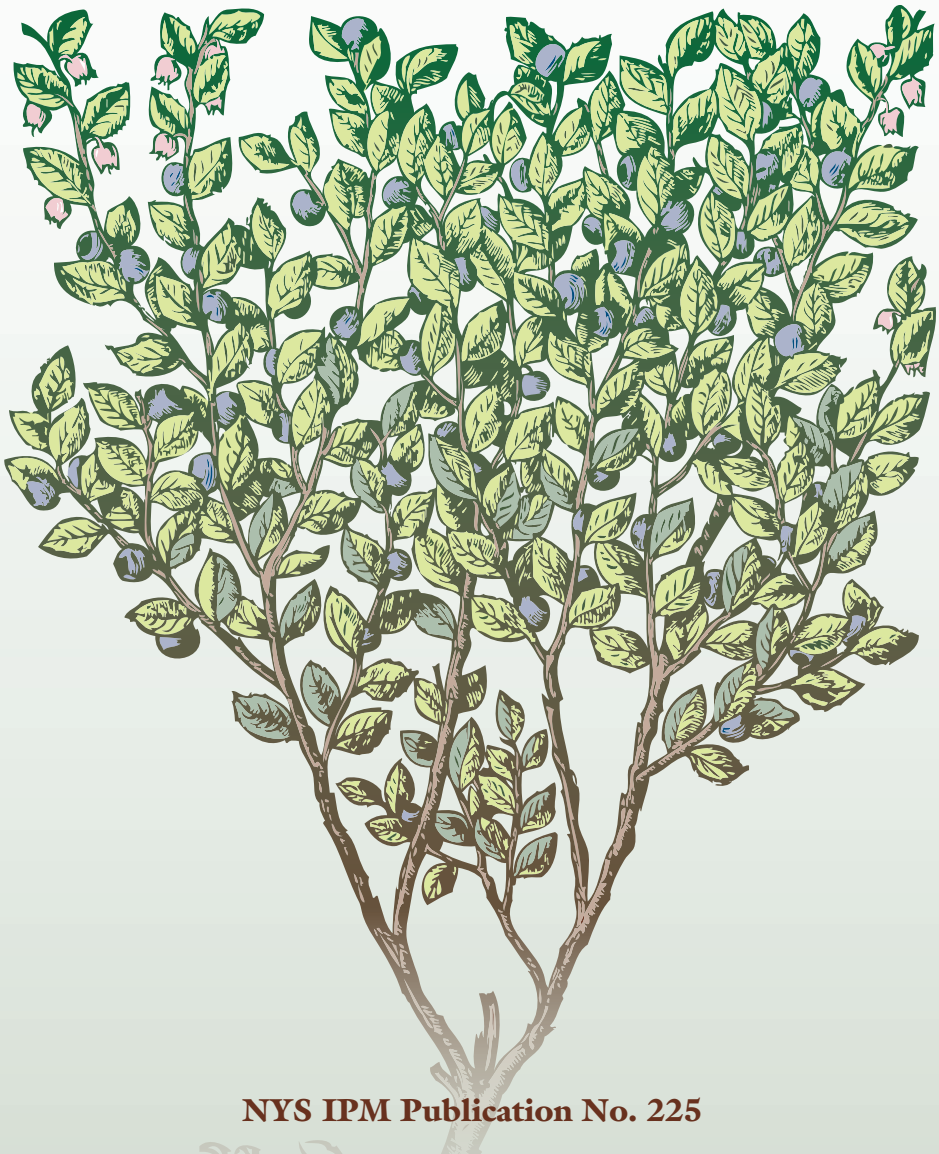
2010

Production Guide for Organic Blueberries



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New York State
Department of
Agriculture & Markets

2010 Production Guide for
Organic Blueberries

Coordinating Editors

Juliet Carroll (Cornell University, New York State IPM Program)

Marvin Pritts* (Cornell University, Department of Horticulture)

Catherine Heidenreich* (Cornell University, Department of Horticulture)

Contributors and Resources

Kerik Cox* (Cornell University, Department of Plant Pathology and Plant Microbe-Biology)

Greg Loeb* (Cornell University, Department of Entomology)

Michael Helms* (Cornell University, Pesticide Management Education Program)

Andrew Landers (Cornell University, Department of Entomology)

Paul Curtis (Cornell University, Department of Natural Resources)

Laura McDermott (Cornell Cooperative Extension, Capital District Vegetable and Small Fruit Program)

**Pesticide Information and Regulatory Compliance*

Staff Writers

Elizabeth Graeper Thomas (Cornell University, New York State IPM Program)

Theodora Bucien (Cornell University, New York State IPM Program)

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INTRODUCTION

This guide for organic blueberry production is an outline of cultural and pest management practices and includes topics that have an impact on improving plant health and reducing pest problems. The guide is divided into sections, but the interrelated quality of organic cropping systems makes each section relevant to the others.

Of all the fruit crops grown in the Northeast, blueberries are perhaps the most amenable to organic production. Pest problems are fewer than with most other fruits, and they preferentially use ammonium nitrogen which is a direct breakdown product of organic nitrogen sources such as manure. Even with these advantages, more research on growing blueberries organically is needed, especially in the area of pest management. This guide attempts to compile the most current information available, but acknowledges that effective means of organic control are not available for some pests. Future revisions to this guide will incorporate new information providing organic growers with a complete set of useful practices to help them achieve success.

This guide uses the term Integrated Pest Management (IPM), which has an affinity to organic production in its emphasis on the use of cultural practices to minimize pest outbreaks. With the limited pest control products available in many organic production systems, IPM techniques such as keeping accurate pest history records, selecting the proper site, and preventing pest outbreaks through use of sanitation, variety selection and biological controls are essential to producing a high quality crop.

The focus of this guide is nutrient and pest management. For a more comprehensive understanding of blueberry production we suggest the following resources: Highbush Blueberry Production Guide, NRAES-55 available for purchase from: www.nraes.org/, and Blueberries: Organic Production, available online at: http://attra.ncat.org/attra-pub/blueberry.html.

All website addresses and links are listed in section 10. References. A glossary of terms used in this guide is included at the end in section 11.

1. GENERAL ORGANIC MANAGEMENT PRACTICES

1.1 Organic Certification

Who needs to be certified?

Operations or portions of operations that produce or handle agricultural products that are intended to be sold, labeled, or represented as "100 percent organic," "organic," or "made with organic ingredients" or food group(s).

Farming operations that gross more than $5,000 per year in organic products and want to use the organic label must be certified by a USDA National Organic Program (NOP) accredited certifying agency. The choice of certifier may be dictated by the processor or by the target market. A list of accredited certifiers operating in New York can be found on the New York State Department of Agriculture and Markets Organic Farming Resource Center web page. See more certification details in this guide under Section 3.1: Organic Certification Site Requirements.

Who does NOT need to be certified?

Producers and handling (processing) operations that sell less than $5,000 a year in organic agricultural products. Although exempt from certification, these producers and handlers must abide by the national standards for organic products and may label their products as organic. Handlers, including final retailers, that: do not process or repackage products; only handle products with less than 70 percent organic ingredients; process or prepare, on the premises of the establishment, raw and ready-to-eat food labeled organic; choose to use the word organic only on the information panel; and handle products that are packaged or otherwise enclosed in a container prior to being received by the operation and remain in the same package. More information can be found at the National Organic Program USDA Agricultural Marketing Service website.

1.2 Organic Farm Plan

An organic farm plan is central to the certification process, and is a good management tool, regardless. The farm plan describes production, handling, and record-keeping systems, and demonstrates to certifiers an understanding of organic practices for a specific crop. The process of developing the plan can be very valuable in terms of anticipating potential issues and challenges, and fosters thinking of the farm as a whole system. Soil, nutrient, pest, and weed management are all interrelated on organic farms and must be managed in concert for success. Certifying organizations may be able to provide a template for the farm plan. The following description of the farm plan is from the NOP web site:

The Organic Food Production Act of 1990 (OFPA or Act) requires that all crop, wild crop, livestock, and handling operations requiring certification submit an organic system plan to their certifying agent and, where applicable, the State Organic Program (SOP). The organic system plan is a detailed description of how an operation will achieve, document, and sustain compliance with all applicable provisions in the OFPA and these regulations. The certifying agent must concur that the proposed organic system plan fulfills the requirements of subpart C, and any subsequent modification of the organic plan by the producer or handler must receive the approval of the certifying agent.

Find more details at the USDA Agricultural Marketing Service's National Organic Program website. The National Sustainable Agriculture Information Service, (formerly ATTRA), has produced a guide to organic certification that includes templates for developing an organic farm plan. The Rodale Institute has also developed resources for transitioning to organic and developing an organic farm plan.

It is important to note that the USDA National Organic Program requires that applicants for certification must keep accurate post-certification records for 5 years concerning the production, harvesting, and handling of agricultural products that are to be sold as organic. These records must document that the operation is in compliance with the regulations and verify the information provided to the certifying agent. Access to these records must be provided to authorized representatives of the USDA, including the certifying agent.

2. SOIL HEALTH

Healthy soil is the basis of organic farming. Regular additions of organic matter in the form of cover crops, compost, or manure create a soil that is biologically active, with good structure and capacity to hold nutrients and water (any raw manure applications should occur at least 120 days before harvest). Decomposing plant materials will support a diverse pool of microbes, including those that break down organic matter into plant-available nutrients as well as others that compete with plant pathogens in the soil and on the root surface. The practice of crop rotation to promote a healthy soil should be initiated in the one or two years prior to planting establishment or is limited to row middles in a perennial crop such as blueberries. Organic growers must attend to the connection between soil, nutrients, pests, and weeds to succeed. An excellent resource for additional information on soils and soil health is Building Soils for Better Crops, 3rd edition, by Fred Magdoff and Harold Van Es, 2009, available from SARE, Sustainable Agriculture Research and Education, www.sare.org/publications/soils.htm. For more information, refer to the Cornell Soil Health website, www.hort.cornell.edu/soilhealth.

3. SITE SELECTION

For organic blueberry production, the importance of proper site selection cannot be over-emphasized. Blueberries are a perennial crop, meaning decisions made on site selection and improvement prior to planting will impact all aspects of production for years to come. Once blueberries are planted it is very difficult to make major changes to improve soil and air drainage, or to soil tilth, pH, or nutrient status. Improving soil structure or eliminating soil compaction layers in an established blueberry planting rarely proves successful. Consider that an ideal blueberry soil should have a pH of 4.5, have 18 inches or more of rooting depth, and be well drained; these requirements make it imperative to conduct needed site improvements prior to planting.

Assuming that the soil pH is 4.5 or can be adjusted, there are still three criteria that must be met before blueberries can be successfully grown on a given site: appropriate soil texture, good internal soil drainage, and low soil calcium. Avoid clay soils as they tend not to drain well because of small pore space and the fibrous roots of blueberries have a difficult time penetrating heavy soil. Avoid soils with high calcium content (>2000 lb/acre or >1000 ppm) which are also unacceptable for blueberry production. Even with a low pH, high calcium will interfere with the physiology of the plant. Sites not meeting any one of the 3 criteria should not be planted to blueberries. Soil amendments (e.g. compost, peat, sand) can help alleviate these conditions on a small scale, but large scale adjustments would not be economical.

Weather plays a critical role in site selection, as well. The macroclimate, mesoclimate and microclimate of a blueberry site play important roles in variety selection and potential profitability. Of particular importance are the potential for spring frosts, winter minimum temperatures, length of the growing season, and growing season heat accumulation. Blueberry plantings should be planted away from any wild relatives or abandoned plantings which can serve as reservoirs of pests and diseases. More detailed information on the site selection information presented here also can be found in The Highbush Blueberry Production Guide, NRAES-55.

A web-based, interactive site selection tool, the New York Vineyard Site Evaluation System www.nyvineyardsite.org, uses specific climate information with a 3 kilometer resolution, based on 30 years of weather data, to determine the suitability of your site for different grape varieties. Although the tool was developed for vineyards, the map-based system integrates information on climate, topography, soils, and winter low temperatures much of which may be applicable to site selection for blueberry varieties across the state.

3.1 Organic Certification Site Requirements

The National Organic Program regulations include requirements that affect site selection. Fields must not have been treated with prohibited products for three years prior to harvest of the certified organic crop. If replanting blueberries as a certified organic grower, the mandated 1-year crop rotation out of blueberries must be observed, though a 3-4 year rotation may prove more beneficial to break disease and insect life cycles and reduce pest pressure (e.g. anthracnose, mummy berry, Fusicoccum and Phomopsis cankers, and blueberry maggot). Adequate buffer zones must exist between certified organic and conventionally grown crops to prevent drift of prohibited materials onto certified organic crops. The buffer zones must be either a barrier (diversion ditch or dense hedgerow) or an area of sufficient size and distance. The buffer zone needed will vary depending on equipment used on adjacent non-certified land. For example, use of high-pressure spray equipment or aerial pesticide applications in adjacent fields will increase the buffer zone size. Check with your certifier for site-specific buffer requirements. Buffer zone sizes commonly range from 20 to 250 ft, depending on adjacent field practices. Buffers can include windbreaks and living barriers such as a dense hedgerow. A dense hedgerow less than 50 ft wide may offer better protection from contamination than a 50-ft-wide open buffer zone. The National Organic Farmers Association of New York (NOFA NY) standards prohibit a field's buffer zone to be planted to the same crop, with the exception of hay and pasture fields. Crops grown in the buffer zone may not be marketed as certified organic, or used for feed or bedding for certified organic livestock or dairy cattle.

3.2 Soil and Air Drainage and Soil Depth

Preparations for a blueberry planting must begin at least one year in advance. Selecting a site with good air and water drainage is essential for successful organic production. A nutritionally healthy planting in a well-drained soil with exposure to air movement is least susceptible to damage from pests.

