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ORGANIC BLUEBERRY PRODUCTION

HORTICULTURE PRODUCTION GUIDE

ATTRA is the national sustainable agriculture information center funded by the USDA's Rural Business -- Cooperative Service.

Abstract: *This publication focuses on organic production practices for blueberry culture, with some information on marketing outlook. A list of resources includes websites.*

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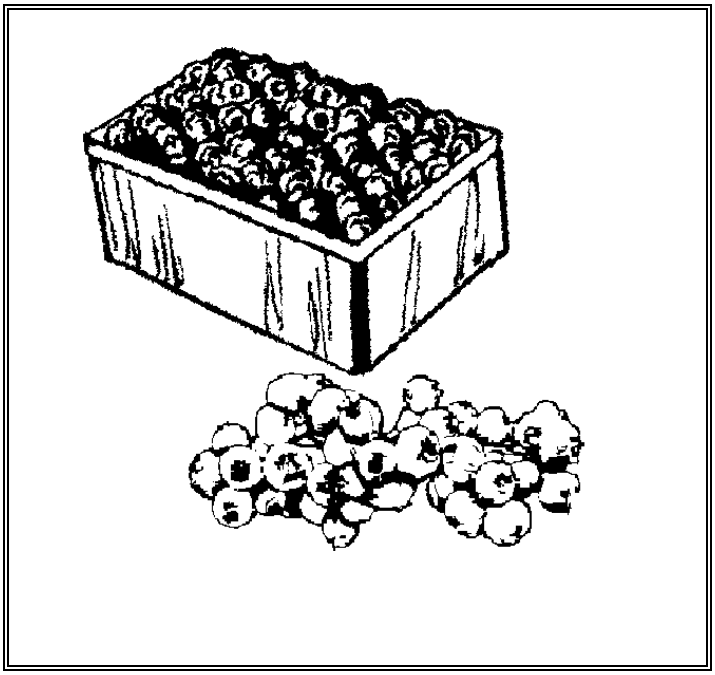
Introduction

The following is an introduction to *organic* blueberry production, designed to supplement information from conventional sources on basic cultivation practices. Matters such as pruning, training, variety choice, sources of propagation material, and planting are essentially the same in both organic and conventional culture. Generic blueberry information can be obtained from the Cooperative Extension Service and common horticultural texts and periodicals.



The word *organic* has precise legal definitions in most states, and there are certification groups that maintain standards for what can be certified and marketed as organically grown, as well as prescribed record-keeping procedures. An organic certification agency or organic growers organization should be contacted to determine exact requirements and a list of prohibited practices and substances.

However, some smaller producers may wish to follow organic practices without becoming formally certified. The information provided here should be useful to them, as well.

This publication is generally applicable to organic culture of all three cultivated blueberry species. Information on improved blueberry cultivars is continually being released by research and extension agencies.

Additional ATTRA publications on organic certification include:
Organic Certifiers Resource List
Resources for Organic Marketing

Contents

Rabbiteye (*Vaccinium ashei)*—adapted type in the South (roughly south of Interstate 40).

Highbush (*V. carymbosum*)—adapted to intermediate climates.

Southern highbush (*V. ashei x carymbosum*)

In the Far North, low-bush and dwarf highbush blueberry cultivars are more climatically adapted than are highbush types. The lowbush wild blueberry (*V. angustifolium*) is commercially important in Maine. The Wild Blueberry Association of North America (WBANA) website (http://www.wildblueberries.com) promotes marketing and is an excellent source of information on production practices.

Blueberries have fewer pest problems than most other fruits, offering an advantage for organic production. Most insect and disease problems can be controlled through cultural manipulation. Blueberries have a relatively low nitrogen requirement and thrive on organic sources. Adjusting soil pH low enough and protecting from predatory birds and mammals are the major production constraints. Weather fluctuations and geographic seasonal advantage are the major economic considerations.

Generally, non-organic transplants can be used for establishing perennial crops. However, most certifiers require the plants to be grown at least 12 months under organic conditions after trans-planting before any harvested product can be marketed as organic.

For more information about marketing options, see the ATTRA publications *Direct Marketing* and *Farmers' Markets*. On-farm value-added blueberry products usually require setting up a second rural enterprise besides farming, and may entail considerable additional planning, management, and start-up expense.

Soils and Fertility

The Importance of Soil pH

Blueberries are distinct among fruit crops in their soil and fertility requirements. As members of the Rhododendron family, blueberries require an acid soil, preferably in the 4.8–5.5 pH range. The reasons for this are several. First of all, when soil pH is appreciably higher than 5.5, iron chlorosis often results; when soil pH drops below 4.8, the possibility of manganese toxicity arises. In either case, plants do not perform well.

Soils with a native pH above 5.5 pose special problems for organic producers. Recurrent applications of acidifying agents are necessary in order to keep pH from drifting back to its natural level. Non-organic methods may depend on acidifying agents such as ammonium sulfate or di-ammonium phosphate which are not allowed under organic certification criteria. Not all certifiers allow the usual flowers of sulfur and ferrous sulfate for pH correction in organic culture. Acceptable substitutes are cottonseed meal (from organic cotton) and, if pH is not too high, sawdust or pine needle mulches, which can assist in lowering pH a few tenths of a unit.

