Organic Small Fruit Disease Management Guidelines

Integrated Management of Blueberry Diseases

Prepared by
Mike A. Ellis,
Professor
and
Mizuho Nita,
Graduate Research Associate

Department of Plant Pathology
at the Ohio State University/OARDC

Introduction

Disease management strategies are very similar for both organic and conventional small fruit production systems in the Midwest. In both systems it is important to develop and use an integrated disease management program that integrates as many disease control methods as possible, the more the better. Major components of the disease management program include: **use of specific cultural practices; developing knowledge of the pathogen and disease biology, use of disease resistant cultivars, and timely application of organically approved fungicides or biological control agents or products when needed.** These guidelines have been written for caneberries (raspberry and blackberry), strawberry, blueberry and grape. Specific information is provided for each crop in its respective chapter. Most disease control methods or strategies are identical for both conventional and organic production systems. Perhaps the greatest difference between organic and conventional production systems is that organic growers are not permitted to use synthetic "conventional" fungicides. If disease control materials are required in the organic system, growers are limited to the use of "inorganic" fungicides such as sulfur (elemental sulfur and lime-sulfur) or copper fungicides (Bordeaux mixture and fixed copper products). In addition, there are several new "alternative" disease control materials and biological control products that are currently available and are cleared for use in organic production.

There are several problems associated with the use of these inorganic fungicides and "alternative" products in small fruit disease control programs. Among the most important are 1) **Phytoxicity**, which is the potential to cause damage to foliage, fruit set and fruit finish (this is a concern primarily with copper and sulfur fungicides); and 2) **their limited spectrum of fungicide activity**, which means they may not be capable of providing simultaneous control of the wide range of fungal pathogens that can cause economic damage to the crop. For example, sulfur is highly effective for controlling powdery mildew on most fruit crops, but provides little or no control of most other diseases.

In a climate like the Midwest, environmental conditions during the growing season are generally very conducive (warm and wet) to the development of several important diseases, insect pests and weeds. Limitations in relation to which pesticides may or may not be used, present the organic grower with some unique and very demanding challenges. Whereas the use of various cultural practices and disease resistance will be the "back bone" of the organic disease management program, the limited use of organically approved pesticides or biocontrol agents will probably be required at times.

Integrated Management of Blueberry Diseases

In relation to disease control, blueberries have the greatest potential for organic production. The lack of wild relatives of blueberry in much of the Midwest provides a degree of isolation from some of the more damaging diseases. In addition, blueberry plantings in states like Ohio are often scattered and somewhat isolated. Several commercial plantings in Ohio that are 15 to 20 years old have never received a fungicide application, yet have been very productive. However, if diseases such as mummy berry and anthracnose are introduced into the planting, they can be very destructive. For the most destructive blueberry diseases, organic fungicides are of little value once the diseases are established in the planting.

As with all crops, the development and use of an integrated disease management program will be essential to the organic production of blueberries. The objective of an integrated disease management program is to provide a commercially acceptable level of disease control on a consistent (year-to-year) basis. This is accomplished by developing a program that integrates all available control methods into one program. An effective disease management program for blueberries must emphasize the integrated use of specific cultural practices, knowledge of the pathogen and disease biology, disease resistant cultivars and timely applications of organically approved fungicides or biological control agents, when needed. In order to reduce the use of fungicides to an absolute minimum, the use of disease resistant cultivars and various cultural practices must be strongly emphasized.

Identifying and Understanding the Major Blueberry Diseases

It is important for growers to be able to recognize the major blueberry diseases. Proper disease identification is critical to making the correct disease management decisions. In addition, growers should develop a basic understanding of pathogen biology and disease cycles for the major blueberry diseases. The more you know about the disease, the better equipped you will be to make sound and effective management decisions.

The following literature contains color photographs of disease symptoms on blueberries, as well as information on pathogen biology and disease development.

Compendium of Blueberry and Cranberry Diseases - Published by the American Phytopathological Society, 3340 Pilot Knob Rd., St. Paul, Minnesota 55121. Phone: 612-454-7250 (1-800-328-7560). This is the most comprehensive book on blueberry diseases available. All commercial growers should have a copy. The following information gives a description of symptoms, causal organisms, and control of the most common blueberry diseases in the Midwest.

Highbush Blueberry Production Guide - This is a very comprehensive book covering most phases of blueberry production. It can be purchased from: Northeast Regional Agricultural Engineering Service, 152 Riley-Robb Hall, Cooperative Extension, Ithaca, NY 14853. Phone: 607-255-7654.