Blueberries need good internal soil drainage to grow. Wet soils restrict root growth and respiration, resulting in weak growth, reduced yields and small plant size. Coarse-textured and gravelly soils have excellent soil drainage, but heavier soils, or soils with perched water tables often need drainage tiles to remove excess water and improve internal soil drainage. Drainage tile is best installed before planting. Where possible, tile layout should be coordinated with planting design, so that tile lines run parallel to rows. Local soil and water conservation districts and private tiling contractors can provide technical assistance in designing a drainage plan, but keep in mind that many base their designs on annual row crops. Blueberry plantings often require more intensive drainage than row crops. Planting on berms or raised beds will also help reduce issues with less than adequate drainage.

Air drainage is an important consideration in choosing a blueberry site. Cold air, like water, runs down hill, and collects in low areas, or areas where trees or hedgerows obstruct airflow. These 'frost pockets' increase the risk of both mid-winter cold injury and spring or fall frosts. Selecting a site with a gentle slope and good air drainage will reduce the risk of cold or frost injury. If this is not an alternative, selecting late flowering varieties may be an option to minimize frost injury. Overhead irrigation, where available is also a frost protection option. Good air drainage also promotes faster drying of foliage which will reduce the duration and frequency of disease infection periods making it an essential organic disease management strategy. Wide row spacing can provide improved air circulation in the planting, with 12 ft row centers and 5 ft between plants in the row allowing for good air movement.

Blueberries have a shallow root system that is sensitive to drought and intolerant of standing water. Organic blueberry growers may benefit from not driving heavy equipment in the row middles to prevent soil compaction. Rooting depth of at least 18 inches is considered important for adequate growth and cropping levels. Digging test soil pits can help you evaluate potential rooting depth and drainage issues and evaluate what measures to take to address soil management issues before planting. Soils that are well-drained, acid (pH 4.5), and sandy loams with an organic matter content greater than 3% are considered ideal.

3.3 Soil Testing

Knowing all you can about the soil of a potential blueberry site will allow for better management decisions prior to planting. Soil testing is recommended to provide information on pH, availability of major and minor nutrients, organic matter and cation exchange capacity. A pH between 4.0 and 5.5 is suggested for blueberry production, with 4.5 to 5.0 optimum. Knowing the

current soil pH will determine the needed amount, if any, of sulfur to apply to adjust the soil pH. Soil calcium content should be below 2000 lb/acre (below 1000 ppm). See Table 6.1 for soil and tissue testing laboratories and refer to section 6, Nutrient Management, for more information.

A nematode analysis performed on representative soil samples is a wise step in the year or two prior to planting since it will allow time for using a cover crop to reduce plant parasitic nematode populations, see section 4, Cover Crops, for more information. Samples may be submitted for nematode testing to the Plant Disease Diagnostic Clinic, College of Agriculture and Life Sciences, Ithaca, NY. For more information and fee schedules visit their website at www.plantclinic.cornell.edu. The best time for collecting samples for nematode testing is during summer, when soils are moist, not dry. A minimum of 6 soil subsamples, approx. 1″ diameter and 4″ deep should be collected randomly from an area approx. ½ acre in size. Gently mix samples together, transfer about 1 pint of mixed soil to a plastic bag, and ship as soon as possible to the diagnostic lab. Refrigerate sample if it cannot be shipped immediately.

3.4 Irrigation Water Source

Another important criterion to consider when selecting a blueberry planting site is irrigation water quantity and quality. The irrigation water source should provide sufficient volume of water to irrigate as needed during the growing season. Blueberries typically require 20 to 25 inches of rainfall during the growing season. Be sure to have a water test done on irrigation water sources prior to site selection to determine its physical, chemical, and biological constituents. Irrigation water pH should be 5.5 or below. When site criteria have been met but soil or irrigation water pH is still above 5.5, then acidification of irrigation water may be appropriate, otherwise soil pH may increase over time and cause deleterious effects on the blueberry plants. Always check with your certifier on the products used for lowering irrigation water pH. Irrigation water should also have a low salt content (<2.0 ds/m; preferably <1.0 ds/m) as blueberries are a salt-sensitive fruit crop. For more information on this topic see: Highbush Blueberry Production Guide, NRAES-55.

4. COVER CROPS – BEFORE PLANTING & ROW MIDDLES

Cover crops are grown for their valuable effect on soil properties, such as organic matter, and, in blueberries, on their ability to provide nutrients to the plant, control weeds between the rows, prevent erosion on slopes and to assist in the manipulation of soil moisture. They can also improve water infiltration into the soil, maintain populations of beneficial fungi, and may help control insects, diseases, and nematodes. To be effective, cover crops should be treated as any other valuable crop on the farm, with their cultural requirements carefully considered and met, including nutrient requirements; susceptibility, tolerance, or antagonism to root pathogens and other pests; life cycle; and mowing/incorporation methods. See Table 4.1 for information on specific cover crops useful as pre-plant, incorporated green manures or as ground covers in the row middles.

A certified organic farmer is required to plant certified organic cover crop seed. If, after contacting at least three suppliers, organic seed is not available, then the certifier may allow conventional seed to be used. Suppliers should provide a purity test for cover crop seed. Always inspect the seed for contamination with weed seeds and return if it is not clean. Cover crop seed is a common route for introduction of new weed species onto farms.

4.1 Goals and Timing for Preplant Cover Crops

Cover crops play an important role in a blueberry planting in the years prior to planting through improvement of soil organic matter, breaking up of compaction layers, erosion control and suppression or elimination of weeds. Goals should be established for choosing a cover crop; for example, the crop can add nitrogen, smother weeds, or both. The cover crop will best achieve some of these goals if it is used for one to two growing seasons prior to plant establishment. Because the blueberry planting can live for 100 years or more, a key benefit from preplant cover cropping will be in promoting plant establishment by minimizing weed competition during this crucial phase.

Cover crops planted in late summer will suppress annual weed growth, improve soil texture, provide organic matter, and may increase soil nitrogen. The cover crop can be incorporated in late fall or in the spring before planting. Certain cover crops (marigold, brassicas) will either suppress or resist nematode populations. These should be considered where reduction of nematode populations is needed. See Table 4.1. In addition to producing large amounts of biomass that out-compete other plant species, some cover crops (ryegrass) can inhibit weed growth through allelopathy, the chemical inhibition of one plant species by another. Rye provides allelopathic suppression of weeds when used as a cover crop, and when crop residues are retained as mulch. Rye residues retained on the soil surface release chemicals that inhibit germination and seedling growth of many grass and broadleaf weed species. Retention of residue on the soil surface can be accomplished by mowing before seed head formation.

Table 4.1. Cover Crops for Blueberries: Cultural Requirements and Crop Benefits						
Species	**Use in Blueberry Plantings**	**Planting Dates**	**Life Cycle**	**Soil Type Preference**	**Seeding (Lb/A)**	**Comments**
Barley	Preplant	Early-mid Aug.	Annual	Most	75-100	+Mow or incorporate before seed formation
Brassicas e.g. mustards, rapeseed	Preplant	April OR late Aug.-early Sept.	Annual / biennial	Loam to clay	5-12	+Good dual purpose cover & forage +Establishes quickly in cool weather +Mow or incorporate before seed formation +Biofumigant properties
Buckwheat	Preplant	Late spring-early summer	Summer annual	Most	35-134	+Rapid grower (warm season) +Good catch or smother crop +Good short-term soil improver for poor soils +Mow or incorporate before seed formation +Will winter kill
Cereal Rye	Preplant	August-early October	Winter annual	Sandy to clay loams	60-200	+Most cold-tolerant cover crop +Excellent allelopathic weed control +Good catch crop +Rapid germination & growth +Mow or incorporate before seed formation +Temporary N (nitrogen) tie-up when turned under
Fescues fine (red, hard) tall	Row middles	April-May OR late Aug.-Sept.	Long-lived perennial	Most	70-100	+Very good low-maintenance permanent cover, especially in infertile, acid, droughty &/or shady sites +Tall - high vigor, more frequent mowing, moderately high water use +Fine - low vigor, less frequent mowing, moderate water use
Marigold	Preplant	Late May-June	Annual	Most	5-10	+Will winter kill +Biofumigant properties
Oats	Preplant	Mid-April OR late Aug.-mid Sept.	Summer annual	Silt & clay loams	60-100	+Incorporate in late June when planted in the spring +Rapid growth +Ideal quick cover crop +When planted in late summer, will winter kill
Ryegrass	Row middles	August-early Sept.	Short-lived perennial	Most	14-35	+Rapid growth +Good catch crop +Heavy N & moisture users
Vetch [1]	Preplant	August	Annual / biennial	Most	30-40	+Does not need added N +Mow or incorporate before seed formation
Wheat	Preplant	Early-mid Sept.	Winter annual	Most	80-100	+Mow or incorporate before seed formation

Adapted from M. Sarrantonio. 1994. Northeast Cover Crop Handbook; the Mid-Atlantic Berry Guide for Commercial Growers. 2008. Penn State Univ; and the Pest Management Guidelines for Berry Crops. 2009. Cornell Univ.

[1] Legumes may benefit from inoculation of seed with nitrogen-fixing bacteria when planted in a field for the first time. Check with your certifier for allowable sources of inoculum.

See Cornell's online decision tool to match goals, season, and cover crop. Although written for vegetable growers it has comprehensive information on various cover crops. Another resource for determining the best cover crop for your situation is *Northeast Cover Crop Handbook*, by Marianne Sarrantonio.

Allowing cover crop residue to remain on the soil surface might make it easier to fit into a crop rotation and will help to conserve soil water. Keep in mind that some of the nitrogen contained in the residue will be lost to the atmosphere, and total organic matter added to the soil will be reduced. Turning under the cover crop will speed up decomposition and nitrogen release from the crop residue.

4.2 Cover Crops for Row Middles

Use of cover crops in the row middles (the area between the plant-rows) in blueberry plantings can have both beneficial and detrimental impacts, but most growers consider the benefits to outweigh the disadvantages. The main disadvantages are the cost of establishment and competition that can occur during the critical 30-day post bloom period. In some areas prone to spring frost, bare soil middles provide greater protection because the dark soil holds more heat. However, even without planting a specific cover crop between rows, the middle vegetation will need to be managed, either by regular mowing or cultivating. Permanent row-middle alleyways require regular mowing as well, but the advantages are improved traction for equipment, reduced soil rutting and compaction, little dust, mud, and erosion, biodiversity for the planting agroecosystem, and increased soil organic matter. Growers like the ability to work in the fields shortly after a rain. This is often not possible with bare or weedy alleyways.

Three types of sod are suggested for blueberry plantings: perennial tall fescue, hard fescues, or perennial ryegrass (Table 4.1). Each is tolerant to low pH and fertility, drought, and disease, competes with weeds effectively, and does not spread into planting rows.

Although sod is preferred, it is possible to plant different species in the row middles, but these should be tolerant of low pH and outcompete most weeds. In most plantings there is an endemic seed bank of clovers (*Trifolium* spp.), plantain (*Plantago* sp.), dandelions (*Taraxacum*) and other herbaceous broadleaf plants that will naturally establish within a mowed grass lane. When blueberries are flowering, mow flowering groundcovers and weeds to remove their flowers and encourage bees and other pollinators to visit blueberry flowers.

Bear in mind that weed species may become infected with and serve as reservoirs of the soilborn ringspot viruses (Tomato ringspot virus and Tobacco ringspot virus) which, in the presence of the nematode vector, can spread to and infect blueberry plants, leading to slow decline and death in sensitive varieties.

5. VARIETY SELECTION

Blueberry varieties are grouped into early-season, early mid season, mid-season and late season varieties, depending on when fruit ripens. Consider the needs of your market when selecting blueberry varieties and maximize your returns by choosing varieties that bloom and mature at staggered times during the season, according to your market's preferences and availability of labor to harvest the crop. Availability of bees to pollinate the crop should also be considered, mason bees, bumble bees, wild bees, and honey bees are often used by blueberry growers and varieties vary in their pollination requirements; refer to the Highbush Blueberry Production Guide, NRAES-55 available for purchase from: www.nraes.org/ for more information.

In organic blueberry production the variety's relative resistance or susceptibility to fungal diseases can also be an important factor because of the limited number of organic fungicides that are available for disease management. Resistant varieties, where known, are listed in the disease management tables in section 7. If susceptible varieties are considered, the importance of site, canopy management, sanitation and the selection of proper fungicides and application procedures will increase. Overall, for successful organic production, blueberry varieties should be vigorous enough to tolerate marginal conditions, weed competition, and be less prone to fruit rots.

Varieties which have the best potential for organic production in New York State include:

Early/midseason: Draper, Bluejay, Northland
Midseason: Bluecrop
Late season: Aurora, Elliott, Liberty, Nelson

Growers must also consider where they obtain their planting stock. According to language in the USDA-NOP regulation §205.202, "the producer must use organically grown seeds, annual seedlings, and planting stock. Seed and planting stock treated with substances that appear on the National List may be used when an organically produced or untreated variety is not commercially available. Planting stock used to produce a perennial crop may be sold as organically produced planting stock after it has been maintained under a system of organic management for at least 1 year. Seeds, annual seedlings, and planting stock treated with prohibited substances may be used to produce an organic crop when the application of the substance is a requirement of Federal or State phytosanitary regulations."

With the limited availability of organically certified planting material, blueberry growers will likely be able justify the use of non-organic sources to their certifying agency. Furthermore, because blueberry plants typically do not bear fruit prior to year three or four after planting, the requirements for organic transition would likely be met between the time of planting and the first harvested crop.