Soil pH also plays a significant role in crop nitrogen management. Research has shown that blueberries are preferential to soil and fertilizer nitrogen in the ammonium form, absorbing and utilizing it much more efficiently than nitrate nitrogen—the form preferred by most other commercial crop plants. Neutral and basic soils favor *nitrification*—the rapid conversion of ammonium nitrogen to nitrate through the activity of nitrifying microorganisms. When an acidic soil environment is maintained, the ammonium form of nitrogen predominates and is readily available to blueberries.

This principle also applies to the addition of supplemental nitrogen fertilizers. Conventional recommendations routinely emphasize the use of ammonium fertilizers, particularly ammonium sulfate, which also acts as a soil acidifier. When a slow-release organic fertilizer like fish meal is applied, the nitrogen in the proteins is converted

first into ammonium. The ammonium—which would rapidly convert to nitrate under neutral soil conditions—tends to remain in the desired, ammoniated form.

One preferred method of lowering soil pH in organic culture is application of sulfur. Pre-plant incorporation of sulfur to lower the pH to an optimal blueberry range of 4.8–5.5 should be based on a soil pH test. Because soil pH is subject to considerable seasonal fluctuation—especially on cropped soils—it is advisable to do soil sampling and testing in winter or very early spring, when biological activity is at a low level.

The table below provides guidelines for sulfur application on different soil types.

detrimentally affect soil biology if overused. Organic growers sometimes increase their applications of peat moss at planting time as it, too, is a soil acidifier (pH 4.8), reducing the need for sulfur. The Ozark Organic Growers Association suggests as much as 5–10 gallons of peat moss per blueberry plant. While costly, peat is resistant to decomposition and provides the benefit of soil humus.

Those seeking alternatives to spaghnum peat moss might consider the use of pine bark or similar amendments incorporated in the planting rows or holes. While viewed as less desirable than spaghnum peat moss, pine bark can often be obtained locally at a much lower cost. A new

Approximate pounds per acre of sulfur or ground limestone to change soil pH one unit (1).

Soil Texture	Pounds per acre of sulfur to lower soil pH one unit (e.g. 6.0 to 5.0)	Pounds per acre of lime to raise soil pH one unit (e.g. 4.0 to 5.0)
Sand (CEC=5)	435 to 650	1000
Loam (CEC=15)	870 to 1300	2800
Clay (CEC=25)	1300 to 1750	4400

Powdered sulfur takes about one year to oxidize and reduce soil pH. Prilled sulfur takes somewhat longer. Limestone, too, requires time to effect changes in pH and reactive time is highly dependent on the fineness of grind.

Single applications of sulfur should not exceed 400 pounds. Best results are obtained by applying 200 pounds in spring, followed by 200 later in the fall for as many intervals as is required to deliver the total amount. It is advisable to re-test the soil one year after each application to determine if additional acidification is truly necessary (2).

Organic growers are advised to be conservative in the application of soil sulfur. Sulfur has both fungicidal and insecticidal action and can

commercial substitute for peat called *coir,* made from coconut fiber pith, appears promising, but only if it becomes available at a reasonable price.

It is advisable to monitor soil pH over time as production practices can cause gradual changes to occur. Irrigation water often contains calcium and magnesium, which may cause soil pH to creep upwards, while repeated use of acidifying fertilizers, such as ammonium sulfate or cottonseed meal, may lower pH. Fortunately, the presence of abundant organic materials such as peat and the breakdown products of sawdust and woodchip mulches tend to buffer soil pH. (Several organic growers have even observed that blueberries grown in high organic matter soils will perform well at a pH as high as 6.0 with few apparent problems.) As a result, additional

NATURAL MATERIALS FOR SUPPLEMENTARY FERTILIZATION		
Material	**Estimated N–P–K**	**Characteristics**
Alfalfa meal	3–1–2	Good trace mineral source.
Blood meal	12–1.3–0.7	Medium N release rate of 6–8 weeks.
Cottonseed meal	7–2–2	Slow to medium N release of 4–6 months. Soil acidifier
Feather meal	13–0–0	Slow N release of 4–6 months
Fish meal	10–2–2	Slow to medium N release of 4–6 months.
Leather meal	10–0–0	Slow N release. Restricted use in organics due to heavy metal contamination.
Compost and compost-blended fertilizers	Analysis is highly variable depending on raw materials in compost and materials added to fortify the blend. Analyses commonly range from less than 1% to about 8% N. Considered a slow-release source of N, but preferred overall as a fertilizer.	

sulfur (or lime for that matter) is seldom needed. When it is needed, top dressing is usually done, but delivery of soluble sulfur through drip irrigation lines is also an option.

