2022

Organic Production and IPM Guide for Blueberries

NYSIPM Publication No. 225

New York State Integrated Pest Management Program

Cornell Cooperative Extension

NEW YORK STATE OF OPPORTUNITY. Agriculture and Markets

2022 Organic Production and IPM Guide for **Blueberries**

Coordinating Editors

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

Marvin Pritts* (Cornell University, Horticulture Section)

Contributors and Resources

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

Greg Loeb* (Cornell University, Department of Entomology)

Lynn Sosnoskie* (Cornell University, Horticulture Section)

Mary Kirkwyland* (Cornell University, New York State IPM Program)

Michael Helms* (Cornell Cooperative Extension Pesticide Safety Education Program (CCE-PSEP))

Courtney Weber (Cornell University, Horticulture Section)

Paul Curtis (Cornell University, Department of Natural Resources)

Laura McDermott (Cornell Cooperative Extension, Eastern New York Commercial Horticulture Program)

Elizabeth Bihn* (Cornell University, Department of Food Science)

Andrew Landers (Cornell University, Department of Entomology)

Amara Dunn (Cornell University, New York State IPM Program)

**Pesticide Information and Regulatory Compliance*

Special Appreciation

Format based on the Pest Management Guidelines for Berry Crops https://cropandpestguides.cce.cornell.edu/, editor Marvin Pritts; and on the Organic Production and IPM Guide for Grapes, coordinating editors Tim Weigle and Juliet Carroll.

Funded in part by the New York State Department of Agriculture and Markets.

This guide is published by the New York State Integrated Pest Management Program, which is funded through Cornell University, Cornell Cooperative Extension, the New York State Department of Agriculture and Markets, the New York State Department of Environmental Conservation, and USDA-NIFA. Cornell Cooperative Extension provides equal program and employment opportunities. NYS IPM Publication number 225, March 2022. https://nysipm.cornell.edu/ .

How to cite this publication: Carroll, J., and Pritts, M.P., eds. (2022). *Production and IPM Guide for Organic Blueberries.* New York State Integrated Pest Management Program. Ithaca, NY. 55 pages.

Table of Contents

INTRODUCTION **3**
1. GENERAL ORGANIC MANAGEMENT PRACTICES **3**
1.1 Organic Certification 3
1.2 Organic System Plan 3
2. SOIL HEALTH **4**
3. SITE SELECTION **4**
3.1 Organic Certification Site Requirements 4
3.2 Soil and Air Drainage and Soil Depth 5
3.3 Soil Testing 5
3.4 Irrigation 5
4. COVER CROPS – BEFORE PLANTING AND ROW MIDDLES **6**
4.1 Goals and Timing for Preplant Cover Crops 6
4.2 Cover Crops for Row Middles 6
5. VARIETY SELECTION **8**
6. NUTRIENT MANAGEMENT **8**
6.1 Soil and Leaf Analysis 9
6.2 Soil pH 9
6.3 Managing Nutrients 10
6.4 Preparing a Nitrogen Budget 11
7. ORGANIC BLUEBERRY IPM **12**
7.1 Developing a Blueberry IPM Strategy 13
7.2 Weed Management 13
7.3 Principles of Insect and Disease Management 15
7.4 Diseases of Primary Concern 16
7.5 Other diseases of note 24
7.6 Insects of Primary Concern 28
7.7 Minor and Sporadic Insect Pests 36
7.8 Wildlife management 40
7.9 Considerations during harvest and post-harvest 41
8. FOOD SAFETY **42**
9. SMALL-SCALE SPRAYER TECHNOLOGY **43**
9.1 Spraying Small Blueberry Plantings: 43
9.2 Selecting a Small Sprayer for the Small, Organic Blueberry Planting 45
10. PESTICIDES MENTIONED IN THIS PUBLICATION **46**
10.1 Pesticide use in organic blueberry production 50
10.2 Biopesticides 50
10.3 Pesticide Regulatory Considerations 50
10.4 Optimizing Pesticide Effectiveness 51
11. REFERENCES AND RESOURCES **51**
12. GLOSSARY **54**

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 among 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. We acknowledge that effective means of organic control are not available for some pests. Most challenging is the relatively recent introduction of spotted-winged drosophila into the environment. This pest is difficult to control and affects later-ripening varieties more than those that fruit early. Some growers are installing fine nets over their plantings to screen out this and other pests such as birds and Japanese beetles.

This guide attempts to compile the most current information available on variety selection, nutrient management and pest management, but does not go into detail on aspects of production that are common to all growers such as production methods, irrigation, application technologies, marketing and budgeting. Refer to the *Highbush Blueberry Production Guide* (NRAES-55) and the *Blueberries: Organic Production* guide, available from the National Sustainable Agriculture Information Service, ATTRA, for general information.