6. NUTRIENT MANAGEMENT

To produce a healthy crop, soluble nutrients must be available from the soil in amounts that meet the minimum requirements for the whole plant. The challenge in organic systems is balancing soil fertility to supply required plant nutrients at a time and at sufficient levels to support healthy plant growth. Plant growth, and hence nutrient demand, is highest during shoot growth in spring, yet soils can still be cool and limit nutrient availability and uptake then. Conversely, too much nutrient availability in fall (when soils are warmed and nutrient release is greater) can increase the risk of winter injury in a crop like blueberries. Restrictions in any one of the needed nutrients will slow growth and can reduce crop quality and yields. In blueberry plantings, the key considerations when managing nutrition organically is to adjust soil pH and nutrient amendments before planting and to provide adequate nutrition (especially nitrogen) in established plantings by understanding carbon to nitrogen ratios and release rates.

Organic growers often speak of feeding the soil rather than feeding the plant. A more accurate statement is that organic growers focus their fertility program on feeding soil microorganisms rather than the plant. Soil microbes decompose organic matter to release nutrients and convert organic matter to more stable forms such as humus. This breakdown of soil organic matter occurs throughout the growing season, depending on soil temperatures, water availability and soil quality. The released nutrients are then held on soil particles or humus making them available to crops or cover crops for plant growth. Amending soils with compost, cover crops, or crop residues also provides a food source for soil microorganisms and when turned into the soil, starts the nutrient cycle again.

One goal of the grower is to optimize resource use efficiency (land, water, nutrients) to optimize plant growth and fruit yield. Plant size and yield can be influenced by water and nutrient supply (i.e. adequate water is needed for adequate nutrient uptake). Weak plants with few, small leaves and short shoots will intercept insufficient sunlight to produce adequate yields in the current season or to develop flower buds for the next season. Conversely, over-stimulated plants with abundant large, dark green leaves have low water use efficiency, are self-shaded, are more prone to winter injury, diseases and insect feeding, and produce fewer fruit. Organic blueberry plantings should strive to balance soil nutrient availability—via irrigation, organic matter content, soil pH, and microbial activity—with plant growth and production goals.

Nutrient demand is greatest during green shoot and fruit development when reserve nutrients carried over from the previous year have been used up and the plant is actively growing. Plant age, vegetative growth, and fruit yield determine the need for nutrients during the growing season. In general, blueberries have a lower demand for nutrients than other fruit crops and require little supplemental fertilizer.

6.1 Soil and Leaf Analysis

Regular soil and leaf analysis helps monitor nutrient levels. Choose a reputable nutrient testing lab (see Table 6.1) and use it consistently to avoid discrepancies caused by different extraction methods. It is recommended that regular leaf testing be incorporated into a fertility management program with soil testing to assist in determining the plants' nutrient status and to make sure that what is in the soil is making it into the plants in the proper amounts. It is recommended that soil and leaf tests be completed in each block a minimum of every three years. Leaf testing is especially crucial in getting the information needed to make management decisions in problem areas of the planting and should be used on a more frequent basis, if needed.

Table 6.1. Nutrient Testing Laboratories

Testing Laboratory	Web URL	Soil	Leaf	Compost/ Manure	Forage
Agro-One (Cornell Recommendations)	www.dairyone.com/AgroOne/	x	x	x	x
Agri Analysis, Inc.	www.agrianalysis.com/		x	x	
A&L Eastern Agricultural Laboratories, Inc.	www.al-labs-eastern.com/	x	x	x	
Penn State Agricultural Analytical Services Lab.	www.aasl.psu.edu/	x	x	x	
University of Massachusetts	www.umass.edu/plsoils/soiltest/	x	x	x	
University of Maine	anlab.umesci.maine.edu/	x	x	x	x

Table 6.2 gives the target values for blueberry leaf nutrients sampled in late July or early August in the Northeast. Regular soil testing helps monitor nutrient levels, in particular phosphorus (P) and potassium (K). The source of these nutrients depends on soil type and historic soil management. Some soils are naturally high in P and K, or have a history of manure applications that have resulted in elevated levels. Additional plant available nutrients are supplied by decomposed soil organic matter or through specific soluble nutrient amendments applied during the growing season in organically managed systems. Many types of organic fertilizers are available to supplement the nutrients supplied by the soil. ALWAYS check with your certifier before using any product to be sure it is approved.

Table 6.2. Deficient, sufficient, and excessive nutrient concentrations in blueberry leaves.

		Target values (ppm, unless otherwise noted)		
Nutrient	**Symbol**	**Deficient Below**	**Sufficient**	**Excess Above**
Nitrogen	N	1.70%	1.70-2.10%	2.30%
Phosphorus	P	0.08%	0.10-0.40%	0.60%
Potassium	K	0.35%	0.40-0.65%	0.90%
Calcium	Ca	0.13%	0.30-0.80%	1.00%
Magnesium	Mg	0.10%	0.15-0.30%	0.40%
Sulfur	S	—	0.12-0.20%	—
Boron	B	20	30-70	200
Copper	Cu	5	5-20	—
Iron	Fe	60	60-200	400
Manganese	Mn	25	50-350	450
Zinc	Zn	8	8-30	80

Adapted from: Hart, Hansen and Strik (1992) Nutrient Management. Chpt. 11 In: Highbush Blueberry Production Guide. M.P. Pritts and J.F. Hancock (eds.). NRAES-55. Ithaca, NY.
Note: ppm is parts per million.
% by dry weight of blueberry leaf

6.2 Soil pH

Maintaining a soil pH of 4.5 to 5.0 is best for blueberries, ideal is pH 4.5. Blueberries will tolerate soil pH between 3.8 and 5.5 if the organic content of the soil is high. The low soil pH is required to prevent nutrient deficiencies, especially iron. Sulfur is useful for lowering the soil pH for blueberries. The amount of sulfur required depends on soil type, cation exchange capacity, and current pH, see table 6.3. Apply sulfur to the entire field intended for blueberry production prior to planting. During site preparation, it is not recommended to acidify only the strips into which blueberries will be planted. In established plantings on a high pH soil, sulfur also can be used until pH 4.5 is achieved. Apply no more than 400 lb/acre per year, preferably split between fall and spring. In established plantings, apply the sulfur in a band in the plant row or in a circle around each plant, roughly corresponding to the foliage drip edge. Refer to CALCULATING THE AMOUNT OF PESTICIDE TO USE in Section 8.1 for converting amounts per acre to amounts needed for smaller areas.

Table 6.3. Approximate amounts of sulfur (lb/Acre) required to lower soil pH to 4.5.

	Soil type		
Current pH	**Sand**	**Loam**	**Clay**
5.0	175	530	800
5.5	350	1050	1600
6.0	660	2020	3030
6.5	840	2550	3830

Prilled sulfur formulations are preferred for soil application because they are easier to work with, provide better coverage, and are cheaper than powdered sulfur. Prilled sulfur takes about one year or more to oxidize and reduce soil pH. Organic growers sometimes increase their applications of peat moss at planting time, since it too can be a soil acidifier, reducing the need for sulfur. While costly, peat is resistant to decomposition and provides the additional benefit of increasing soil humus. For more information consult *Blueberries: Organic Production*, online at attra.ncat.org/attra-pub/blueberry.html.

6.3 Managing Nutrients

Follow the recommendations of the soil test when adding nutrients to prepare a site for planting. If preplant recommendations are followed, additional phosphorus and potassium likely will not be required unless the soil is very sandy. If interpreting your own soil tests, it is important to know the phosphorus extraction method used by your analytical lab in order to get a proper

recommendation. Refer to CALCULATING THE AMOUNT OF PESTICIDE TO USE and Tables 8.1, 8.2, and 8.3 in Section 8.1 for converting amounts per acre to amounts needed for smaller areas and for measuring and mixing small amounts.

Table 6.4. Available Potassium in Organic Fertilizers

	Pounds of Fertilizer/Acre to Provide given Pounds of K_2O per acre:				
Sources	**20**	**40**	**60**	**80**	**100**
Sul-Po-Mag 22% K_2O also contains 11% Mg	90	180	270	360	450
Wood ash (dry, fine, grey) 5% K_2O, also raises pH	400	800	1200	1600	2000
Alfalfa meal* 2% K_2O, also contains 2.5% N and 2% P	1000	2000	3000	4000	5000
Greensand or Granite dust 1% K_2O (x 4)**	8000	16000	24000	32000	40000
Potassium sulfate 50% K_2O	40	80	120	160	200

*Only non-GMO sources of alfalfa may be used. Check with your certifier.

**Application rates for some materials are multiplied to adjust for their slow to very slow release rates. Should be broadcast and incorporated prior to planting.

Table 6.5. Available Phosphorous in Organic Fertilizers

	Pounds of Fertilizer/Acre to Provide given Pounds of P_2O_5 Per Acre				
Sources	**20**	**40**	**60**	**80**	**100**
Bone meal 15% P_2O_5	130	270	400	530	670
Rock Phosphate 30% total P_2O_5 (x4)*	270	530	800	1100	1300
Fish meal 6% P_2O_5 (also contains 9% N)	330	670	1000	1330	1670

* Application rates for some materials are multiplied to adjust for their slow to very slow release rates. Should be broadcast and incorporated prior to planting.

In established plantings, base fertilizer amounts on leaf analysis. See table 6.4 for organic sources of potassium. Potassium is basic and will tend to increase soil pH, but it is important for the plants to have sufficient potassium even if soil pH may increase.

Magnesium is frequently low in blueberry plantings. In established plantings that are low to deficient in magnesium typical recommendations would be for 10-40 lb/acre actual magnesium, but follow recommendations of the leaf analysis.

Boron is frequently low in fruit plantings throughout the Northeast. If boron is required, then apply no more than 2 lb/acre actual boron in any one year.

Foliar feeding sprays may be used to supply deficient nutrients (e.g. boron, magnesium) identified through leaf analysis. However, there is no evidence that these should be applied where adequate nutrient levels exist. Check with your certifier for information on allowable sources of magnesium and boron.

Phosphorus requirements in berry crops are relatively low, and phosphorus is usually not required in established plantings. Table 6.5 lists some organic fertilizer sources of phosphorus.

6.4 Preparing a Nitrogen Budget

The carbon to nitrogen (C/N) ratio in compost can provide a guide for nitrogen release into the soil solution. When a decomposing material has a low C/N ratio (a lot of nitrogen) microbes release the excess nitrogen into the soil solution. When a material undergoing decomposition has an initially high C/N ratio (very little nitrogen), microbes will use whatever nitrogen is available for their own growth, leaving little for plants. This can result in temporary nitrogen deficiency. Once the decomposition process begins to slow and those microbes die off, they will release their nitrogen back into the soil where it will become available to plants. The rule of thumb is that if the C/N ratio is less than 20 or the material's nitrogen content is greater than 2.5%, then there will be enough nitrogen available for both decomposer microbes and plants. If the C/N ratio is above 20, then nitrogen will likely be immobilized until sufficient decomposition has taken place. One reason that additional nitrogen is recommended for plantings mulched with sawdust or wood chips (these have a very high C/N ratio) is to help overcome the temporary nitrogen deficiency that will occur during decomposition of the wood.

Develop a plan for estimating the amount of nutrients that will be released from soil organic matter, cover crops, compost, and manure. Submit soil samples for a Cornell Soil Health Test. This test includes an estimate of nitrogen mineralization rate, which indicates the potential release of N from soil organic matter. Test results will provide feedback on how the soil sample compares

to other New York soils. The results can also be useful for monitoring changes in the nitrogen mineralization rate over time and during the transition to organic production.

Management of N, and insuring adequate supply at the times of crop need, requires some planning. Prepare a nitrogen budget for organic production to estimate the amount of N released by various organic amendments as well as native soil organic matter. Examples of manures and their nutrient content are shown in Table 6.6. Compost and manure should be tested for nutrient content at an analytical lab, and cover crops can be tested at a forage testing lab (Table 6.1). Knowing nutrient content values will help evaluate if the budget plan is providing appropriate amounts of N (and other nutrients) during the growing season by comparing them to the nitrogen guidelines for blueberries (Table 6.7). For example, one concern might be the amount of calcium in pelleted poultry manure; if from egg layers whose feed may contain supplemental calcium, with sustained use a calcium imbalance could develop.

Table 6.6. Estimated Nutrient Content of Common Animal Manures

	N	P_2O_5	K_2O	N1[1]	N2[2]	P_2O_5	K_2O
	Nutrient content lb/ton			*Available nutrients lb/ton in first season*			
Dairy (with bedding)	9	4	10	6	2	3	9
Horse (with bedding)	14	4	14	6	3	3	13
Poultry (with litter)	56	45	34	45	16	36	31
Compost (from dairy manure)	12	12	26	3	2	10	23
Composted poultry manure	17	39	23	6	5	31	21
Pelleted poultry manure[3]	80	104	48	40	40	83	43
Swine (no bedding)	10	9	8	8	3	7	7
	Nutrient content lb/1000 gal.			*Available nutrients lb/1000 gal first season*			
Swine finishing (liquid)	50	55	25	25*	20+	44	23
Dairy (liquid)	28	13	25	14*	11+	10	23

1-N1 is the total N available for plant uptake when manure is incorporated within 12 hours of application.
2-N2 is the total N available for plant uptake when manure is incorporated after 7 days.
3 –Pelletized poultry manure compost. Available in New York from Kreher's.
* injected, + incorporated.
Adapted from *"Using Manure and Compost as Nutrient Sources for Fruit and Vegetable Crops"* by Carl Rosen and Peter Bierman and Penn State Agronomy Guide 2007-8.