Blueberry Fertilization Practices

Soil building practices prior to establishment can go a long way towards providing the fertility necessary to a healthy blueberry planting. High levels of soil organic matter are especially important in blueberry culture, contributing to the soil's ability to retain and supply moisture to the crop, buffering pH and releasing nutrients through the decay process. Organic-rich soils are also a desirable environment for symbiotic mycorrhizal fungi that assist blueberry roots in absorbing water, nitrogen, phosphate and other minerals. Cover crop and green manures can play an important part in cycling organic matter into the soil system, as can applications of composts and livestock manures. ATTRA has several publications which can be useful in these areas including *Overview of Cover Crops and Green Manures* and *Farm-Scale Composting Resource List*.

Once a blueberry planting is established, supplemental fertilization can be applied in a number of forms and by several means. Generally, supplemental nitrogen is the greatest concern, followed by potassium. Blueberries have a low phosphorus requirement and typically require little, if any, phosphorus fertilization. In fact, excessive phosphate has been one of the factors linked to iron chlorosis in blueberries. High calcium levels are also considered problematic.

Nitrogen fertilizer recommendations vary somewhat from region to region. As a general guideline, 100–120 lbs. of nitrogen per acre are commonly recommended on mulched berries; a reduced rate of 50–60 lbs. per acre is advised where little or no mulch is used (3). Nitrogen is often applied in three split applications—one at bud break, followed by two more at six week

intervals. These recommendations apply to conventional soluble fertilizers, and adjustments may be appropriate for less-soluble organic fertilizers. One rule of thumb suggests that organics be applied from 1–4 weeks ahead of the schedule recommended for soluble fertilizers. This allows additional time for decomposition processes to make nutrients available. Applications after mid-July are discouraged, as plants tend to develop late growth that is particularly sensitive to freeze damage. A table of natural materials used by organic growers for supplementary fertilization is provided on p. 10 (4).

Current fertilization practices among organic growers vary considerably. In one example (5), an organic blueberry grower in the Missouri Ozarks applies 1/2 pound of feathermeal per mulched plant in late May of the establishment year followed by a similar application 4–6 weeks later. In subsequent years, an additional (third) application of 1/2 pound feather meal is made earlier in mid to late March. As the feather meal products available in this region contain roughly 13% nitrogen, this grower is applying approximately 141 pounds of actual N per acre in the establishment year, and an annual total of 212 pounds per acre thereafter .

Using the same schedule of split applications, another organic grower in the Arkansas Ozarks, also growing mulched berries, applies cottonseed meal (estimated at 7% N) at 1 lb. per plant each time. At these rates this grower is applying roughly 152 lbs. per acre N in the establishment year and about 229 lbs. per acre in subsequent years (6). (It should be noted that the use of cottonseed meal in certified organic production is controversial because cotton is one of the most heavily sprayed agronomic crops and the presence of residues is a concern. In addition, certified organic growers should specify "mechanically extracted" cottonseed meal and not "chemically extracted" or "solvent extracted" cottonseed meal.)

Associate professor John Clark (3) at the University of Arkansas believes the fertilization rates used by these organic growers are probably excessive. Despite the slower availability of organic-based nitrogen, the carry-over from previous seasons should result in roughly the same amount of nitrogen released each season as is being applied. But since detailed research is lacking, no one can be certain of the best rates to use.

Clark suggests that the best way to determine whether fertilization rates are "on target" is to annually test foliar nitrogen levels. This is accomplished in late July or early August (in Arkansas) by sampling leaves from the mid-shoot area on fruiting canes and sending them to an appropriate laboratory. Lab results showing nitrogen levels below 1.6% indicate a nitrogen deficiency; a level in excess of 2.2% indicates nitrogen excess. This service is available through Cooperative Extension in Arkansas and several other states. Several commercial laboratories also provide foliar analysis. ATTRA can provide a short list of laboratories that offer various soil and plant tissue testing services.

Potassium needs in blueberries are often provided through decaying mulches. The need for further supplementation should be determined by soil and/or tissue testing. Where additional potassium is needed, it may be applied in a number of forms—including sul-po-mag, epsom salts, granite meal, and greensand. The latter two sources are relatively low in available potash and are not usually advisable from an economic standpoint if potash supplementation is the sole objective. Since chloride-based fertilizers have proven detrimental to blueberries, natural sources of potassium chloride (though acceptable to some certifying agencies) should not be applied in significant amounts.

An all-around good blueberry fertilizer is high quality compost. Depending on the humus condition and biological activity in the soil, compost may be able to provide all the fertility needs of the crop. Where compost is of average quality, it may still function as a good soil conditioner. The use of aged animal manures in blueberry production is also possible, but is less common.

Fertigation of blueberries—the practice of injecting soluble fertilizers through drip irrigation

lines—is a common practice in conventional production. Since fertigation is based on the complete solubility of fertilizers in water, there are limited options among organic fertilizers. Attempts at fertigation with blood meal by Arkansas blueberry growers have resulted in clogged emitters and algae growth. More recently, however, researchers in California demonstrated the use of spray-dried fish protein and poultry protein in drip systems (7). In addition, several liquid fertilizers used by organic greenhouse growers (Green Juice™, Simeon's Super Tea™) look promising.

As previously mentioned, the root systems of blueberry plants are also limited with regard to where they grow within the soil agroecosystem. Unlike the roots of grapes and bramble fruits, which extend well into the interrow area, blueberry roots are confined to a zone much closer to the row. As a result, all fertilizers and amendments must be applied under the plant canopy to assure that they reach the roots.