Fruit Diseases

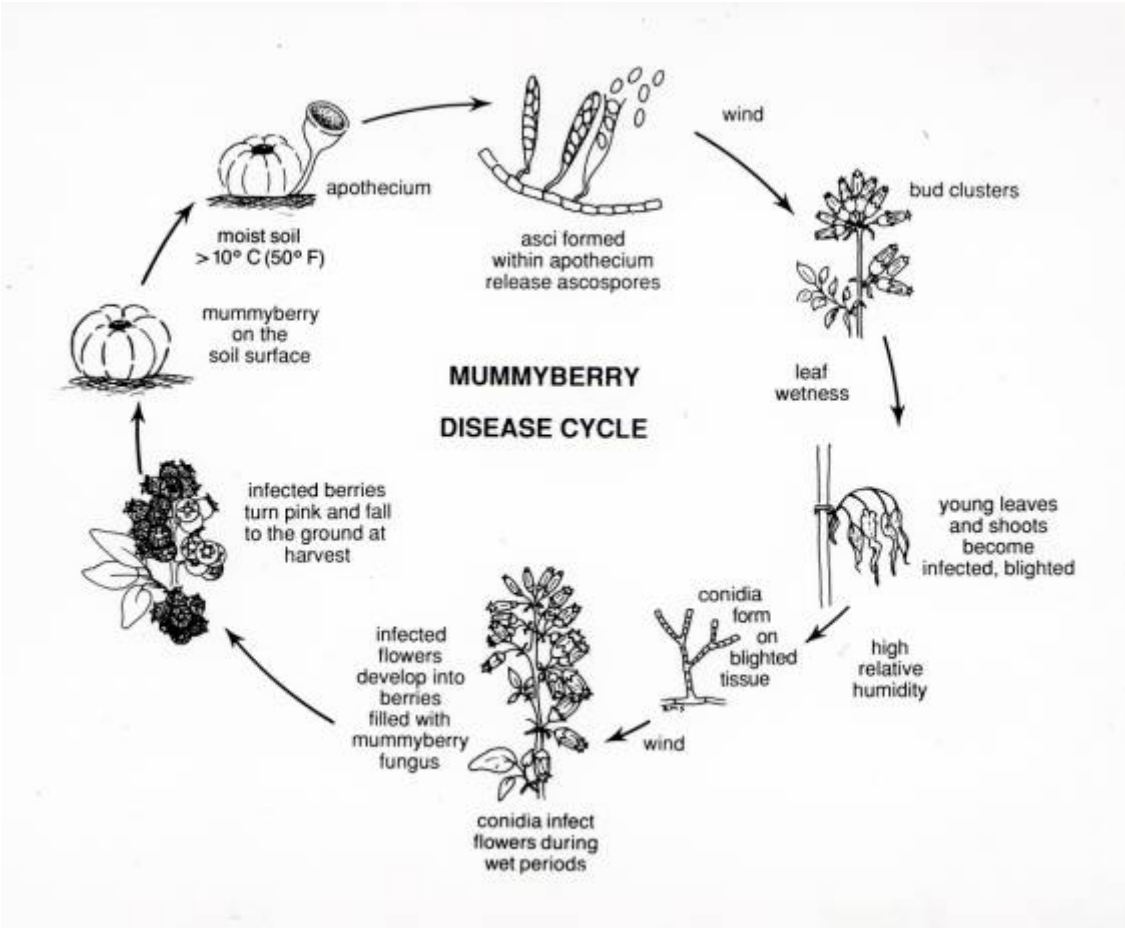
Mummy Berry (*Monolinia vaccinii-corymbosi*)

Mummy berry is becoming increasingly important is some parts of the Midwest; its severity varies from year to year. It is caused by a fungus which attacks new growth, foliage, and fruit and can cause extensive loss.

The fungus overwinters in mummified fruit on the ground (Figure 56). 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 (Figure 57). By fall, these fruit drop to the ground where they turn into mummies ready to produce apothecia the next spring.

Figure 56: Mummy berry on blueberry.

Figure 57: Mummy berry disease cycle. Taken from Small Crop IPM Diseases Ident Sheet No. 3. We wish to thank the New York State Agricluture Experiment Station for use of this figure.



Management

Cultural controls are extremely important in organic production and can be used to reduce inoculum levels in the spring. In very small plantings, mummies can be raked up and burned. In larger plantings, mummies can be buried by cultivating or disking between rows or by covering them with a new layer of mulch at least 2 inches in thickness. Combining cultivation and an application of nitrogen in the spring speeds destruction of the mummies. The cultivation should be done just as apothecia start to emerge in the spring, which usually coincides with budbreak on the blueberry bushes.