Using the values from your soil test, estimate that 20 lbs. of nitrogen will be released from each percent organic matter in the soil. From the test of total N in any manure applied, estimate that 50% is available in the first year, and then 50% of the remaining is released in each of the next two years. So, for an application rate of 100 lbs. of N as manure, 50 lbs. would be available the first year, 25 lbs. the second, and 12.5 lbs. the third. Remember to check with your certifier on the days-to-harvest interval when using raw manure and allow a minimum of 120 days between application and harvesting. To prevent run-off, do not apply raw manure to bare ground in established blueberry plantings.

Estimate that between 10% and 25% of the N contained in compost will be available the first year. It is important to test each new mix of compost for actual amounts of the different nutrients available. Compost maturity will influence how much N is available. If the material is immature, more of the N may be available to the crop in the first year. A word of caution: using compost to provide for a crop's nutrient needs is not generally a financially viable strategy. The total volume, trucking, and application can be very expensive for the units of N available to the crop. Most stable composts should be considered as soil conditioners, improving soil health, microbial diversity, tilth, and nutrient retaining capacity.

Add together the various N values from these different organic sources to estimate the N supplying potential of the soil. There is no guarantee that these amounts will actually be available in the season, since soil temperatures, water, and crop physiology all impact the release and uptake of these soil nutrients. If early in the organic transition, a grower may consider increasing the N budget supply by 25%, to help reduce some of the risk of N being limiting to the crop. Remember that with a long-term approach to organic soil fertility, the N mineralization rates of the soil will increase. This means that more N will be available from organic

amendments because of increased soil microbial activity and diversity. Feeding these organisms different types of organic matter is essential to helping build this type of diverse biological community and ensuring long-term organic soil and crop productivity.

The annual nitrogen guidelines for blueberries are outlined in Table 6.7. Use leaf analysis for determination of nutrient status in established plantings, and adjust nitrogen fertilization accordingly (see section 6.1). The primary challenge in organic systems is synchronizing nutrient release from organic sources, particularly nitrogen, with crop requirements. In cool soils, microorganisms are less active, and nutrient release may be too slow to meet the crop needs. Once the soil warms, nutrient release may exceed crop needs. In a long-term organic nutrient management approach, most of the required crop nutrients would be in place as organic matter before the growing season starts. Nutrients needed by the crop in the early season can be supplemented by highly soluble organic amendments such as poultry manure composts or organically approved bagged fertilizer products (see Tables 6.6 and 6.8). These products can be expensive, so are most efficiently used if applied in a 3 foot band in the plant row, splitting applications between May and June.

Table 6.8 lists some commonly available fertilizers, their nutrient content, and the amount needed to provide different amounts of available nitrogen, Adapted by Vern Grubinger from the University of Maine soil testing lab.

Table 6.7. Annual Nitrogen Guidelines for Blueberries

Planting Age (years)	Amount Actual Nitrogen (lbs/Acre)
0	0
1	15
2	20
3	25
4	35
5	45
6	55
7+	65

Table 6.8. Available Nitrogen in Organic Fertilizers

	Pounds of Fertilizer/Acre to Provide given Pounds of N per Acre				
Sources	**20**	**40**	**60**	**80**	**100**
Blood meal 13% N	150	310	460	620	770
Soy meal 6% N (x 1.5)*, also contains 2% P and 3% K_2O	500	1000	1500	2000	2500
Fish meal 9% N, also contains 6% P_2O_5	220	440	670	890	1100
Alfalfa meal 2.5% N also contains 2% P and 2% K_2O	800	1600	2400	3200	4000
Feather meal 15% N (x 1.5)*	200	400	600	800	1000

* Application rates for some materials are multiplied to adjust for their slow to very slow release rates.

7. ORGANIC BLUEBERRY IPM

Organic production of blueberries can be challenging in New York State given the abundant rainfall during the growing season leading to increased pressure from diseases, insects and weeds. However, growers in New York and the eastern United States, through proper variety and site selection, strict attention to cultural practices and sanitation, and increased attention paid to scouting plantings on a weekly basis to catch pest outbreaks early, have succeeded in producing quality organic blueberries. In contrast, a failure to appreciate the risk of disease, insect and weed development, and failure to devise and implement a season-long (and multiyear) management strategy, can lead to serious crop losses in particular years. Successful IPM is essential to the sustainable production of organic blueberries.

7.1 Developing a Blueberry IPM Strategy

1. Examine your blueberry operation closely. Break it down into specific plantings, or "blueberry blocks."
2. Produce a map of each planting (or block) to record weeds, pest outbreaks, nutrient deficiencies, drainage problems, missing plants, and any other abnormalities you find.
3. Develop a record-keeping system for each planting or block.
4. Develop a scouting plan for each block and record results.
5. Monitor and record weather factors and understand basic weather patterns of the area.
6. Keep accurate records of spray applications, tools, or tactics used to manage pests.
7. Properly maintain your spray equipment, calibrate the sprayer, select appropriate nozzles, and reduce spray drift. Consult the Pesticide Application Technology website at Cornell University: www.nysaes.cornell.edu/ent/faculty/landers/pestapp/.

8. Develop a thorough knowledge of the blueberry pests you are likely to encounter during the year. This includes basic pest biology, symptoms or damage, whether they are a primary or secondary pest, scouting thresholds, and the best time to apply management practices.
9. Choose a pest management strategy for the planting (or block) that is based on all of the information you've gathered. Use the options that make the most sense for your operation.
10. Continue your pest management education.

Other resources available online, include:
New York State IPM website: nysipm.cornell.edu/fruits/
Cornell Fruit Resources: www.fruit.cornell.edu
New York State berry IPM insect and disease fact sheet index: nysipm.cornell.edu/factsheets/berries/
Cornell University Pesticide Management Education Program: pmep.cce.cornell.edu/
Pesticide Application Technology at Cornell University: www.nysaes.cornell.edu/ent/faculty/landers/pestapp/
Elements of IPM for Blueberries in New York State www.nysipm.cornell.edu/elements/blueb.asp
Network for Environment and Weather Applications (NEWA) newa.cornell.edu
Berry Diagnostic Tool www.hort.cornell.edu/diagnostic

7.2 Weed Management

Weeds are part of the blueberry planting ecosystem. Weed management decisions are based on balancing the positive and negative aspects of weed growth in the planting. Weeds can compete for water and nutrients; contaminate mechanically harvested fruit; provide alternate hosts for pests; and interfere with planting operations. Weed growth can also alter the microclimate around plants, leading to higher disease pressure and increasing the risk of spring frost. However, managing weed or cover crop growth in row middles can be a powerful tool for minimizing erosion, and improving equipment access in wet seasons. For more information on cover crops, refer to section 4.

Good preplant preparation, plant establishment, and use of cover crops in the alleyways or row middles help reduce weed pressure considerably. Perennial weeds should be eliminated from the site before planting. This can be achieved with repeated cultivation or using "green manure" cover crops that are plowed under prior to planting. Refer to sections 3 and 4 for more information.

Minimizing weed competition during plant establishment is critical to achieve optimal plant growth and yields. One approach is to use synthetic mulch such as thick plastic on each side of the plant row in the year of establishment and then roll it off and apply mulch. In organic production in NY, plastic mulch must be removed from the ground each year. In mature plantings, productivity of shallow-rooted blueberry bushes can be severely limited due to weed competition. Some level of weed control is usually necessary, as described in Table 7.1, to limit weed growth into the plant canopy which can interfere with sunlight penetration and lead to higher disease pressure.

Table 7.1. Weed management without herbicides in a blueberry planting.

Year	Month	Non-herbicidal options
Planting year*	**April**	Till to prepare for planting unless planting into killed sod.
	April - May	Hand weed.
***CRITICAL TIME FOR REDUCING WEEDS.**	**Mid-June after planting**	Hand weed and mulch within row. Mow row middles and planting borders.
	Mid-July	Hand weed. Mow row middles and planting borders.
	October	Hand weed. Mow row middles and planting borders.
	November	Hand weed. No late season mowing.
Fruiting year	**March - April**	Hand weed. Replenish mulch every 2-3 years.
	Early May	Hand weed. Mow row middles and planting borders.
	Late July after harvest	Hand weed. Mow row middles and planting borders.
	September into October	Hand weed. Mow row middles and planting borders.
	November	Hand weed. No late season mowing.

Cultivation is sometimes used as a row-middle weed management tool. However, there are negative aspects to continuous cultivation. Excessive cultivation can lead to undesirable consequences such as soil erosion, reduced soil organic matter, and breakdown in soil structure resulting in compaction and reduced permeability. Cultivation should be minimized because the blueberry root system is very shallow. If cultivation is used for row middle management it is suggested that negative effects be limited by not cultivating more often than necessary to suppress weed growth, to shallow (1-2") depths only, and with the goal of reducing, rather than completely eliminating, weed or cover crop growth.

Grasses (ryegrass, fescue) can be planted between rows and managed with regular mowing to minimize weeds within the planting, provide winter cover for row middles, and provide a good surface for equipment and foot traffic. Fescues are excellent plants for the row middles because they do not tiller and will not invade the plant row and are intolerant of sulfur when banded in the plant row. See section 4 for more information on appropriate ground covers for blueberry plantings or consult the Blueberry Production Guide (NRAES-55).

Managing weeds within the row may be one of the most difficult tasks in the production of organic blueberries. Yet it is essential because of the low competitive ability of the crop. A 4-inch layer of mulch greatly aids in weed management in blueberries. Bark or sawdust are most commonly used, but rice hulls or other appropriate ag waste, or a combination can be used, provided soil pH is kept low. Mulches are generally applied in a 3-4 foot band under the row. However, this single application every 2-3 years should not be counted on as the sole means of weed control, as annual and perennial weeds are likely to proliferate during the summer months. Financial assistance may be available from your county's Soil and Water Conservation District office to help pay for mulch.

There are a number of mechanical, thermal and animal measures that can be used to limit the effects of weeds under the row. Mechanical and thermal options include weed whackers, fixed hoes, rotary cultivators, flamers, steamers, and hot water applicators. Animal weeders have also been used with some success in organic plantings across the United States. The use of weeder geese, guinea fowl, and sheep have some effectiveness, but due to food safety concerns regarding microbial contamination of food crops from manure they must be removed from the planting 90 days prior to harvest.

It is important to keep areas around the field mowed to prevent weed seeds from blowing into the planting. Also, cultivating, mulching, and pulling weeds by hand help maintain weed-free blueberry plantings, as outlined in Table 7.1. An organic herbicide strategy alone cannot provide satisfactory weed control for organic growers.

Herbicides are applied on the basis of the sprayed area. Use the formula below to calculate rates needed. For example, if plants are set in rows 8 feet apart and there is to be a 4-foot grass aisle between the rows and a 4-foot weed-free strip within the row, only 50 percent of the given rate of herbicide will be required per planted acre.

$$\frac{\textbf{Width of weed-free strip}}{\textbf{Distance between rows}} \times \textbf{Recommended rate of herbicide} = \textbf{Rate per planted acre}$$

Organic Herbicides Labeled for Management of Weeds in Blueberry					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
GreenMatch *(citrus extract d-limonene)*	14% solution	7	4	4	There are reports of some efficacy on some broadleaves such as *Brassicas*. Minimum of 60 gallons per acre sprayed. Do not exceed 8-1/2 gallons per acre per application.
Matran EC *(clove oil)*	5 – 8% solution	None listed	0	3	25(b) active ingredient. Trials on Long Island indicate very little efficacy, even with organic surfactants.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

7.3 Principles of Insect and Disease Management

While blueberry production may be severely limited by insect pests and plant diseases, an understanding of the factors involved in their development can ensure effective management. The development of disease and insect damage is highly dependent on characteristics and conditions of the crop (host), the pathogen/pest population, and the environment. These factors all must be conducive before disease development and considerable insect damage will occur.

Pruning practices can promote plant health in the blueberry planting, some key considerations include:

- Keep vertical branches to promote upward growth
- Prevent horizontal branches which will fall to the ground
- Keep fruit off the ground
- Open the canopy to promote air drainage
- Reduce touching branches
- Open the plant center to allow easier picking
- Keep plant row middles open to allow for mowing and air flow

Characteristics of the host that influence disease and pest susceptibility include the host's vigor, physiology, and variety (genetics). Aggressiveness or virulence, abundance, and physiology are characteristics of the pest or pathogen populations that influence their ability to cause disease or damage. At the same time, abiotic environmental conditions such as temperature, moisture, light, and soil chemistry can affect both the host and pest and may promote or prevent disease. Moreover, the presence, abundance and activity of natural enemies can play an important role in determining pest status. The most successful disease pathogens and insect pests have coevolved with their hosts over many years to incite disease and damage at the most opportune times. To successfully minimize disease and pest damage, the relevant aspects of the host, pathogen/pest, and environment must all be managed within specific timeframes.

Although insect pests and plant disease pathogens are vastly different in their biology, they often have enough similarity in life history strategies to allow successful management under a single set of underlying principles. These principles include avoidance/exclusion, eradication, and protection. They are defined below.

Avoidance/exclusion: This principle focuses on preventing pathogen introduction and minimizing factors that favor the establishment of pests and pathogens. Several practices that exclude or limit pathogen and pest presence include the following:

- Select sites with good soil drainage. Install tile in plantings with less than optimal drainage and/or incorporate raised beds or berms to further promote soil drainage.
- Choose sites with good air drainage. Promote air circulation by selecting an open site, removing dead or senescent plant material through proper pruning and reducing weeds; these practices allow fruit and leaves in berry plantings to dry more quickly.
- Plant only disease free and insect free planting stock.
- Practice weed management as weeds can be hosts for blueberry pathogens and insect pests.
- Avoid planting blueberries in proximity to wild blueberries or other crops or habitats that harbor large pathogen and/or pest populations.