Foliar feeding of blueberries is practiced by some organic growers and is especially helpful when plants are stressed or not thrifty. Foliar fertilization programs usually consist of seaweed and fish emulsion. The Ozark Organic Growers Association has recommended a seaweed-fish mix applied three times per growing season—at bud break, just prior to harvest, and just after harvest. More detailed information on foliar fertilization technology is available from ATTRA, on request.

Cultural Considerations

Plant spacing

Highbush blueberries are typically spaced 4–4 ½ feet in the row, with 8–12 feet between rows. As bushes can get quite large at maturity, many growers find that 10–12 foot row spacings—approximately 900 to 1090 plants per acre—are preferable for tractor operations (mowing, harvesting, spraying). Rabbiteyes are typically spaced at 5–8 feet in a row with 12–14 feet between the rows, or 388 to 726 plants per acre.

Dr. J.N. Moore and others at the University of Arkansas have experimented with denser within-row plant spacings for highbush blueberries, effectively doubling the number of plants per acre. Yields during the first five years after planting were found to be substantially higher (a boon to the overall economics of blueberry production—especially where high investments in bird netting, etc. have been made).

These researchers have been careful to point out, however, that beyond the fifth year, inter-plant competition may create problems, requiring removal of every other plant in the row (2). Fortunately, highbush blueberries transplant easily, and removed bushes can be used in establishing another field.

Interrow Management

The root system of the blueberry is not extensive. As a result, clean cultivation of row middles to control weeds and to incorporate cover crops is less damaging to blueberries than it is to bramble fruits. Still, it is wise to till no deeper than 3 inches. Similarly, interrow living mulches—also called *sodded middles*—are generally not competitive with the crop unless the species employed are aggressive and invade the rows. Fescue is commonly used in the Mid-South for sodded middles, though several other grass species are also in use.

Timely mowing—usually 3–5 times per year—is the common means of controlling weeds and other vegetation in sodded middles. It is most important that weeds not be allowed to produce seed which may be scattered into the rows to germinate later.

In a Texas study, researchers demonstrated that the interrow area could be utilized to produce significant quantities of mulch for rabbiteye blueberries. Successful winter crops of rye, ryegrass, and crimson clover, and a summer crop of pearl millet, were grown, cut, and windrowed onto the blueberry rows. Nitrogen proved the major limiting factor for non-leguminous cover crops. Low soil pH and browsing by deer limited the biomass production of legumes. Pearl millet

demonstrated the greatest level of allelopathic weed suppression (8).

In many systems which employ sodded middles, a weed-free strip about 6–12 inches wide is often maintained between the edge of the mulch and the cover crop. The strip reduces competition between cover crop and crop, and lessens the chance that weeds or the cover crop itself will advance into the mulch. It has the added bonus of discouraging cutworms—an occasional pest in blueberries. In conventional systems, this strip is maintained through the use of herbicides.

Organic growers typically employ mechanical cultivators of various types. Gordon Watkins (9) describes two modified "off-the-shelf" cultivators used by growers in the Ozark region. One, referred to as the *Vasluski Edger*, uses a single disc from a rice levee plow in conjunction with two shanks from a spring-tooth chisel. These are mounted on a tool-bar which extends past the rear tractor tire. The disc cuts a strip along the row edge and throws soil towards the plants while the shanks stir soil closer to the bed. The result is a weed-free strip about 6–8 inches wide. The drawback of this implement is the amount of dirt shifted by the disc and the resulting "ditch" which remains.

The second implement Watkins describes is the Lilliston Rolling Cultivator™, with all the heads removed except those two extending beyond the rear tire. One head rolls in the ditch area that is (or would be) created by the Vasluski Edger disc. The second extends approximately 12 inches onto the side of the bed. Depth of penetration is set at 1 inch and it is best operated at relatively high speeds. Since it cultivates about one-half of the bed surface, only about a 2–foot strip remains for hand-pulling and hoeing. The tool works well on small weeds but does not control larger, well-established weeds.

In-Row Weed Management and Mulching

As in other perennial fruit crops, weeds can build to damaging levels in blueberry plantings. It is especially important to control aggressive perennial weeds such as johnsongrass, bermudagrass and quackgrass prior to crop establishment. Details of pre-plant and post-plant weed management for all fruit plants are provided in ATTRA's *Overview of Organic Fruit Production.* Some techniques, however, deserve additional detail.

In much of the country blueberries are grown on raised beds and mulched. Raised beds reduce the incidence of soil- and water-borne diseases. Thick mulches provide weed suppression, soil temperature regulation, slow-release nutrients, organic matter and moisture conservation. The latter is especially important because blueberry roots lack root hairs—the primary sites for water and mineral absorption on most plants. This characteristic makes water management of paramount concern and goes a long way towards explaining why irrigation and mulching are recommended practices.

