, less herbicide is needed in each

acre. For example, a 3 foot band (1.5 feet on either side of the row) where rows are spaced 9 feet apart will require only on third the amount of herbicide normally required for a broadcast treatment.

Cultivation and mulching are sometimes used as weed management tools. All cultivations should be timely and shallow to minimize crop root injury, to

minimize loss of soil moisture, and to avoid repositioning new weed seeds to the soil surface. Mulches that are free of weed seeds and placed thickly enough can be very effective at reducing or eliminating most annual weeds from the crop row. They are seldom effective on perennial weeds. If mulches are used in combination with herbicides, use the lowest recommended herbicide rate to avoid crop injury.

**Table 31.** Weed management for highbush blueberries in the transplant year and in established plantings.

TRANSPLANT YEAR			
Weed Problem	Herbicide	Rate/Acre	Comments and Limitations
<b>PREEMERGENCE WEED CONTROL</b>			
Annual grasses and small seeded broadleaf weeds	(napropamide) Devrinol 50WP	8 lb	Apply after transplanting to weed-free soil. Devrinol must be activated within 24 hrs by cultivation or enough water by irrigation or rainfall to wet the soil to a depth of 2 to 4 inches. The full rate may not be necessary at transplanting.
	Devrinol 50 DF	8 lb	
	(oryzalin) Surflan 4AS	2 to 4 qt	Do not apply until soil has settled around the plants and no cracks are present. Irrigation or 1 inch of rain is needed within 21 days of application. Shallow cultivation will improve control. May injure newly planted tissue culture plants.
Broadleaf weeds and some grasses	(simazine) Princep 80WP	1.25 to 2.5 lb	Use to improve the broadleaf weed activity of Devrinol or Surflan. Consider applying half the maximum rate after planting and half in the fall before winter annuals emerge. Do not use on newly transplanted tissue culture plants.
	Princep 4L	1 to 2 qt	
	Caliber 90	1.1 to 2.2 lb	
	Princep 4G	25 to 50 lb	
<b>POSTEMERGENCE WEED CONTROL</b>			
Emerged annual and most perennial grasses	(fluazifop) Fusilade DX	16 to 24 oz	See label for best times to treat specific weeds. Will not control broadleaf weeds or sedges. Do not apply to crops to be harvested within 1 year of application. Do not apply if rainfall is expected within 1 hour or if grasses are under drought stress. Must be used with a crop oil concentrate or non-ionic surfactant.
	(sethoxydim) Poast	1 to 2.5 pt	
Emerged annual weeds and suppression of perennial weeds.	(pelargonic acid) Scythe	3-10% solution	Contact material for burn down only. See Scythe comments in Strawberry section. See label for complete instructions.
Emerged annual and perennial weeds	(sulfosate) Touchdown	1 to 5 pt	NON-BEARING USE ONLY. Apply to actively growing weeds during site preparation prior to planting and no later than 1 year before harvest. Apply with a wiper or a shielded/directed spray. Do not allow the spray, spray drift, or mist to contact green foliage or green bark on the trunk, suckers, open wound, or other green parts of the bush. Consult the label for rates for specific weeds and other precautions. Use with a surfactant or wetting agent.

## ESTABLISHED PLANTINGS

Weed Problem	Herbicide	Rate/Acre	Comments and Limitations
<b>PREEMERGENCE WEED CONTROL</b>			
Annual grasses and small seeded broadleaf weeds	(napropamide) Devrinol 50WP	8 lb	Apply in the early spring before seedling weeds emerge. Devrinol must be activated within 24 hours by shallow cultivation or with enough rainfall or irrigation to wet the soil to a depth of 2 to 4 inches.
	Devrinol 50 DF	8 lb	
	(oryzalin) Surflan 4AS	2 to 4 qt	
	(norflurazon) Solicam 80DF	2.5 to 5 lb	Apply in early spring when crop is dormant to clean and weed-free soil. May result in temporary bleaching or chlorosis of leaves from which the plant will recover. Do not use on nursery stock.
<b>NOTE: For broad spectrum preemergence weed control, consider applying one of the above three "grass" herbicides (napropamide, oryzalin, or norflurazon) in addition to one of the following "broadleaf" herbicides (simazine, terbacil, or dichlobenil).</b>			
Broadleaf weeds, some grasses, and suppression of some perennial weeds	(simazine) Princep 80WP	2.5 to 5 lb	Apply in the spring before bud break and before weeds emerge, or in the fall. Do not apply when fruit is present. For improved control as well as quackgrass suppression apply half in the spring and half after harvest.
	Princep 4 L	2 to 4 qt	
	Caliber 90	2.2 to 4.4 lb	
	Princep 4G	50 to 100 lb	
	(terbacil) Sinbar 80WP	0.5 to 2 lb	Apply in the early spring or in the fall as a directed spray to the base of the plants. Will also control small emerged weeds. Do not contact new shoots and avoid contact with foliage. Spring application must be made before fruit set. Avoid application on plantings low in vigor. Planting must be at least 1 year old before application. Do not apply within 70 days before harvest.
	(dichlobenil) Casoron 50 WP	100 lb	Apply at temperatures below 40°F, preferably just before rain or snow. Soil must be settled around established plants. Uniform application is essential. Do not apply during new shoot emergence. The 4G formulation is effective on many perennial weed species. May reduce plant growth in plantings that are young or lacking vigor. High leaching risk.
Casoron 4G	100 lb		
<b>POSTEMERGENCE WEED CONTROL</b>			
Emerged annual grasses and broadleaf weeds. Suppression of emerged perennial weeds	(paraquat) Gramoxone Extra	2 to 3 pt	Contact herbicide. Use with a non-ionic surfactant. Apply as a coarse directed spray to wet the weeds. Apply before emergence of new canes or shoots to avoid injury. Use of a shield is highly recommended.
Emerged annual and most perennial grasses	(sethoxydim) Poast	1 to 2.5 pt	Effective on actively growing grasses. Do not apply to grasses under stress (e.g., drought). Crop oil concentrate must be added to spray tank. Do not cultivate 5 days before or 7 days after application. Do not apply within 30 days before harvest in blueberries. Do not exceed 5 pints per acre per year.
Emerged annual weeds and suppression of perennial weeds.	(pelargonic acid) Scythe	3-10% solution	Contact material for burn down only. See Scythe comments in Strawberry section. See label for complete instructions.
Emerged annual and perennial weeds	(glyphosate) Roundup Ultra	1 to 5 qt	Apply to actively growing weeds. Apply with a wiper or a shielded/directed spray to the base of the plants. Do not permit herbicide solution to contact desirable vegetation, including green shoots, canes, or foliage. Do not cultivate within 7 days after application.

<sup>1</sup>Where brand names for chemicals are used, it is for the reader's information. No endorsement is implied, nor is discrimination intended against products with similar ingredients. Please consult pesticide product labels for rates, application instructions and safety precautions. Users of these products assume all associated risks.

<sup>2</sup>Restricted use pesticide.