Eradication: This principle is concerned with the destruction of pathogen/pest populations. These practices include:

- Sanitation of plantings by removal of infected/infested plant material including overripe fruit, leaf litter, and branch prunings to eradicate pathogen and pest populations. Destruction of this material is accomplished through burning, chipping, burying in mulch, and composting.
- Pheromone traps may reduce insect numbers by trapping; however, best results are generally obtained with these products when they are used for scouting.
- Several biological control alternatives are available for insect suppression for blueberry crops including products based on formulated *Bacillus thuringiensis*. Currently, no reliable biological control tactics have been developed for blueberry diseases, although biopesticides, such as Serenade, are available.
- Chemical application of fungicides, insecticides, and miticides may reduce pathogen and pest populations below damage thresholds, but will rarely eradicate them.

Protection: This principle is founded on protection of plants from pathogen infection and pest damage. Practices that protect plants by minimizing factors favoring infection and damage include the following:

- Plant blueberry varieties that are disease resistant or less susceptible to diseases of concern.
- Mating disruption using pheromones may protect berry crops by limiting growth of insect populations. Although no mating disruption products are currently available for NY blueberry insect pests, there is ongoing work on their development.
- Avoid excessive nitrogen fertilization as many pathogens, insects and mites thrive on succulent tissues.
- Harvest fruit promptly and cool it to protect from fruit rots and insect infestations on overripe fruit.
- Applications of fungicides or insecticides may protect susceptible tissues from disease and insect damage.

7.4 Diseases of Primary Concern

Several important diseases that occur in the temperate climate of the northeastern U.S. are described below to help growers manage them with appropriate organic practices.

PHOMPOSIS CANKER New shoots wilt and die back from the tips toward the crown. The pith and cambium of infected shoots become discolored (dead). Infected mature canes suddenly wilt and collapse in the summer. Sudden death of canes on an otherwise healthy plant is a strong indicator of Phomopsis infection. Also**,** injured or weakened plants are most susceptible to infection by this fungus. A low level of tip dieback caused by Phomopsis is common in NY blueberry plantings and may not require chemical intervention.

Phomopsis Canker Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No known resistant varieties. 'Coville' and 'Jersey' are moderately susceptible varieties. 'Weymouth', 'Earliblue', and 'Berkeley' are particularly susceptible varieties.
Cultural management	Management is best accomplished by maintaining plants in a vigorous condition with proper pruning and management and by taking all possible precautions to minimize winter injury and early spring frost damage. To reduce spread, prune, and burn diseased twigs and canes as they appear, ensuring that all infected (brown) stem tissue below the canker is removed.
Chemical treatment	Apply a delayed dormant spray of an OMRI-approved lime sulfur or copper.

Pesticides Labeled for Management of Phomopsis Canker					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Miller Lime Sulfur *(lime sulfur)*	5-6 gal/100 gal of diluted spray/acre	-	48	4	Do not use within 14 days of an oil spray or when temperatures are above 85°F

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

FUSICCOCUM CANKER Reddish spots appear on the canes, frequently around a leaf scar near the ground. As the canker enlarges, a bull's-eye pattern develops. Plant parts above the canker may suddenly wilt and die during warm, dry weather, calling attention to the disease. Infection is relatively uncommon except in the colder regions of New York State.

Fusicoccum Canker Management Options	
Scouting/thresholds	None established.
Variety susceptibility	'Rancocas' is resistant. Moderately susceptible varieties are 'Coville', 'Berkeley', 'Blueray', 'Burlington', and 'Rubel'. Very susceptible varieties are 'Jersey', 'Earliblue', and 'Bluecrop'.
Cultural management	Prune and burn symptomatic canes as they appear. Take care to avoid winter injury.
Chemical treatment	No organic fungicides were available that included Fusicoccum canker on the label at the time of publishing this guide. A delayed dormant application of lime sulfur or copper for Phomopsis canker may reduce incidence of this disease as well.

BOTRYTIS BLOSSOM AND TWIG BLIGHT After several days of rainy or foggy weather, young shoots die, turn brown, and become covered with a dusty gray mass of fungus spores. Botrytis blossom and twig blight is not common in New York State, but develops occasionally. Blossom blight is usually a concern only when rainy, foggy weather prevails during the prebloom and bloom period.

IPM fact sheet on Botrytis Blossom and Twig Blight www.nysipm.cornell.edu/factsheets/berries/botrytis.pdf

Botrytis Blossom and Twig Blight Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known.
Cultural management	Avoid high rates of nitrogen fertilization. This leads to excessive succulent shoot growth, which is more susceptible to infection.
Chemical treatment	See below.

Pesticides Labeled for Management of Botrytis Blossom and Twig Blight

Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Actinovate-AG *(Streptomyces lydicus)*	3-12 oz/acre	0	1 or until spray has dried	4	For best results apply with a spreader/sticker prior to onset of disease. Re-apply at 7-14 day intervals depending on disease pressure and environmental conditions.
OxiDate *(hydrogen dioxide)*	Curative: 128fl /100gal Preventative: 40fl /100gal	0	0	4	Apply 30-100 gallons of water/acre
Serenade ASO *(Bacillus subtilis)*	2-6 qt/acre	0	4	2	Begin application prior to disease development and repeat at 7-10 day intervals or as needed. For improved performance, add an organic-approved surfactant to improve coverage.

Pesticides Labeled for Management of Botrytis Blossom and Twig Blight					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Serenade MAX *(Bacillus subtilis)*	1-3 lbs/acre	0	4	2	For improved performance add an organic-approved surfactant to improve coverage.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

ANTHRACNOSE FRUIT ROT AND BLOSSOM BLIGHT occurs sporadically in New York, primarily in seasons or locations with abundant rainfall and warm temperatures. Berry infections are not usually apparent until fruit become ripe but can occur any time during and after bloom and are favored by warm (>70F) rains. For instance, many infections occur during flowering and the green fruit stage but remain "dormant" until harvest. Infections are most common at the blossom end of the fruit. When fruit begins to color, infected regions will become slightly sunken, giving the surrounding area a puckered appearance. Under very wet or very humid conditions, a layer of slimy pink-orange colored spores will develop on the sunken infected regions.

Anthracnose Fruit Rot and Blossom Blight Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known. Particularly susceptible varieties include 'Berkeley', 'Coville', and 'Bluecrop'.
Cultural management	Prune and remove or destroy dead wood in the spring to reduce overwintering inoculum of the anthracnose fungus. Avoid excessive nitrogen fertilization; this practice promotes prolific development of succulent tissues which are highly susceptible to infection. Anthracnose is more common and pronounced on overripe fruit, so harvest promptly. Reducing overwintering inoculum and prompt harvest of ripe fruit is probably the best approach to organic disease management.
Chemical treatment	None suggested.

MUMMY BERRY Upon infection young leaves and, in some cases, new shoots will wilt, turn violet/brown, and die (similar in appearance to frost injury). The blighted tissues resulting from infection remain fairly soft compared to blighted shoots resulting from spring frost damage. Grayish masses of conidia (spores) can sometimes be observed along the midrib of the blighted leaves. These conidia are the means by which the mummy berry fungus subsequently infects the fruit.

Mummy berry disease is not present in all blueberry plantings; however, management measures are usually necessary in those plantings where the disease has occurred previously. In these plantings, fungicide sprays may provide some additional benefit when applied between bud break and bloom. If not brought under control when first observed, the disease can become unmanageable in subsequent years as inoculum accumulates.

IPM fact sheet Mummy Berry www.nysipm.cornell.edu/factsheets/berries/mummyberry.pdf

Mummy Berry Management Options	
Scouting/thresholds	None established.
Variety susceptibility	'Burlington', 'Collins', 'Jersey', 'Darrow', 'Rubel', 'Bluetta', and 'Dixi' are most resistant to this disease. 'Rancocas', 'Weymouth', 'Berkeley', 'Bluecrop', 'Herbert', and 'Coville' are less resistant. The most susceptible varieties are 'Earliblue' and 'Blueray'.
Cultural management	Control is greatly aided by disturbing the soil (raking or disking) beneath the blueberry bushes just prior to bud break. The tiny apothecia (little brown trumpet shaped mushrooms 1/8" to 1/4" high) fail to produce infective spores when disturbed during development. Covering apothecia with fresh mulch may impede emergence. Rake away mummies and or existing mulch, and then re-mulch rows. Remove mummies, before they drop to the ground, and bury or burn them. Sweep fallen mummies from the ground and remove from the planting and bury or burn them.
Chemical treatment	Chemical treatment should only be made from green tip to petal fall in order to target the pathogen.

Pesticides Labeled for Management of Mummy Berry					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Actinovate-AG *(Streptomyces lydicus)*	3-12 oz/acre	0	1 or until spray has dried	2	For best results apply with a spreader/sticker prior to onset of disease. Re-apply at 7-14 day intervals depending on disease pressure and environmental conditions.
Serenade ASO *(Bacillus subtilis)*	2-6 qt/acre	0	4	2	For suppression, begin application at bud break and repeat on a 7- 10 day interval or as needed. For improved performance, use in a tank mix or rotational program with other registered fungicides.
Serenade MAX *(Bacillus subtilis)*	1-3 lbs/acre	0	4	2	For improved performance add surfactant to improve coverage.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

7.5 Other Diseases of Note

BLUEBERRY VIRUSES There are a number of virus and virus-like diseases of blueberry; most of which have biological vectors, such as insects or nematodes, that carry and spread the virus between plants. Symptoms often are similar to those of other blueberry problems and range from stunting of blossoms and leaves to leaf, blossom and flower necrosis, leaf discoloration (spotting, flecking, streaking), red streaking or ring spotting on stems. To confirm a virus infection, it is best to submit tissue samples to the Plant Disease Diagnostic Clinic www.plantclinic.cornell.edu/, or contact your local Cornell Cooperative Extension agent for additional testing options. Plant only certified (virus-indexed) nursery stock. Plants propagated in the laboratory and greenhouse by tissue-culture techniques (i.e., those that have never been grown in the field) are most likely to be free of harmful viruses. Separate new plantings from old blueberries or wild bushes. Remove and destroy obviously infected plants as soon as possible. Establish a proactive vector management program.

CROWN GALL Stem galls are most frequently seen at cane bases or on large roots. Young galls appear cream to light brown in color; galls become dark brown to black with age. The soilborn bacterium causing the disease enters wounds at or below the soil line. This disease is occasionally a problem in new plantings but is seldom seen on mature plants. All blueberry varieties are susceptible to crown gall. Plant only disease-free planting stock from reputable nurseries. Carefully inspect new planting stock for galls on arrival. Discard any infected plant materials.

WITCHES' BROOM Witches' broom is a relatively minor disease of blueberries in New York State. It requires both blueberry and fir trees to complete its life cycle. Unusual numbers of broom-like, swollen, cracked shoots arise from over-production of lateral buds. Several brooms may appear on a single plant. Generally disease occurrence is so low that crop loss is negligible. However, heavily infected plants may fail to produce fruit. The pathogen is perennial and infection is systemic in blueberry crowns and rhizomes which makes pruning ineffective in eliminating the disease from the planting. Infected bushes and their associated root systems must be removed to eliminate the source of inoculum for surrounding fir trees. Elimination of the alternate host (fir trees, *Abies* spp.) within 51 yards (460 m) of the planting will break the disease cycle and reduce further infection. Little is known about resistance to witches' broom, though 'Rancocas' appears to be least susceptible.

POWDERY MILDEW Since symptoms usually do not appear until after harvest, most growers do not attempt to control this disease. Powdery mildew does not seriously impact blueberry production, but premature defoliation caused by mildew may affect long-term productivity on susceptible varieties such as Collins, Rubel, Blueray, Herbert, and Jersey when they are grown in dense plantings with poor air circulation and humid conditions. Reduce humidity in the plantings through orientation of the plant rows parallel with prevailing winds, wider plant spacing, pruning to maintain open canopies, and by limiting overhead irrigation. On susceptible varieties, leaf surfaces may be covered with white fungal mycelia and spores. Bluecrop, Rancocas, Weymouth, Pemberton, and Dixi are moderately susceptible. Berkeley, Earliblue and Ivanhoe are resistant.

Infections typically occur at bloom, but symptoms may manifest later in the season. Infected leaves sometimes curl or pucker, and both leaf surfaces may be infected. Chlorotic spots with reddish borders are common on the upper leaf surface, similar to symptoms of red ringspot virus. Water-soaked areas on lower leaf surfaces, directly underneath the chlorotic areas, distinguish mildew from the virus. Because control measures for the two diseases are very different, it is important to distinguish between them.

Fungicide applications are not recommended unless powdery mildew is severe. If fungicide applications are used, it is important to make the first application early, after petal fall, to reduce primary infections and to make follow-up applications in June, July, and August to reduce secondary infections.

Pesticides Labeled for Management of Powdery Mildew					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Actinovate-AG *(Streptomyces lydicus)*	3-12 oz/acre	0	1 or until spray has dried	4	For best results apply with a spreader/sticker prior to onset of disease. Re-apply at 7-14 day intervals depending on disease pressure and environmental conditions.
JMS Stylet Oil *(paraffinic oil)*	3-6 qt/100 gal water	-	4	1	Apply for optimum coverage of leaf surfaces. Use high pressure, small droplet size, and adequate gallonage to ensure good coverage.
Kaligreen *(potassium bicarbonate)*	2.5-3.0 lbs/acre	1	4	1	Do not mix with highly acidic products or nutrients.
Kumulus DF *(sulfur)*	6-15lbs/acre	-	24	1	Begin when new shoots are 6 inches long or when disease first appears. Repeat at 7-14 day intervals as necessary. **Note:** Do not use within 2 weeks of an oil treatment.