The importance of maintaining a weed-free zone around blueberries was demonstrated in a Georgia study (10) using rabbiteye blueberries —considered to have a more vigorous root system than highbush types. Researchers determined that an optimum vegetation-free zone during the first 2–3 years of growth extends to roughly 1.5–2.5 ft from the plant. This translates to a 3–5 ft wide weed-free row bed, whether maintained by mulch, tillage, herbicides, or some other means.

The Georgia study appears to confirm conventional practices which have evolved in recent years. Current recommendations suggest mulching a 3–4 foot-wide strip to a depth of 3–5 inches with sawdust, bark, wood chips, or wood shavings. Organic growers often prefer a deeper mulch of up to 6 inches over a strip at least 4 feet wide. Ideally, the mulch should be sufficiently coarse to minimize crusting, and the surface relatively flat to encourage water penetration and gas exchange.

While the mulch suppresses many weeds, there are some that find this habitat hospitable. Among these are several perennials that can become persistent and troublesome. Tractor-drawn cultivation implements are somewhat

impractical for in-row weed control on deep-mulched blueberries. This is especially true since blueberry roots often grow into the mulch and significant plant damage can result from tillage. Shallow hoeing or hand-pulling weeds are two traditional options practiced by organic growers.

Other organic options that might be considered include spraying a natural herbicidal product such as soap-based Scythe™ or Safer Superfast™. In a similar vein, the Kerr Center for Sustainable Agriculture (11) in Oklahoma has experimented with concentrated vinegar solutions. Soap-based products and vinegar are contact herbicides which "burn down" the sprayed vegetation. They are most effective against small, annual weeds and seedling perennials. Damage to blueberries should be minimal if the spray is properly directed below the canopy to the base of the crop and if drift is properly controlled. Since these products vary in their chemical make-up and their legal and practical uses, all pesticide labeling should be thoroughly read and the appropriate certifying agency consulted for approved usage in organic production.

Weeder geese are another possibility for weed management. Weeder geese can eliminate most of the grass and many of the tender broadleaf weeds from a planting. They are prone to eating ripe fruit, however, and may damage some of the newly emerging canes, so their use should be timed accordingly. Obviously, stocking rates are much lower, and management easier on clean cultivated plantings. Investigators at the Kerr Center for Sustainable Agriculture have used weeder geese for effective weed control in blueberries with sodded middles. Their strategy entails use of movable electric fencing and intensive grazing. One possible drawback cited by Kerr Center researchers was the tendency of geese to compact soil and mulch. ATTRA can supply further information on weeding with geese, on request.

An alternative to organic mulching that looks very promising is the use of geotextile fabric weed barriers. While fabric mulches may not provide all the benefits of a deep organic mulch, they are highly effective for weed control; and though the initial cost is high, it may prove reasonable when amortized over the expected lifetime of 10–12 years.

Note that **non**-porous, black plastic mulches—commonly used in vegetable production—are not recommended for blueberries. The reason commonly given is that polyethylene plastic mulch encourages surface rooting—making the plants more susceptible to drought stress and winter injury.

Some research has also been done on flame weeding in blueberries—presumably on non-mulched plantings—in Michigan (12, 13). Damage to crop plants proved a problem which was alleviated considerably using a water spray to shield the crop. Researchers do not appear especially optimistic about the use of flame weeding in blueberries at this time and it is unclear whether research continues. Please consult ATTRA's *Overview of Organic Fruit Production* for further details of these and other weed control options.

Refugia

Cover crops and adjacent vegetation may act as habitat to populations of beneficial insects which provide pollination and help to suppress pest insects and mites. In blueberries, increasing the number of pollinators can be quite important. Wild bees (carpenter bees, bumblebees, orchard bees, etc.) are the most efficient pollinators of blueberries. Several varieties of blueberry require, and almost all varieties yield better as a result of, cross-pollination. When crops and field borders are managed with beneficials in mind they are often referred to as *refugia*, and represent a new approach to pest management based on planned biodiversity. To learn more about refugia, request the ATTRA publication entitled *Farmscaping to Enhance Biological Control.*

Arthropod Pests

Rabbiteye blueberries seem more tolerant of insect damage than highbush varieties. The most common insect problem is the blueberry maggot. Although insect damage in blueberry plantings rarely reaches economic thresholds, regular monitoring by walk-throughs and use of insect

traps is advised. See chart 1 (p. 10) for more information.

Diseases

Diseases common to blueberries include mummy berry, *Botrytis*, stem blight, stem canker, phytophthora root rot, blueberry stunt, and several virus diseases. For proper disease identification, consult Cooperative Extension Service publications and related literature. Many states also have pathology laboratories associated with Cooperative Extension that can provide assistance. For a summary of blueberry diseases and their control, see chart 2 (p. 11).

Bird and Rodent Control

Birds are often serious pests of blueberries. Various methods of control have been tried—including "scare-eye" balloons, Mylar™ reflective tape, sonic devices, etc.—with varying levels of success. The problem with most repellents or scare tactics is that birds become habituated to the stimulus, and are not scared off. Sometimes, growers overcome this problem by changing the stimulus frequently—e.g., switching from balloons to Mylar™ tape or moving the balloons from one site to another. Properly applied bird netting has provided consistent and predictable control, but is expensive to purchase and set up (materials cost for 1/3 acre planting in 1992 was $659.11) (14). An Illinois study (15) found the yield increase on net-protected blueberries paid 80% of the costs of installation at a problem site. As growers report a 10-year life expectancy for netting, the investment proved profitable by the second year.