This guide uses the term Integrated Pest Management (IPM) which, like organic production, emphasizes 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.

All website addresses and links are listed in section 11, References and Resources. A glossary of terms used in this guide is included at the end in section 12.

1. GENERAL ORGANIC MANAGEMENT PRACTICES

1.1 Organic Certification

The United States Department of Agriculture Agricultural Marketing Service (USDA AMS) National Organic Program (NOP) is the federal regulatory program that develops and enforces uniform national standards for organically produced agricultural products sold in the United States. The USDA AMS NOP website contains valuable resources for organic operations, including an electronic copy of the NOP Handbook, *Guidance & Instructions for Accredited Certifying Agents & Certified Operations.*

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 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 Foods and Farming 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 do not need to be certified. 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.

1.2 Organic System Plan

An organic system plan (OSP) is a central requirement to the certification process. The OSP 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 helps producers to anticipate 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. Comprehensive instructions and a list of requirements for the OSP is provided in the *Instruction Organic System Plans, Organic System Plan Updates, and Notification of Changes* pdf document.

Resources are available to help develop the OSP. Some certifying organizations, such as the Northeast Organic Farming Association of New York (NOFA-NY), guide you through the process of creating an OSP as part of the application process. The National Sustainable Agriculture Information Service, ATTRA, has published a Guide for Organic Crop Producers that includes a chapter on writing the organic system plan. The USDA has also published a Streamlined Organic System Plan for Crop Production.

It is important to note that section 205.103 of the USDA NOP 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, upon request, to authorized representatives of the USDA.

2. SOIL HEALTH

Healthy soil is the basis of organic farming. Decomposing plant materials incorporated before planting blueberries 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. Growing cover crops to promote a healthy soil should be initiated in the one or two years prior to planting establishment. After establishment, the regular addition of mulch around plants contributes to a healthy soil ecosystem. Regular additions of organic matter in the form of compost, sawdust, wood chips or manure create a soil that is biologically active, with good structure and capacity to hold nutrients and water. The minimum acceptable days-to-harvest interval for raw manure is 120 days (see National Organic Standards); buyers may require a period longer than 120 days between application and harvest however. Most blueberry growers prefer to apply a durable mulch like wood chips or sawdust on their blueberries since it breaks down slowly and reapplication isn't required annually. A few growers may have an inexpensive source of straw; if straw was used as animal bedding, it must never be applied within 120 days of the first harvest. 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, 2010, available from the Sustainable Agriculture Research and Education (SARE) website. For more information, refer to *Comprehensive Assessment of Soil Health: The Cornell Framework*, a pdf document. See also the 14 part Berry Soil and Nutrient Management In-Depth Webinar Series along with *Berry Soil and Nutrient Management - A Guide for Educators and Growers*.

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 thereto, there are still three remaining 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; moreover, 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 three 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*.

3.1 Organic Certification Site Requirements

The National Organic Program has 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. Other practices outlined in the NOP Regulations such as crop rotation, weed control practices and addition of soil amendments must also be followed during the three year transition of a field from conventional to organic production. Adequate buffer zones must exist between certified organic and conventionally grown crops to prevent drift of prohibited materials onto certified organic crops, even if the non-certified farm is not yours. The buffer zones must be either a barrier (diversion ditch or dense hedgerow) or an area of sufficient size and should be under the management control of the certified farmer. 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 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 Northeast Organic Farming Association of New York also states in the *USDA National Organic Program Regulations & NOFA-NY Certified Organic, LLC Guidance and Policy Manuals* pdf document "If the buffer is planted to the same crop as the

field, documentation of what is done with the non-certified buffer crop is required. If harvested, non-certified harvest records and equipment cleanout logs should be maintained." 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 because plant roots persist during late fall and early spring when soils tend to be the wettest. Planting on berms or raised beds will help reduce issues with less than adequate drainage.

Air drainage is an important consideration in choosing a blueberry site. Cold air, like water, runs downhill, 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 frost damage. 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. Sandy loam soils that are well-drained, acidic (pH 4.5), 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 being 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). A Cornell Soil Health Test prior to planting will provide field-specific information on constraints in biological and physical processes, in addition to standard soil nutrient analysis. See Table 6.1.1 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. 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

An important tool for organic management is irrigation. In most situations, drip irrigation is preferred rather than overhead. With drip irrigation, plants are not wetted and field activities can occur during the irrigation interval. Nutrients can be delivered through the irrigation system to provide more precise amounts to the blueberry plants. Also, the row middles are not irrigated with drip systems and this reduces weed pressure and conserves resources. Blueberries typically require 20 to 25 inches of rainfall during the growing season, so when this is not achieved, supplemental irrigation is required. Soil moisture tensiometers are recommended to gauge the amount of supplemental water that should be applied to maintain proper soil water status. During the hottest days of summer, one acre of blueberries can transpire 8,000 gallons of water per day.