Pesticides Labeled for Management of Powdery Mildew					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Milstop *(potassium bicarbonate)*	2.5-5.0 lbs/acre	-	1	1	Do not mix with other pesticides or fertilizers. Not compatible with alkaline solutions.
OxiDate *(hydrogen dioxide)*	Curative: 128fl /100gal Preventative: 40fl /100gal	0	0	4	Apply 30-100 gallons of water/acre
Thiolux Jet *(sulfur)*	5-10lbs/acre	-	24	1	Begin when new shoots are 6 inches long or when disease first appears. Repeat at 7 -14 day intervals as necessary. **Note:** Do not use within 2 weeks of an oil treatment.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

BLUEBERRY LEAF RUST Infections can take place as early as bloom. However, reddish brown spots usually don't appear on the upper leaf surface until mid-season. On the lower leaf surface, these spots (pustules) contain yellowish orange spore masses and may turn rusty red with age. Infected leaves may drop prematurely. Leaf rust is a minor disease of blueberries in New York State. However, somewhat severe epidemics may occur sporadically at a local level under favorable weather conditions. The disease generally has little effect on yield unless defoliation is severe. In cases of severe defoliation, yield is reduced the following season. Removal of hemlocks (*Tsuga* spp.), the alternate host, especially those trees upwind within a 0.4 km radius of the planting may be beneficial. Resistant varieties include Bluecrop, Burlington, Collins, Dixi, Earliblue, Gem, Ivanhoe, Olympia, Stanley, and Weymouth. Jersey, Herbert, Berkeley, Blueray, and Pacific are moderately susceptible. Coville, Pemberton, Washington, and Atlantic are susceptible.

Pesticides Labeled for Management of Blueberry Leaf Rust					
Trade Name (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[1]**	**Comments**
JMS Stylet Oil *(paraffinic oil)*	3-6 qt/100 gal water	-	4	2	Apply for optimum coverage of leaf surfaces. Use high pressure, small droplet size, and adequate gallonage to ensure good coverage.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

7.6 Insects of Primary Concern

The insects that are considered major pests in blueberries can vary in occurrence both from year to year and from site to site. For these reasons it is important to be familiar with the life cycles of the various blueberry insect pests to assist in developing a scouting program that will ensure a pest problem can be discovered and dealt with before it becomes an outbreak. Alternatively, it is important to know when a potential pest is not causing significant economic damage so that unnecessary controls can be avoided. Applying an organically approved broad-spectrum insecticide such as PyGanic EC (a pyrethrum) when not necessary, for example, is not only a waste of money but also has the potential to disrupt biological control by beneficial organisms. This illustrates the need to take potential biological control agents (predators, parasitoids, parasites, microbes) into account when making management decisions. Following are descriptions of the most commonly found insect pests in blueberry plantings.

BLUEBERRY MAGGOT This pest is potentially very destructive, but generally has not been as serious a problem in New York as in other blueberry-growing regions. Larvae attack the berries (one per fruit) and may cause them to drop, decreasing yield; if infested berries remain on the plant and are harvested, the crop is not acceptable for market.

Blueberry Maggot Management Options	
Scouting/thresholds	Use yellow sticky cards with ammonium acetate. When 1 adult maggot is trapped, consider treatment. Place traps at periphery of field for early detection.
Variety susceptibility	No resistant varieties known.
Cultural management	Sanitation of fields and removal of overripe fruit. If possible, avoid planting near wild blueberries. Baited sticky cards or cups placed around the entire periphery of small plantings have been used to reduce adult blueberry maggot populations.
Chemical treatment	See below.

Pesticides Labeled for Management of Blueberry Maggot					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
GF-120 NF Naturalyte Fruit Fly Bait *(spinosad)*	10-20 fl oz/acre	-	4	1	Use large droplet size and apply to internal parts of canopy as much as possible to reduce exposure to sun and rain.
Surround WP *(kaolin)*	25-50 lbs/acre	See comments	4	1	For suppression only. Apply on fresh market berries only up to the first 3 weeks after fruit set as residues may be difficult to remove after harvest. For processing berries, Surround may be applied up to the day of harvest.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

CHERRY FRUITWORM The adults (moths) of the cherry fruitworm appear during late May and early June and lay their eggs at the base of the newly set fruit. The pinkish larvae are up to 1/3 inch long. Cherry fruitworm larvae tend to feed inside a single berry and not create as externally obvious damage symptoms as cranberry fruitworm, discussed next. Just a few worms can do extensive damage.

Cherry Fruitworm Management Options	
Scouting/thresholds	A sex pheromone for cherry fruitworm is commercially available and can be used to monitor male moth flight activity and aid in timing insecticide applications. Do not put the lure in the same trap with a lure for cranberry fruitworm.
Variety susceptibility	No resistant varieties known.

Cherry Fruitworm Management Options	
Cultural management	Infested berries culled from the clusters should be promptly burned before the larvae inside have a chance to emerge and pupate. Separate infested fruit from uninfested fruit at harvest and promptly burn it before the larvae inside have a chance to emerge and pupate. Post-harvest grading should be done to remove berries infested with cherry fruitworm, as seen by the entrance hole in the fruit.
Chemical treatment	See below.

Pesticides Labeled for Management of Cherry Fruitworm					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Deliver *(Bacillus thuringiensis)*	0.25-1.5 lbs/acre	0	4	1	No concern with bee toxicity.
Dipel DF *(Bacillus thuringiensis)*	1-2 lbs/acre	0	4	1	No concern with bee toxicity.
Entrust Naturalyte *(spinosad)*	1.25-2.0 oz/acre	3	4	1	No concern with bee toxicity.
Javelin WG *(Bacillus thuringiensis)*	0.25-1.0 lbs/acre	0	4	1	No concern with bee toxicity.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

CRANBERRY FRUITWORM The adults (moths) of the cranberry fruitworm appear during late May and early June and lay their eggs at the base of the newly set fruit. The pale yellowish-green larvae are up to 1/2 inch long and brownish red on the back. Cranberry fruitworm larvae web the berry clusters together and feed inside. Damage is obvious. Just a few worms can do extensive damage.

Cranberry Fruitworm Management Options	
Scouting/thresholds	A sex pheromone for cranberry fruitworm is commercially available and can be used to monitor male moth flight activity and aid in timing insecticide applications. Do not put lure in the same trap with a lure for cherry fruitworm. A phenology model being tested in Michigan indicates 80 to 100 degree-days (base 50 °F lower developmental threshold) after first significant trap capture of male moths is an appropriate time to initiate the first treatment. This timing is approximately correct for both cherry and cranberry fruitworm species.
Variety susceptibility	No resistant varieties known.

Cranberry Fruitworm Management Options	
Cultural management	Infested berries culled from the clusters should be promptly burned before the larvae inside have a chance to emerge and pupate. Separate infested fruit from uninfested fruit at harvest and promptly burn it before the larvae inside have a chance to emerge and pupate. Post-harvest grading should be done to remove berries infested with cranberry fruitworm, as seen by the frass on the fruit.
Chemical treatment	See below.

Pesticides Labeled for Management of Cranberry Fruitworm					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Dipel DF *(Bacillus thuringiensis)*	1-2 lbs/acre	0	4	1	No concern with bee toxicity.
Entrust Naturalyte *(spinosad)*	1.25-2.0 oz/acre	3	4	1	No concern with bee toxicity.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

JAPANESE BEETLES Beetles emerge in early July and feed on leaves and fruit. Although there are Japanese beetle traps, research has shown that the traps may attract more beetles into a planting than they eliminate in the traps.

Japanese Beetle Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known.
Cultural management	Beetles can be removed by hand and killed on small acreages. Post-harvest grading by rolling fruit over hardware cloth may help remove beetles which get stuck on the hardware cloth.
Chemical treatment	See below.

Pesticides Labeled for Management of Japanese Beetles					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Aza-Direct *(azadiractin)*	1-2 pts/A	0	4	4	Is reported to have some repellent activity for beetles.

Pesticides Labeled for Management of Japanese Beetles					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Surround WP *(kaolin)*	25-50 lbs/acre	See comments	4	-	For suppression only. Apply on fresh market berries only up to the first 3 weeks after fruit set as residues may be difficult to remove after harvest. For processing berries, Surround may be applied up to the day of harvest.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

7.7 Minor and Sporadic Insect Pests

Many insects found in blueberry plantings of New York, while having the capacity to cause economic damage, do not occur on a yearly basis at damaging levels and therefore are considered minor or sporadic pests. For these reasons it is important to be familiar with the life cycle of the pest to assist in developing a scouting program that will ensure a pest problem can be discovered and dealt with before it becomes an outbreak. And again, it is important to know when a potential pest is not causing significant economic damage so that unnecessary controls can be avoided.

ANTS Ants nesting at the base of blueberries may be an indication of the presence of blueberry mealybug, a pest of the roots. The ants tend the mealybugs and feed on the honeydew that they produce. Significant decline in plant vigor, in combination with ant activity, could indicate a problem. Excavate a plant in decline to confirm the presence of the 3-4 mm long, white to pink mealybugs. Controlling the ant population may help reduce the mealybugs. No known organic pesticides.

BLUEBERRY STEM BORER This beetle is responsible for two types of injury. In late June and July, the first 3 to 4 inches of the current season's growth may wilt or die; this can occur on large, rapidly growing suckers or on small slow-growing twigs. An examination of the injured twig will show it has been girdled in two places, about half an inch apart, caused by egg deposition. The other injury is the dying out of canes. The leaves first turn from green to yellow or reddish green and drop off, and the cane dies. Close examination may show pinholes at 3-4 inch intervals along the shoot and yellowish strings of castings hanging from them. The cane, when split, contains a yellowish, legless grub, one half to one inch long, at the end of a long tunnel. As wilted tips appear in the summer, cut them off below evidence of insect damage, remove them from the field, and burn them. Chemical control is not effective against this pest.

BLUEBERRY TIP BORER This is a tiny moth that emerges sometime in early June and deposits eggs on the undersides of tip leaves. The larvae bore into the current season's wood, each forming a channel several inches in length; this causes the shoot to wilt and die back.

Pesticides Labeled for Management of Blueberry Tip Borer					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
PyGanic 1.4 EC_{II} *(pyrethrin)*	16-64 fl oz/acre	0	12	4	Target petal fall and first cover. Caution: do not use when bees are active in the planting.
PyGanic 5.0 EC_{II} *(pyrethrin)*	4.5-18 fl oz/acre	0	12	4	Target petal fall and first cover. Caution: do not use when bees are active in the planting.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

INSECT STEM GALL Large bulbous galls form on the stems, often near the terminals. Larvae of a tiny flightless wasp cause these galls. This is a periodically important blueberry pest, particularly in young plantings still being trained. The adults overwinter in the galls, emerge in early June, and crawl or hop to other stems to deposit eggs. Galls form around egg deposition sites. Infestations are usually localized, but may be extensive (50 to 70 galls per plant). Hand picking (pruning) and burning the galls when the leaves fall after harvest is the most advisable course of action. Prune and burn all insect-infested or galled wood. Repeat during the growing season as blighted tips appear. Wasp emergence is so protracted it is difficult to predict; chemical measures are of little use.

LEAFROLLERS Small terminal leaves are used to construct a shelter for the insect larvae. Flower and fruit may be tied with silk while constructing the shelter. Leafrollers contaminate harvested fruit. Pheromone traps can be used for scouting. Threshold is 1 larva per 100 leaf shoots.

Pesticides Labeled for Management of Leafrollers					
Trade Name (*active ingredient*)[1]	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
Deliver *(Bacillus thuringiensis)*	0.25-1.5 lbs/acre	0	4	1	Apply by ground equipment only. Labeled for blueberry leafrollers.
Dipel DF *(Bacillus thuringiensis)*	0.5-1.0 lbs/acre	0	4	1	Labeled for oblique banded leafroller
Entrust Naturalyte *(spinosad)*	1.25-2.0 oz/acre	3	4	1	
Surround WP *(kaolin)*	25-50 lbs/acre	See comments	4	-	Suppression only. Apply on fresh market berries only up to the first 3 weeks after fruit set as residues may be difficult to remove after harvest. For processing berries, Surround may be applied up to the day of harvest.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

PLUM CURCULIO The plum curculio is better known as a serious pest of tree fruit crops but occasionally can cause significant injury to blueberries. Female weevils lay eggs in very young fruit, leaving a characteristic crescent-shaped scar that persists throughout the season. The larvae or grubs develop during the season and then exits the fruit to pupate in the ground. The pupae become adults later in the summer. Adults overwinter in hedgerows. Plum curculio is of economic importance on occasion; early-ripening varieties are more vulnerable; with late-ripening varieties the damaged berries drop to the ground before harvest. After fruit-set fields should be scouted for the characteristic egg-laying scar on young berries. An economic threshold has not been established. Early-ripening varieties are more at risk of being harvested before damaged berries drop to the ground. It is reported that clean cultivation will provide some control by killing pupae.

Pesticides Labeled for Management of Plum Curculio					
Trade Name (*active ingredient*)[1]	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
Surround WP *(kaolin)*	25-50 lbs/acre	See comments	4	-	Suppression only. Apply on fresh market berries only up to the first 3 weeks after fruit set as residues may be difficult to remove after harvest. For processing berries, Surround may be applied up to the day of harvest.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

SCALE INSECTS A number of species of scale insects, including Oystershell and European lecanium scale, feed on the twigs and can greatly reduce plant vigor. Look for the hard-covered female scale insects on small branches early in the spring. Good pruning practices should reduce the likelihood of scale problems. No known organic pesticides.

7.8 Wildlife Management

Damage to fruit by birds is a serious problem in many areas of New York. Flocking birds can destroy a crop in a matter of days. Visual scare devices such as whirlers, streamers, flash tape, reflectors, and plastic hawk and owl models are seldom effective if used alone. They should be supplemented with sound devices such as exploders, alarms, or recorded devices. For sound devices to be effective, their location and the frequency of sounds should be changed daily. They also should be in place before the fruit ripens. The most effective sound device is Bird-Gard with species-specific bird distress calls programmed into the device. One unit with 4 speakers is effective on 10 acres. Some towns have passed ordinances regulating the use of sound devices.