Various rodents can be problematic in blueberries, primarily voles which feed on roots and bark. Several other soil dwellers such as moles and shrews may also be present. These are largely carnivores which feed on grubs and worms; however, their tunneling can prove harmful to the plants. Rodent problems are largely confined to plantings that are mulched and those with permanently sodded middles. Clean cultivation provides little shelter and disturbs burrows. Organic alternatives include trapping, encouraging predators (e.g. setting out perches to attract raptor birds), frequent mowing of sodded middles, and managing fencerows and adjacent areas to discourage in-migration (16).

For details on options for rodent control, please refer to ATTRA's *Overview of Organic Fruit Production.* This publication also discusses management of bird problems. Cooperative Extension and the U.S. Fish and Wildlife Service also have information on rodent and bird control options.

Marketing

In the mid-90s consolidation in the food industry left fruit growers fewer marketing options. These large corporate buyers demanded that growers provide larger units of higher quality fresh product. For instance, frozen blueberry exports to Japan tripled in 1997. The North American Blueberry Council launched a feasibility study for a national promotion and research program for blueberries (17). The Council's website (see **Electronic Resources**, below) has industry information, including statistics, future prospects, promotional materials, and data on markets, including consumer, food service, and export.

According to recent market reports in *The Packer*, a considerable amount of fresh blueberries are being imported from Chile during the winter months, providing year-round availability for American consumers. However, the demand for "organically grown" fruit has continued to increase (18).

A breakthrough in value-added marketing came in the late 90's with scientific research indicating special health benefits of blueberry consumption. This research, conducted at the USDA Human Nutrition Research Center at Tufts University, continues (19). More farmers are now looking at on-farm value-added products.

Summary

Blueberries adapt well to organic culture. Costs of production may be somewhat higher using organic methods but this might be effectively

Chart 1: Insect Pests and Controls

Insect	Pesticide	Remarks and other controls
Caterpillars: Gypsy moth Bagworm Leafrollers Cranberry fruit worm	Bt var kurstaki	Apply when insects are feeding.
Fruit worms	Bt var kurstaki Pyrethrum spray*‡	Apply when insects are feeding. Must target adult flies before they lay eggs. 24 hours pre-harvest interval.
Cranberry fruit worm		Elimination of weeds and vegetative litter around plants helps cut down on overwintering protection for fruitworm cocoons. In small planting with light infestations, can be effectively controlled by picking off infested berries, which are easily detected because of the webbing and their early ripening.
Blueberry maggot		Sticky traps can be used to monitor maggot in adult stage. Sustained catch of several adult flies per week indicates that it is an optimal time to make an insecticide treatment.
Japanese beetles	Pyrethrum spray*‡ Sabadilla dust or WP‡	24 hour pre-harvest interval. Dust: apply to wet plants Clean harvesting prevents accumulation of overripe fruit, helping to prevent beetles from being attracted to plantings. Use pheromone lure-traps near but not in the planting. In small planting with light infestations, can be effectively controlled by picking beetles off the bushes by hand.
Leafroller	Bt var kurstaki Pyrethrum spray*‡	Apply when insects are feeding. 24 hour pre-harvest interval.
Mites	Ultra-fine horticultural oil	Foliar spray.
Scale insects	Ultra-fine horticultural oil	Dormant spray; remove canes weakened by scales. Monitoring can be done by wrapping sticky tape, sticky-side out, around twigs. Light-colored crawlers show up well if dark tape is used such as black electrical tape.

*Some cerfifiers restrict the use of pyrethrums to special situations; certain formulations may be prohibited.
‡Most certifiers do not allow botanical pesticides to be used as the primary method of pest control.

Chart 2: — Blueberry diseases and their control.

Fungal diseases

Mummy berry (*Monilinia vacinii-corymbosi*) — Fungus overwinters in mummified berries that have fallen to the ground. Sod or moss directly under the plant will contribute to spore production. To control this fungus, remove infested fruit ("mummies") from the plant, rake and burn the mummified berries, or cover the fallen berries with at least two inches of mulch. Cultivation during the moist spring weather will destroy the spore-forming bodies.

Botrytis Blight (*Botrytis cinerea*) — The fungus survives the winter on dead twigs and in soil organic matter. The disease is more severe when excessive nitrogen has been used, where air circulation is poor, or when frost has injured blossoms. Cultivars possessing tight fruit clusters are particularly susceptible to this disease. Remove dead berries, debris, and mulch during the winter and compost it or destroy it. Replace with new mulch. Do not place mulch against the trunk of the plant.

Anthracuose (*Colletotrichum acutatum* and *C. gloeosporioides*) — The fungus overwinters in dead or diseased twigs, fruit spurs, and cankers. Spores are released in the spring and are spread by rain and wind. Cultivars in which the ripe fruit hangs on for a long time on the bush prior to picking are especially susceptible. Removal of infected twigs by pruning, and frequent harvesting are beneficial to control. Old canes and small twiggy wood should be removed in order to increase air circulation around the fruit clusters.