Organic fungicides (sulfur and copper) are not effective for control of mummy berry.

Botrytis Blight/Gray Mold (*Botrytis cinerea*)

As with other small fruits, Botrytis primarily affects ripening fruit, although under certain circumstances the fungus can cause stem blight as well. Infection occurs primarily 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 of several days duration. The most critical period for infection is during bloom. The disease is more severe when excessive nitrogen has been used, where air circulation is poor, or when frost has injured blossoms. Rotted berries typically have a gray cast due to mycelium and spore-bearing structures present, which gives the disease its name. Stem symptoms are difficult to distinguish from those caused by Phomopsis. For positive diagnosis, the fungus usually must be isolated from infected tissue in a diagnostic laboratory. Cultivars possessing tight fruit clusters ("Weymouth","Blueray" and "Rancocas" are particularly susceptible to this disease.

Management

Any cultural practice that promotes faster drying of foliage and fruit in the planting should be beneficial for gray mold control. The use of excessive nitrogen should be avoided. Fertilization should be based on results for soil and foliar analysis. Organic fungicides (sulfur and copper) are of little value for gray mold control. Several biocontrol products are available for control of gray mold on small fruit crops (Table 1). In general, their efficacy under moderate to severe disease pressure needs to be determined.

Anthracnose (*Colletotrichum gloeosporioides*)

This fungus damages primarily fruit, but also infects twigs and spurs. It causes a salmon- or rust-colored berry rot. Infected 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 postharvest losses. Spores are spread mainly by rainwater. The disease is especially prevalent during hot, muggy weather and frequently occurs postharvest.

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

Management

Organic fungicides are of little value for controlling anthracnose. Pruning out small twigs and frequent harvesting are beneficial to control. Removing and destroying infected fruit should be beneficial. Old canes and small twigs should be removed in order to increase air circulation around the fruit clusters.

Stem and Foliage Diseases

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. Spores are released from March to July. 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 between 50-72ºF. New infections can occur throughout the growing season. Cold stress or winter injury may play a part in increasing disease damage. Leaves turn a reddish-chocolate color 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, with a bull's-eye pattern obvious on the lesion. As the lesion enlarges, the margin remains red and the center becomes gray and dies. On young (1· 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 stem girdling.

Management

Sanitation is essential. Removal of infected canes from the planting is critical for control. A dormant application of liquid lime sulfur (5 gallons in 100 gallons of water) may be beneficial for control. Varieties differ in their resistance to the disease.

Phomopsis Twig Blight (*Phomopsis vaccinii*)

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

Spores from old cankers are released in the spring and, to a limited extent, in summer. Most spores are released from bud swell to petal fall. None are released after September 1. Rain is necessary for spore release; temperatures ranging from 70-80ºF encourage

infections. The disease is most severe after winters in which mild spells are interspersed with cold periods. Periods of hot, dry weather during the growing season probably predispose the plants to infection. The fungus overwinters in infected plant parts.

Symptoms first appear on smaller twigs. The disease then 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 is rare and usually only occurs where the crown itself has been injured, after a particularly severe winter, or in highly susceptible cultivars. Young tissue initially shows no symptoms, 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. Leaf spots also have 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 cultivar.

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 long-term production of the bush. Keep the plants well-watered through prolonged periods of dry weather in the summer. Avoiding stress will help prevent this disease. Dormant sprays of lime sulfur (5 gallons in 100 gallons water) also help to reduce inoculum of the pathogen. A fall application can be made when most of the leaves have dropped. Spring applications should be applied early, before warm weather occurs, or injury may result.

Blueberry Root Diseases

Phytophthora Root Rot (*Phytophthora cinnamomi*)

This disease is usually associated with poorly-drained areas of a field. The fungus thrives in wet (saturated) soils and survives for long periods of time in soil. Symptoms are observed 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 and totally black. Above-ground symptoms include chlorosis and reddening of the leaves, small 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 a group of plants in a low lying area of the field. The disease is most severe 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.

Management

The disease is avoided through careful site selection before planting. Heavy soil which becomes waterlogged or has a high water table should be avoided. Internal and surface water drainage should be improved before planting. Plants can be grown on raised beds if desired. Manage irrigation to avoid prolonged periods of saturated soil. Most cultivars are susceptible to the disease, although some cultivars may better tolerate some degree of infection better than others. "Bluecrop" and "Weymouth" are two cultivars which have shown promise.