Several types of netting, such as plastic, nylon, cotton, and polyethylene, are marketed for protecting fruits. A lightweight acrylic netting that can be draped directly over plants is available. It does not require support and it does not interfere with sunlight, pollination, or growth. Most netting is expensive, but it can be reused for many years.

Various rodents can damage a small-fruit planting, especially as they feed under bark in the winter. Closely mowing the area around the planting and between the rows in early November will reduce the habitat for voles and mice. The habitats (woodlots) of predators that feed on rodents (hawks, owls, foxes) should be protected around the area. A number of poisonous baits are labeled for use in agricultural areas. To be most effective, baits should be placed in feeding stations that exclude large animals and are replenished throughout the winter.

Deer browsing can devastate berry plantings. Multiple strategies are required to discourage deer from feeding on berry plantings. Refer to *Reducing Deer Damage to Home Gardens and Landscape Plantings* by P. Curtis and M. Richmond for recommended methods.

When using dogs and invisible fence to manage vertebrate pests in a planting, there is food safety risk associated with the dog excrement. If the dog consistently uses an area away from the field, the risk is somewhat reduced. Also, if the dog prevents other vertebrate animals from using the field, that also reduces the risk to food safety. Using dogs primarily in the winter and early spring when deer browsing is greatest (and avoiding use during harvest) will also minimize food safety risk.

Plantskydd repellent, www.plantskydd.com, is an OMRI-approved product that is registered for use in New York and may provide benefit by repelling vertebrates from blueberry plantings.

Table 7.2. Vertebrate Damage Mitigation Practices	
Animal Pest	**Management Practices[1]**
Birds	Avoid sites with woods along the edge(s) because these will support bird populations. Netting; visual scare devices (eye-spot balloons, silhouettes, reflective tape); auditory frightening device (recorded alarm calls, pyrotechnics, propane cannon). Population reduction through shooting by licensed hunter of game species in appropriate season (crows, turkeys); or unprotected species (European starlings, English sparrows, pigeons). Songbirds are protected and cannot be killed. All state and local firearms laws or regulations must be followed*.
Mice and voles	Wire trunk guards; close mowing of planting middles especially in late fall; vegetation reductions (<40% ground cover) under bushes; removal of dropped fruit and prunings; habitat manipulations including elimination of unmowable areas within plantings; monitor to determine the need for management. Population control through trapping by landowner.
Raccoons	Avoid sites with woods along the edge(s) because these will support raccoon populations. Electrified exclusion fencing. Population reduction through shooting by licensed hunters or landowners in appropriate seasons; through trapping by landowner, by licensed trapper, or by licensed nuisance wildlife control agent.
Red and gray foxes	Tend to chew on irrigation lines. Manipulation including elimination of protective cover within plantings. Population reduction through shooting by licensed hunters or landowners in appropriate seasons; through trapping by landowner, by licensed trapper, or by licensed nuisance wildlife control agent.
White-tailed deer	Exclusion fencing (8 ft. [250 cm] high-tensile woven wire or 5 to 6 ft. [150 to 200 cm] electric exclusion fencing; peanut-butter baited electric fences; invisible fencing with dogs); habitat manipulation including elimination of protective cover around plantings. Population reduction through shooting by licensed hunters, landowners or their agents with DMAP or nuisance deer permits. Unlike with other vertebrate pests, landowners cannot kill nuisance deer without a permit.
Woodchucks	Exclusion fencing (electrified exclusion fencing); habitat manipulation including removal of brush piles within plantings. Population reduction through shooting by licensed hunters or landowners; through trapping by landowner or by licensed nuisance wildlife control agent.

[1] Conduct shooting and trapping only as defined by New York State Department of Environmental Conservation regulations. Shooting for nuisance wildlife control is allowed only when neighboring occupied buildings are >500 ft. distant; shooting when neighboring buildings are less than 500 ft. distant requires neighbor permission. Shooting also may require a permit, depending on animal and season. Also check local ordinances, as shooting and trapping are prohibited in some areas. Note: It is illegal to trap a nuisance animal and release it onto public lands or someone else's property. It must be released on the landowner's property or killed.

7.9 Considerations During Harvest and Post-harvest

During harvest operations some pests can become a nuisance, e.g. wasps and yellow jackets, particularly in U-pick operations. Wasp and yellow jacket nests can be destroyed during the growing season as they are found in the planting and surrounding areas. Some species are ground-nesting and such nests can be destroyed by drenching with hot water. Traps baited with sugary liquids, such as Hi-C, provide a means of reducing the population of wasps and yellow jackets, but the effectiveness of this tactic on a large scale is unknown. Wasps and yellow jackets are attracted to bird-damaged berries, so managing birds may rule out their foraging in the planting.

During harvest much can be done to reduce disease and insect pressure by eliminating infested and infected fruit from the planting. Separate damaged fruit from healthy fruit as it is being picked. Designate pickers to cull such fruit from the field at harvest time. Then bury or burn the diseased and infested fruit. This is helpful to combat anthracnose (through the removal of overripe and infected fruit), mummy berry (through the removal of mummified fruit before it drops to the ground), blueberry maggot (to remove overripe or infested fruit), cherry fruitworm and cranberry fruitworm (to remove infested fruit before larva in the berries emerge, drop to the ground and pupate).

After harvest, a post-harvest grading table will provide an excellent opportunity to grade out damaged, diseased and infected fruit which will lower quality and market value. All culled fruit should be destroyed by burning or burying. Cleanliness or sanitation in the planting is very important, removing dropped berries by raking or sweeping up all dropped berries will reduce risk from

anthracnose, mummy berry, blueberry maggot, cherry fruitworm and cranberry fruitworm. At this time pruning off broken and damaged branches will help maintain a healthy planting.

Keep in mind your production goals and recognize that it should be possible to obtain comparable yields in organic blueberry production as in conventional production. Therefore, maintain good records of harvests and know your markets. A typical, well-managed highbush blueberry planting should yield approximately 8,000 pints per acre, even when plants are spaced further apart to allow for good air circulation.

8. SMALL-SCALE SPRAYER TECHNOLOGY

8.1 Spraying Small Blueberry Plantings:

On many small-scale plantings, spraying often requires special attention to calibration, calculating amounts of pesticide to use, and measuring pesticide products.

To ensure even distribution throughout the plant canopy, a systematic approach to spraying the whole canopy is essential. Take particular care to cover the top of the canopy as well as ensuring adequate penetration into the inside and middle of the canopy. Spray from both sides of the row. Water sensitive cards (Syngenta) or Surround, kaolin clay, (Engelhard) may be used as tracers to monitor spray distribution.

PRIOR TO SPRAYING—CALIBRATING SPRAYERS

• ***Calibration of backpack sprayers—for canopy spraying***

1. Fill the spray tank with a known quantity of clean water (e.g. 2 gallons)
2. Determine the number of bushes that you can spray on both sides with the spray tank (e.g. 48 bushes covered)
3. Determine the total number of bushes per acre (e.g. 968 bushes per acre)
4. Calculate the spray volume required per acre:

   Spray volume/acre = (bushes per acre ÷ bushes covered per spray tank) **x** volume applied in spray tank

   e.g. Spray volume/acre = (968 ÷ 48) **x** 2 = 40 gallons per acre

• ***Calibration of backpack sprayers—in general***

Use clean water

DYNAMIC CALIBRATION

1. Select correct nozzle and pressure.
2. Measure and mark off an area 10 feet x 10 feet on concrete.
3. Fill sprayer to a known level, mark the fill level.
4. Spray the area on the concrete.
5. Refill sprayer to the fill mark.
6. Compare quantity collected with nozzle chart and desired amount.

STATIC CALIBRATION

1. Select correct nozzle and pressure.
2. Measure and mark off an area 10 feet x 10 feet on concrete.
3. Spray the area and record time taken.
4. Carry out stationary run of same time duration, catching liquid in a graduated measuring jug.
5. Compare quantity collected with nozzle chart and desired amount.

CALCULATING THE AMOUNT OF PESTICIDE TO USE

Some organically approved pesticides are typically sold for large-scale plantings and give application rates on a per acre basis, or an amount per 100 gallons of spray mix. When converting a known quantity per acre to spray a smaller area, the first step is to measure the area to be sprayed using a tape measure. Divide the number of square feet you have measured by 43,560 to obtain the acreage (in decimal form).

Example:

1. If you are going to spray 20,000 sq. ft,
   20,000 divided by 43,560 = 0.459 acre

2. The label states 3 pints of product per acre
   Multiply the label rate per acre by the decimal for you area
   3 pints multiplied by 0.459 = 1.38 pints
3. Remember there are 16 fl oz in 1 pint.

MEASURING SMALL AMOUNTS OF PESTICIDE

The following tables and examples provide information on converting pesticide rate amounts for smaller areas.

Table 8.1. How much powder or granules should I use?

Volume of liquid	*100 gallons*	*25 gallons*	*5 gallons*	*1 gallon*
Amount of powder or granules to use	4 oz	1 oz	$^{3}/_{16}$ oz	½ tsp
	8 oz	2 oz	$^{3}/_{8}$ oz	1 tsp
	1 lb	4 oz	$^{7}/_{8}$ oz	2 tsp
	2 lb	8 oz	1 ¾ oz	4 tsp
	3 lb	12 oz	2 $^{3}/_{8}$ oz	2 Tbsp
	4 lb	1 lb	3 ¼ oz	2 Tbsp + 2 tsp

• ***Powders and granules***
Example: The label states 3 lbs of powdered product per 100 gallons but you only wish to use a backpack sprayer with a 5-gallon tank. Table 8.1 shows you need to mix in 2$^{3}/_{8}$ oz of powder. Use clean weighing scales to provide the correct amount of powder, NEVER use a volumetric measure, e.g. a measuring cup, because the bulk density of different products varies.

Table 8.2. How much liquid should I use?

Volume of liquid	*100 gallons*	*25 gallons*	*5 gallons*	*1 gallon*
Amount of liquid to use	1 gal	2 pts	6 ½ oz	1 ¼ oz
	4 pts	1 pt	3 ¼ oz	$^{5}/_{8}$ oz
	2 pts	½ pt	1 $^{9}/_{16}$ oz	$^{5}/_{16}$ oz
	1 ½ pt	6 oz	1 ¼ oz	¼ oz
	1 pt	4 oz	$^{7}/_{8}$ oz	$^{3}/_{16}$ oz
	8 oz	2 oz	$^{7}/_{16}$ oz	½ tsp
	4 oz	1 oz	¼ oz	¼ tsp

• ***Liquids***
Example: The label states 4 pts of a liquid product per 100 gallons of spray but you only wish to use a backpack sprayer with a 5-gallon tank. Table 8.2 shows you need to mix in 3¼ fl oz of liquid product. Use a clean measuring cylinder or vessel to provide the correct amount of liquid.

Table 8.3. Dilution of liquid products to various concentrations

Dilution rate	*1 gallon*	*3 gallon*	*5 gallon*
1 in 100	2 Tbsp + 2 tsp	½ cup	¾ cup + 5 tsp
1 in 200	4 tsp	¼ cup	6 ½ Tbsp
1 in 800	1 tsp	1 Tbsp	1 Tbsp + 2 tsp
1 in 1000	¾ tsp	2 ½ tsp	1 Tbsp + 1 tsp

• ***Measuring equipment.***
Always use measuring equipment that is dedicated only for pesticide use. For very small quantities of liquids, a syringe can be useful. For powder or granular products use weighing scales, do not rely on a measuring cup as the bulk density of products varies.

• ***Safety.*** Be sure to wear the proper protective clothing and equipment as required on the pesticide label. Always be aware of watercourses, neighboring properties and changes in the weather.

8.2 Selecting a Small Sprayer for the Small, Organic Blueberry Planting

There are many important points to consider before purchasing a sprayer, not the least of which is the area to spray, the proximity of the local supplier, standard of manufacture, etc. There are many growers with small plantings who don't require airblast sprayers and have a need for spraying equipment ranging from backpack sprayers to small truck- or ATV-mounted machines.

CANOPY SPRAYERS

Backpack sprayers

Small capacity (4-5 gallon) sprayers will produce up to approximately 100 psi pressure. Weight is an important consideration and growers should select a sprayer with good, wide, padded straps to ease the load on your shoulders. Correct nozzle selection according to the target is very important to ensure even coverage. A good-sized filling hole at the top is also important.

There are three factors affecting application rate—forward speed, pressure, and nozzle tip size. Unfortunately, most inexpensive backpack sprayers have no pressure gauge. Pay more money and purchase a backpack sprayer with a pressure gauge or, better still, purchase a spray management valve as standard or as an option. Normally output increases or decreases according to the pressure

in the system, (which is dependent upon how vigorous you are in pumping the handle up and down). A spray management valve, such as a CF valve, will ensure a constant output irrespective of hand pump action. The CF valve evens out fluctuations in pressure, e.g. will only allow a maximum and minimum pressure thus ensuring even flow. The Fountainhead Group sells a backpack sprayer with a simple valve which ensures the correct pressure is not exceeded.

An alternative to the hand-operated backpack sprayer is an electrically-operated backpack sprayer, which utilizes a small rechargeable battery. Maximum pressure is relatively low and it is easier than using a traditional hand pump system, particularly if you have many rows of plants to spray. Similarly a small back pack sprayer fitted with a small gas engine is available. The electric version is quieter to use, but you must remember to recharge the batteries otherwise spraying will be delayed.