Botryosphaeria Stem Blight (*Botrysphaeria dothidea*) — Removal of infected wood, pruning about 12 inches below the discolored part of the limb, is the only practical control. Since infection can be spread throughout the growing season, prune during dormancy. Fertilizer management is necessary to prevent formation of succulent shoots late in the growing season. Infection of cold-injured shoots around the base of the bush is a primary means by which this fungus enters the plants. The worst cases of stem blight occur on soils that are extremely sandy or on heavy muck soils that promote excessive growth. Genetic resistance is available and should be a primary consideration in the establishment of new plantings

Rust (*Pucciniastrum vaccinii*) — Remove and burn infected vegetation. Multiple reinfestations possible during one growing season. Native evergreen berries (but not hemlock) are suspected as the overwintering source and a necessary alternate host for completion of the fungus life cycle. It may be beneficial to remove native *Vaccinium* species from lands adjacent to cultivated bushes.

Phytophthora Root Rot (*Phytophthora cinnamomi*) — Control includes use of clean nursery stock and good field drainage. Heavy soil that becomes waterlogged or has a high water table should be avoided. Plants can be grown on raised beds to reduce risks. No recognized method for elimination of disease organism without use of soil fungicides.

Phomophis Twig Blight (*Phomopsis sp.)* — The fungus overwinters in infected plant parts. Spores released from old cankers in the spring; rain is necessary for spore release; temperatures ranging from 70–80 degrees F encourage infections; moisture stress predisposes the plant to infection. The disease is most severe after winters in which mild spells are interspersed with cold periods. Remove and destroy infected plant parts by pruning. Avoid mechanical damage such as that caused by careless pruning and cultivating. Avoid moisture stress by use of irrigation during dry periods. A fall application of lime sulfur (allowed by some organic certifiers) after leaves have dropped help reduce disease inoculum. Spring application of lime sulfur should be made early before warm weather occurs to avoid injury to plants. Refer to your state's spray guide for recommended rates and timing. Careful cultivar selection can greatly reduce the amount of twig blight experienced.

Fusicoccum Canker (*Fusicoccum sp.)* — The fungus overwinters in cankers. Spores are largely disseminated by rainwater. Cold stress may play a part in increasing disease damage. Removal of infected plant parts is essential for control. Varieties differ in their resistance to this disease.

Viral diseases

Shoestring Disease — Other than buying disease-free plants, destroying wild plants near the planting, and removing diseased plants, control does not exist. Some cultivars possess genetic resistance or tolerance.

Stunt -- The only known carrier is the sharp-nosed leafhopper, though other vectors probably exist. Diseased bushes cannot be cured. They must be removed from the field as soon as they are diagnosed. Agitation of the bush during removal will dislodge the leafhoppers, causing them to move to a neighboring healthy bush.

Bacterial disease

Bacterial Crown Gall (*Agrobacterium tumefaciens*) — The crown gall bacterium does not grow well in an acid situation, thus the disease is uncommon where soil pH is maintained in the optimum range for blueberries

counterbalanced through premium market sales. Many cultural practices, such as the use of deep mulching and sodded row-middles, are recommended for both conventional and organic blueberry production systems reflecting a more sustainable approach to commercial horticulture. Additional relevant information on growing blueberries is available through Cooperative Extension and other conventional sources. ATTRA can assist in providing further subject matter relating to organic and sustainable approaches.

References:

1) Whitworth, Julia. 1995. Blueberry Helps: Fertilizing Blueberries. Issue 1. In: Horticulture Tips. Oklahoma State University Cooperative Extension. Stillwater, OK. March.

2) Pritts, Marvin and James Hancock (ed.). 1992. Highbush Blueberry Production Guide. Northeast Regional Agricultural Guide. Northeast Regional Engineering Service, Ithaca, NY. 200 p.

3) Clark, John. Associate Professor of Horticulture, University of Arkansas at Fayetteville. Personal communication. March 18, 1997.

4) Information in this table was taken from Organic Fertilizer NPK Values Compiled, by Ross Penhallegon, in the January 1992 issue of In Good Tilth (p. 6); and Nitron's Product Guide for Natural Fertilizers & Soil Conditioners, published by Nitron Industries, Fayetteville, AR (no date).

5) Moore, J.N. , M.V. Brown and B.P. Bordelon. 1994. Plant spacing studies on highbush blueberries. Arkansas Farm Research. July–August. p. 8–9.

6) Watkins, Gordon E. 1988. Organic Blueberry Culture. Proceedings of the Seventh Annual Oklahoma Horticultural Industries Show. January 28–29. p. 45–51.

7) Schwankl, Lawrence J., and Glenn McGourty. 1992. Organic fertilizers can be injected through low volume irrigation systems. California Agriculture. September–October. p. 21–23.

8) Patten, Kim, Gary Nimr and Elizabeth Neuendorff. 1990. Evaluation of living mulch systems for rabbiteye blueberry production. HortScience. Vol. 25. No. 8. August. p. 852.