Bacterial Crown Gall (*Agrobacterium tumefaciens*)

This 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 environment, the disease is uncommon. 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 contain galls.

Management

Sanitation, purchasing healthy nursery plants, and maintaining proper soil conditions (pH 4.5 to 5.2) are the most reliable controls. A closely related bacterium, Agrobacterium radiobacter, produces an antibiotic called Agrocin and is available as a biological control agent for use either as a soil treatment or for dipping the root system of bushes prior to planting. This control measure is not recommended unless the planting has a history of crown gall problems.

Viruses and Phytoplasmas

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; however, 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 still localized in a small portion of the field. The virus has been observed most often in the cultivars "Burlington", "Jersey", "June", "Cabot", and "Rancocas". Other cultivars may possess field resistance to the disease.

Blueberry Stunt

This disease was originally thought to be caused by a virus, but is now known to be caused by a 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 and low in vigor. Small downward cupped leaves turn yellow along the margins and between the lateral veins, giving a green and yellow mottled appearance. These mottled areas turn brilliant red prematurely in late summer, although the midrib remains dark bluish-green. Fruits on affected bushes are small, hard, lack flavor, ripen late if at all, and remain attached to the plant much longer than on healthy plants.

Mangement

Planting virus-indexed plants is helpful. Diseased bushes cannot be cured. They must be removed from the field as soon as they are diagnosed. The removal process may facilitate the further spread of the disease in the field. Agitation of the bush during removal will dislodge the leafhoppers, causing them to move to a neighboring healthy bush. Therefore, infected bushes should be sprayed with an appropriate insecticide prior to removal. The cultivars "Bluetta", "Jersey", and "Weymouth" are particularly susceptible, whereas "Rancocas"is resistant.

Use of Disease Resistant Varieties

In an integrated organic disease management program, the use of varieties with disease resistance must be emphasized. Blueberry varieties with high levels of resistance to most of the major diseases are not currently available; however, several varieties are known to be resistant to some diseases. The following table provides information on disease resistance in several of the more common varieties grown in the Midwest.

Table 4. Disease resistance in blueberry cultivars commonly grown in the Midwest.

Variety	Mummyberry	Phomopsis twig blight and canker	Fusicoccum canker	Powdery mildew	Anthracnose fruit rot	Red ringspot virus	Shoestring virus
Berkeley	S	VS		R			
Bonus							
Bluecrop	MR		MR	S	MR	VR	
Bluegold	S						
Bluehaven	S	S					
Bluejay	R						R
Blueray	S				S		
Bluetta	S	R					
Burlington	R						S
Chippewa							
Collins	S						
Coville	MR		MR	MR			
Darrow	R						R
Duke	R						
Earliblue	S	S		R			S
Elliott	R	R			R		S
Jersey	MR	VS		S	VS	MR	S
Lateblue	R						
Little Giant					R		
Nelson							

Northblue	R						
Northcountry							
Northland	S						R
Northsky	R						
Patriot							
Polaris							
Rancocas	MS		R	R			MS
Rubel	S	MR	MR		MS		S
Sierra	S						
St. Cloud							
Spartan	MR						S
Sunrise							
Toro							
Weymouth	S						S

VR = very resistant, R = resistant, MR = moderately resistant, MS = moderately susceptible, and S = susceptible and VS = very susceptible

Blank areas mean resistance is not known.

Table prepared by J. Hancock, E. Hanson, D. Trinka, and A.M.C. Schilder, Michigan State University.

Cultural Practices For Disease Control

in Blueberry Production Systems

The use of any practice that provides an environment within the planting that is less conducive to disease development and spread should be used. The following practices should be carefully considered and implemented in the disease management program.

Use Disease-Free Planting Stock

Always start the planting with healthy, virus-indexed plants obtained from a reputable nursery. Remember that disease-free plants are not necessarily disease resistant: cultivar selection determines disease resistance.

Site Selection

Soil Drainage (Extremely Important)- Select a planting site with good water drainage. Avoid low, poorly-drained wet areas. Good water drainage (both surface and internal drainage) is especially important for control of Phytophthora root rot. This disease requires free water (saturated soil) in order to develop. If there are low areas in the field that have a tendency to remain wet, this is the first place that Phytophthora root rot will develop. Any time there is standing water in the field, plants are subject to infection. Any site in which water tends to remain standing is, at best, only marginally suited for blueberry production and should be avoided.

Any practice, such as tiling, ditching, or planting on ridges or raised beds, that aids in removing excessive water from the root zone will be beneficial to the disease management program.