Portable mist and air blower backpacks

These are ideal for plantings where canopy penetration is required, e.g. denser, less manicured canopies. A small gas engine drives a fan blower which creates an airstream which passes along a hand-held tube (similar to a leaf blower). The tube has a nozzle situated at the end so that liquid spray can be squirted into the airstream. The operator directs the spray cloud towards the canopy by pointing the hand-held tube. It is preferable to point the tube backwards to avoid walking into the spray cloud. Engine speed can be reduced which enables a slower airspeed to match a smaller canopy in early season. They are very good at rustling the canopy and getting good penetration and deposition. They are heavy! Noise is a problem, so ear protection must be worn.

Portable engine-driven gas sprayers

If weight is a problem, and ground conditions are relatively smooth, a number of manufacturers offer a sprayer with a small gas engine and a 10 to 12 gallon tank. Larger capacity tanks (14 to 100 gallons) are often trailed and can be pulled by a lawn tractor, ATV, Gator, or small tractor.

Small, mounted sprayers

Ideal for mounting onto the carrier rack of an ATV, 15 to 25 gallons, they use a small electric pump to provide up to 70 psi. When used with a hand wand and a hose, they can be used to spray short lengths of bush rows. The same system is ideal for weed control and spot spraying of weeds.

Large, skid mounted sprayers

Ideal for fitting into the back of a pick-up truck, these sprayers have a tank capacity of 35 to 200 gallons, and an electric-start gas engine.

Small, trailed airblast sprayers

Very small airblast sprayers, with tank capacities up to 110 gallons and a 5.5 to 20 hp gas engine, can be towed by an ATV or a small tractor. Larger tank capacities up to 300 gallons are also available but require larger tractors with weights and brakes for safe operation. Remember, the larger the gas engine, the more important it is to buy an electric start option. Small airblast sprayers are ideal in blueberry plantings with tall plants but suffer from a lack of air direction, therefore purchase sprayers with deflectors or towers to direct the air into the canopy.

Small, mounted airblast sprayers

Three-point hitch, PTO-driven models with a 22- or 24-inch fan, for fitting onto 25 plus hp tractors are available. Beware of drift, again consider models which direct the air via deflectors or towers.

HERBICIDE OR GROUND APPLICATION SPRAYERS

Backpack, small ATV-mounted tank, and hand-lance sprayers

These sprayers can be used for herbicide application **BUT** be very careful that there is no carry-over from herbicide residues in the sprayer, therefore wash them out very thoroughly before using them to apply materials other than herbicides.

Controlled Droplet Applicators (CDA)

The use of CDA's will considerably reduce the need to carry vast amounts of water. A spinning disc (battery powered) will produce 95% of the same-size droplets, thus reducing herbicide rates by at least 50% and water rates by 75%. Herbi and Mantis (trade names) are both hand-held CDA sprayers. ATV- or tractor-mounted shielded CDA sprayers such as the Environmist also reduce spray rates while shielding the plants from the spray.

Wick wipers
Where occasional weeds and access over wet land are a problem, the use of a hand-held wick wiper is an easy-to use, effective option. A small tank, usually contained in the handle, holds the liquid, which soaks a rope wick or a sponge. The rope or sponge can then be wiped against the weeds.

For further information on pesticide application technology visit www.nysaes.cornell.edu/ent/faculty/landers/pestapp.

9. PESTICIDES MENTIONED IN THIS PUBLICATION

Table 9.1 Fungicides and Bactericides

Trade Name	Active Ingredient	EPA Reg. No.
Actinovate-AG	*Streptomyces lydicus*	73314-1
Kaligreen	potassium bicarbonate	11581-2
Kumulus DF	sulfur	51036-352-66330
Miller Lime-Sulfur	lime-sulfur	66196-2
Milstop	potassium bicarbonate	70870-1-68539
Organic JMS Stylet Oil	paraffinic oil	65564-1
Oxidate	hydrogen dioxide	70299-2
Serenade ASO	*Bacillus subtilis*	69592-12
Serenade MAX	*Bacillus subtilis*	69592-11
Thiolux Jet	sulfur	100-1138

Table 9.2. Insecticides and Miticides

Trade Name	Active Ingredient	EPA Reg. No.
Aza-Direct	azadiractin	71908-1-10163
Deliver	*Bacillus thuringiensis*	70051-69
Dipel DF	*Bacillus thuringiensis*	73049-39
Entrust Naturalyte	spinosad	62719-282
GF-120 NF Naturalyte Fruit Fly Bait	spinosad	62719-498
Javelin WG	*Bacillus thuringiensis*	70051-66
PyGanic EC 1.4 II	pyrethrins	1021-1771
PyGanic EC 5.0 II	pyrethrins	1021-1772
Surround WP	kaolin	61842-18

Table 9.3. Herbicides

Trade Name	Active Ingredient	EPA Reg. No.
GreenMatch	citrus extract (d-limonene)	82052-4
Matran EC	clove oil	Exempt from registration

Table 9.4. Vertebrate Repellents

Trade Name	Active Ingredient	EPA Reg. No.
Plantskydd	dried blood	25(b) pesticide

9.1 Pesticides Labeled for use in Organic Blueberry Production

At the time the guide was released, the pesticides listed in this guide were allowable for organic production under the National Organic Program Rule and registered for use in New York. The authors relied mainly on the Organic Materials Review Institute OMRI list for pesticides to include. Always check with your certifier before using any new pesticide.

Given the high cost of many pesticides and the limited efficacy data available for many of them, the importance of developing an integrated approach based on cultural practices for disease and insect management, as described in the previous section, cannot be

emphasized strongly enough. **Pesticides should not be relied on as a primary method of pest control**. Scouting, forecasting, or trapping pests are important for detecting infestations at an early stage. When conditions do warrant an application, proper choice of materials, proper timing, and excellent spray coverage are essential.

9.2 Pesticide Regulatory Considerations

Organic production focuses on cultural, biological, and mechanical techniques to manage pests on the farm, but in some cases organically approved pesticides, which include repellents, are a necessary option. Pesticides mentioned in this organic production guide must be registered and labeled at the federal level for use, like any other pesticide, by the Environmental Protection Agency (EPA), or meet the EPA requirements for a "minimum risk" pesticide, which are exempt from normal registration requirements as described in FIFRA regulation 40 CFR Part 152.25(b).

"Minimum risk" pesticides, also referred to as 25(b) pesticides, must meet specific criteria to achieve the "minimum risk" designation. The active ingredients of a minimum-risk pesticide must be on the list of exempted active ingredients found in the federal regulations (40 CFR 152.25). Minimum-risk pesticides must also contain inert ingredients listed on the most current List 4A published in the Federal Register.

In addition to meeting the active and inert ingredient requirements above, a minimum-risk pesticide must also meet the following:

- Each product must bear a label identifying the name and percentage (by weight) of each active ingredient and the name of each inert ingredient.
- The product must not bear claims to either control or mitigate microorganisms that pose a threat to human health, including, but not limited to, disease-transmitting bacteria or viruses, or claim to control insects or rodents carrying specific diseases, including, but not limited to, ticks that carry Lyme disease.
- The product must not include any false or misleading labeling statements.

Besides registration with the EPA, pesticides sold and/or used in New York State must also be registered with the New York State Department of Environmental Conservation (NYS DEC). However, pesticides meeting the EPA "minimum risk" criteria described above do not require registration with the NYS DEC.

To maintain organic certification, products applied must also comply with the National Organic Program (NOP) regulations as set forth in 7 CFR Part 205, sections 600-606. The Organic Materials Review Institute (OMRI) is one organization that reviews and publishes products they find compliant with the NOP regulations, but other entities also make product assessments. Organic growers are not required to use only OMRI listed materials, but the list is a good starting point when searching for potential pesticides.

Finally, each farm must be certified by an accredited certifier who must approve any material applied for pest management. ALWAYS check with the certifier before applying any pest control products.

Some organic certifiers may allow "home remedies" to be used to manage pests. These materials are not labeled as pesticides, but may have properties that reduce the impact of pests on production. Examples of home remedies include the use of beer as bait to reduce slug damage in strawberries or dish detergent to reduce aphids on plants. Home remedies are not mentioned in these guides, but in some cases, may be allowed by organic certifying agencies. Maintaining good communication with your certifying agent cannot be overemphasized in order to operate within the organic rules.

9.3 Optimizing Pesticide Effectiveness

Information on the effectiveness of a particular pesticide against a given pest can sometimes be difficult to find. Some university researchers include pesticides approved for organic production in their trials; some manufacturers provide trial results on their web sites; some farmers have conducted trials on their own. Efficacy ratings for pesticides listed in this guide were summarized from university trials and are only provided for some products.

In general, pesticides allowed for organic production may kill a smaller percentage of the pest population, could have a shorter residual, and may be more quickly broken down in the environment than synthetic pesticides. Read the pesticide label carefully to determine if water pH or hardness will negatively impact the pesticide's effectiveness. Use of a surfactant may improve organic pesticide performance. OMRI lists adjuvants in OMRI Products List, Web Edition – Crop Products, www.omri.org/crops_category.pdf. Regular scouting and accurate pest identification are essential for effective pest management. Thresholds used for conventional production may not be useful for organic systems because of the typically lower percent

mortality and shorter residual of pesticides allowed for organic production. When pesticides are needed, it is important to target the most vulnerable stages of the pest. Thoroughly cover plant surfaces, especially in the case of insecticides, since many must be ingested to be effective. The use of pheromone traps or other monitoring or prediction techniques can provide an early warning for pest problems, and help effectively focus scouting efforts.

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11. GLOSSARY

(Adapted from: Wikipedia, www.wikipedia.org/, the free online encyclopedia)

Adjuvant – any substance added to the spray tank, (separate from the pesticide) that will improve the performance of the pesticides, (herbicides, insecticides, miticides, fungicides, bactericides), fertilizers etc. by reducing the surface tension of the water and improving spread and coverage.

Agroecosystem – all of the living and non-living components, including inputs and outputs, that comprise a spatial and functional coherent unit of agricultural activity.

Allelopathy – condition in which one plant emits substances that affect germination, development or growth of other plants in contact with the substance.

Annual – a plant that completes its life cycle within one year (germination, flowering, seed production, death).

Biennial – a flowering plant that takes two years to complete its biological life cycle.

Buffer zone – a physical space of sufficient size that separates two or more areas of activity so that these areas do not affect each other.

Cation exchange capacity – (CEC) is the capacity of a soil to retain and substitute cations (positively charged ions, e.g. potassium) between the soil and the soil solution. CEC is a measure of nutrient retention capacity.

Compost – a combination of plant, animal and other organic materials that have been decomposed largely through aerobic processes into a substance rich in carbon, nutrients, and biological activity.

Crop rotation – the practice of growing, in the same area, in sequential seasons, a series of dissimilar types of crops to avoid the build up of pathogens and pests that often occurs when one species is continuously cropped.

Frost pocket – an area where still air, cooled by ground-level radiation, travels downhill, replaces warm air, and accumulates to form pockets of very cold air in depressions, valleys, and hollows.

Green manure – a type of cover crop grown for a specific period of time, then incorporated into the soil to add nutrients and organic matter for soil improvement.

Humus – organic matter that is well-decomposed, stable, and contributes to soil tilth and cation exchange.

Immobilization – is when organic matter decomposes and is absorbed by micro-organisms, therefore preventing it being accessible to plants for periods of time. Immobilization is the opposite of mineralization.

Integrated Pest Management (IPM) – a management strategy aimed at insects, mites, plant diseases, weeds, and other pests that uses a variety of planned, complementary tactics including: mechanical devices, physical devices, genetic resistance, biological control, cultural practices, and chemical treatment. It is an ecological approach with a main goal of significantly reducing or eliminating the use of pesticides while at the same time managing pest populations at an acceptable level.

Macroclimate – refers to the regional climate of a broad agricultural area. It can include an area on the scale of tens to hundreds of kilometers.

Mesoclimate – refers to the climate of a particular planting site and is generally restricted to a space of tens or hundreds of meters.

Microclimate – refers to the specific environment in a small restricted space such as a row of plants or corner of a field.

Mineralization – refers to the process where an organic substance is converted to an inorganic substance that can be taken up by the plant.

Nitrogen assimilation – process by which plants expend energy to take up nitrate and ammonium ions and incorporate them into organic molecules required for growth.

Nitrogen budget – accounting that quantifies the nutrients entering the farm (e.g. fertilizers, manure, legumes crops, soil residual nitrogen) and the nutrients leaving the farm (crop harvest, runoff, leaching, volatilization) for the purpose of balancing inputs and exports.

Nitrogen fixation – the biological process by which nitrogen gas (N_2) in the atmosphere is converted into ammonium compounds that are used by plants.

Organic certification – a certification process for producers of organic food and products that requires strict adherence to production standards for growing, storing, processing, packaging and shipping.

Perched water table – accumulated water above the level of the local water table because impermeable rock or sediment prevents downward movement of water into the local water table.

Perennial –a plant that completes its life cycle (germination, flowering, seed production) over more than one year.

Summer annual – an annual plant that germinates, flowers, produces seed and dies within the same growing season.

Surfactant – (or wetting agent) a soap-like adjuvant added to water or some other liquid to increase wetting properties by reducing the surface tension of the droplets.

Threshold – the density of a pest (insect, mite, plant disease, weed, etc.) at which a control treatment will provide an economic return.

Tilth – a term describing soil that is friable, crumbly, and not compacted which allows rainfall to penetrate and roots to grow without obstruction.

Wind break – (or shelterbelt) is a planting around the edge of a field consisting of one or more rows of trees or shrubs planted in such a manner as to provide shelter from the wind and to protect soil from erosion.

Winter annual – a plant that germinates in the fall or winter, then flowers, produces seed and dies within one year.