

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.

Bacteria

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.

Post-Harvest Diseases

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 ancylus* and *Lecanium nigrofasciatum*): These insects appear mound-shaped, of varied colors, and usually measur-

ing 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 substance 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

Deer: White-tailed deer can cause extensive damage to blueberries by browsing top-growth in winter. Deer can also cause damage to other small fruit crops. For more information on controlling deer, please see Deer Control in the Appendices.

Birds: Birds are a major pest problem in high-bush blueberries. Left unchecked, they can destroy enough of the crop to ruin the profitability of a