Site Exposure

A site with good air circulation that is fully exposed to direct sunlight should be selected. Avoid shaded areas. Good air movement and sunlight exposure are important to aid in drying fruit and foliage after rain or irrigation. Any practice that promotes faster drying of fruit or foliage will aid in the control of many different diseases.

Weed Control

Good weed control is essential to successful blueberry production. From the disease control standpoint, weeds in the planting prevent air circulation and result in fruit and foliage staying wet for longer periods. Several diseases can be more serious in plantings with poor weed control versus plantings with good weed control.

In addition, weeds will reduce production through direct competition with blueberry plants for light, nutrients, and moisture and will make the planting less attractive to pick-your-own customers, especially if you have thistles!

Sanitation

Any practice that removes twigs or branches infected and other plant debris from the planting is beneficial in reducing the amount of fungal inoculum. Removal of fruit mummies is critical for mummy berry control. Removal of infected twigs and branches is also critical for control of Phomopsis twig blight and Fusicoccum canker. Infected plant material should be removed from the planting and destroyed.

Maintaining proper soil conditions

One of the most common problems in midwestern blueberry plantings is iron chlorosis. Affected plants are chlorotic (yellow) and stunted. The major cause of chlorosis is planting on a site with improper ph. The best soils for blueberries are well-drained sandy silt loam or silt loam, with pH 4.5 to 5.2, organic matter of 4 to 7% and adequate phosphorus and potassium. At pH levels above 5.2, chlorosis will probably be a problem.

Most soils will need to be adjusted in pH. Too low a pH can result in manganese or aluminum toxicity, while a high pH results in the unavailability of certain nutrients such as iron. Do not plant blueberries without amending the pH at least 1-2 years before planting. Soil test kits are available from your local county Extension office. Where top and subsurface soils have a naturally high pH (6.0 to 8.0) and there is a high buffering capacity, soil amendments will not adjust the pH and blueberries should not be planted. Where soil pH is too low, apply lime to increase the pH. Sulfur can be used to decrease the pH to the proper level if the pH is not too high. Incorporate sulfur and organic matter into the raised bed (upper 6 to 12 inches) 3 to 6 months prior to planting. This allows time for the chemical reaction to occur and reduces potential root damage. Retest the soil 3 to 6 months after application to determine whether further adjustments are needed. Apply all nutrients according to soil test. Phosphorus will not move through the soil and is ineffective after plant establishment. Applying sulfur to only the raised bed may require 500 to 800 pounds per acre of bed to decrease the pH by 0.5. Incorporate sulfur at least 3 weeks before planting.

In major commercial blueberry areas, blueberries are produced on sandy soils with high water tables. Most midwestern soils (except some Michigan and Wisconsin soils) require soil amendments and irrigation for maximum growth and yield. Tile drainage may be required, but in most midwestern soils containing 10% or more clay, raised beds are preferred for optimal growth. A raised bed 8 to 10 inches high (original height) and 4 feet wide is required. Over time, the bed will compact to 6 inches, but the addition of hardwood or other suitable mulches maintains a height of 6 to 8 inches.

Protect from winter injury

Winter injury predisposes blueberry plants to many diseases. In colder regions of the Midwest, pile snow around bushes to insulate from fluctuating temperatures. Protect crowns (base of plant at soil line) with wood-chip or straw mulch.

Avoid Excessive Fertilization

Fertility should be based on soil and foliar analysis. The use of excessive fertilizer, especially nitrogen, should be avoided. Sufficient fertility is essential for producing a crop, but excessive nitrogen can result in dense foliage that increases drying time in the plant canopy, i.e., it stays wet longer.

Harvesting Procedures

a) Pick fruit ***frequently*** and early in the day before the heat of the afternoon (preferably as soon as plants are dry). Picking berries as soon as they are ripe is critical. Overripe berries will cause nothing but problems during and after harvest.

b) Handle berries with care during harvest to avoid bruising. Bruised and damaged berries are extremely susceptible to rot.

c) Train pickers to recognize and avoid berries that have disease symptoms of mummy berry or anthracnose. If at all possible, have pickers put these berries in a separate container and remove them from the field.

Post Harvest Handling

a) Always handle fruit with care during movement from the field to market to avoid any form of damage.

b) Get the berries out of the sun as soon as possible.

c) Refrigerate berries immediately to 32 to 35°F in order to slow the development of fruit rots.

d) Market the berries as fast as possible. Encourage your customers to handle, refrigerate, and consume or process the fruit immediately. Remember that even under the best conditions, blueberries are quite perishable.