9) Watkins, Gordon. 1989. Non-toxic weed control in blueberries. Ozark Organic Growers Association newsletter. May. p. 6–7. & June–July. p. 6–7.

10) NeSmith, D. Scott and Gerard Krewer. 1995. Vegetation-free area influences growth and establishment of rabbiteye blueberry. HortScience. Vol. 30. No. 7. December. p. 1410–1412.

11) The Kerr Center for Sustainable Agriculture
P.O. Box 588
Poteau, OK 74953
918-647-9123

12) Hansen, C.M. and W. Gleason. 1965. Flame weeding of grapes, blueberries, and strawberries: A progress report. Proceedings of the Second Annual Symposium: Use of Flame in Agriculture. p. 11–12.

13) Hansen, C.M., W. Gleason and J. Hull. 1966. Flaming research. Proceedings of the Third Annual Symposium: Use of Flame in Agriculture. p. 25–26.

14) Anon. 1992. Bird-proof blueberries. Fresh Picks. February–March. p. 5–6.

15) Anon. 1991. Cost-effectiveness of anti-bird netting for blueberries. HortIdeas. April. p. 42.

16) Hauschild, Karen I. 1995. Vole management in small fruit plantings. Northland Berry News. December. p. 22–24.

17) Staff. 1994. Recent downsizing of American business changing face of the blueberry industry. Great Lakes Fruit Growers News. April. p. 32.

18) Torrice, Caleb. 1999. Organically grown blueberries rising in demand. Cornell Cooperative Extension Small Fruit News of Central New York. August. p. 1.

19) Staff. 2000. Blueberry elixir reverses age-related symptoms. Agriculture Research (USDA). February. p. 23.

Additional Resources:

Austin, M.E. Rabbiteye Blueberries: Development, Production and Marketing. AgScience Inc., Auburndale, FL.
AgScience Inc., 206 W. Bridgers Ave., Auburndale, FL 33823. (863) 967-8898. $39.

Baker, M.L. and K. Patten (eds.). 1990. Texas Blueberry Handbook. Texas A&M , Overton, TX. Approx. 100 p.
Marty Baker, P.O. Box 38, Overton, TX 75684. $12.50 (text only),$15 (3-ring binder w/index tabs). Make check payable to Blueberry Publications, Acct. 237202. (903) 834-6191.

Caruso, Frank L. and Donald C. Ramsdell. 1995. Compendium of Blueberry and Cranberry Diseases. APS Press, St. Paul, MN. 87 p.

Doughty, C.C., E.B. Adams, and L.W. Martin. 1981. Highbush Blueberry Production. Washington-Oregon-Idaho Cooperative Extension Service Bulletin. PNW 215.

Eck, P. 1988. Blueberry Science. Rutgers Univ. Press, New Brunswick, NJ. 284 p.

Eck, P. and N.F. Childers (ed.). 1966. Blueberry Culture. Rutgers UP, New Brunswick, NJ. 378 p.

Galletta, Gene J. and David G. Himelrick (editors). 1990. Small Fruit Crop Management. Prentice Hall, Englewood Cliffs, NJ. 602 p.

Gough, R.E. 1995. The Highbush Blueberry and Its Management. Food Products Press, NY. 272 p.

Johnston, S., J. Mouten, and J. Hull, Jr. 1969. Essentials of Blueberry Culture. Michigan State University Extension Bulletin. E-590.

Moore, J.N. 1976. Adaption and Production of Blueberries in Arkansas. Arkansas Agricultural Experiment Station Bulletin. No. 804.

Pritts, Marvin and J.F. Hancock (ed.). 1992.

Highbush Blueberry Production Guide. NE Regional Ag Engineering Service, Ithaca, NY. 200 p.

Scott, D.H., A.D. Draper, and G.M. Darrow. 1978. Commercial Blueberry Growing. USDA Farmers' Bulletin No. 2254. US Gov. Printing Office, Washington, DC. 33 p.

Torrice, Caleb. (annual update). Blueberry Production Summary. Cornell Coop. Extension, Ithaca, NY. 6 p.

Electronic Resources:

Alternative Opportunities for Small Farms: Blueberry Production Review. University of Florida. http://hammock.ifas.ufl.edu/txt/fairs/ac/1360.html

Fruit and Nut Review: Blueberries. Mississippi State University. http://www.ces.msstate.edu/pubs/is1448.htm

Michigan Blueberry Growers. http://www.blueberries.com

North American Blueberry Council. http://www.blueberry.org

Northwest Berry & Grape Infonet. Oregon State University. http://www.orst.edu/dept/infonet/

Suggestions for Establishing a Blueberry Planting in Western North Carolina. North Carolina State University. http://www.ces.ncsu.edu/depts/hort/hil/hil-201.html

U.C. Fruit & Nut Research and Information Center. University of California–Davis. http://pom44.ucdavis.edu

Wild Blueberry Association of North America. Bangor, ME. http://www.wildblueberries.com

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The electronic version of **Organic Blueberry Production** is located at:
http://www.attra.org/attra-pub/blueberry.html

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