Another important criterion is water quantity and quality. The irrigation water source should provide sufficient volume of water to irrigate as needed 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 the *Highbush Blueberry Production* Guide.

Fertilizers can be injected into the irrigation water and distributed by way of the drip system to the plants. This saves quite a bit of time and labor. However, organic fertilizers are typically less soluble in water than synthetic fertilizers. If fertilizers are injected that are not completely dissolved, then emitters can plug and unplugging them is difficult. Use large volume emitters so clogging is less of an issue. Most organic growers distribute nitrogen mechanically within the plant rows and use the drip system for only the most soluble fertilizers.

4. COVER CROPS – BEFORE PLANTING AND ROW MIDDLES

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 are considered biofumigants (marigold, brassicas) because they will either suppress or resist nematode populations, weeds or pathogens when chopped and incorporated into the soil. Cover crops with biofumigant properties should be considered where reduction of nematode populations is needed. See Table 4.1.1. 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.

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.

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.

See Cornell's online cover crop 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 the *Northeast Cover Crop Handbook*, by Marianne Sarrantonio.

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, less 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 4.1.1). 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 officinale*) 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 instead.

Bear in mind that weed species may become infected with and serve as reservoirs for the soilborne 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.

Table 4.1.1 Cover Crops for Blueberries: Cultural Requirements and Crop Benefits

Species	Use Timing	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 *Northeast Cover Crop Handbook*. 1994. M. Sarrantonio; the *Mid-Atlantic Berry Guide for Commercial Growers*. 2013-14. The Pennsylvania State University; and the Pest Management Guidelines for Berry Crops. 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.

Some growers consider tilling strips into existing sod and planting blueberries into those strips. The intention is to avoid seeding a permanent cover in the row middles and acidifying only the tilled strip. This strategy has several drawbacks and is not recommended. First, roots will grow into the row middle where the soil pH is high, and this reservoir of higher pH soil will work to raise the soil pH in the planted strip. Second, the species of plants in the row middle will undoubtedly contain creeping species (i.e. quackgrass) that will move into the planted row. Other species may serve as hosts to diseases and insects. Although it is more expensive to acidify the entire area, cover crop the entire site to increase organic matter, and then seed row middles to a known grass species, the long-term results will be better.

Permanent covers between rows increase soil organic matter, control weeds between the rows, prevent erosion on slopes, assist in retaining soil moisture, and allow field operations to resume quickly after rains. 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, permanent cover 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 methods. See Table 4.1.1 for information on specific cover crops useful as pre-plant incorporated green manures or as ground covers in the row middles.

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, bumblebees, wild bees, and honeybees are often used by blueberry growers and varieties vary in their pollination requirements; for more information refer to the *Highbush Blueberry Production Guide*.

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

Early/midseason: Draper, Duke and Northland

Midseason: Bluecrop, Bluejay

Late season: Aurora, Elliott, Liberty, and Nelson

Growers must also consider where they obtain their planting stock. According to language in the USDA-NOP regulation §205.204:

- 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 of synthetic substances allowed for use in organic crop production 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 heighten 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 usually require only small amounts, if any, of supplemental fertilizer.

See also the 14 part Berry Soil and Nutrient Management In-Depth Webinar Series along with Berry Soil and Nutrient Management - A Guide for Educators and Growers.

6.1 Soil and Leaf Analysis

Regular soil and leaf analysis helps monitor nutrient levels. Choose a reputable nutrient testing lab (see Table 6.1.1) 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 6.1.1. Nutrient Testing Laboratories

Testing Laboratory	Web url	Soil	Leaf	Compost/ Manure	Forage
Analytical Lab and Maine Soil Testing Service	anlab.umesci.maine.edu/	x	x	x	
Cornell Soil Health Lab (Cornell Recommendations)	soilhealth.cals.cornell.edu/	x			
Dairy One (Cornell Recommendations)	http://dairyone.com/analytical-services/agronomy-services/about-agro-one/	x	x	x	x
Penn State Agricultural Analytical Services Laboratory	https://agsci.psu.edu/aasl	x	x	x	
Soil and Plant Nutrient Testing Laboratory, University of Massachusetts Amherst	http://www.umass.edu/soiltest/	x	x		
Waypoint Analytical	https://www.waypointanalytical.com/AGServices	x	x	x	x

Table 6.1.2 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 6.1.2. 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 6.2.1. During site preparation, it is not recommended to acidify only the strips into which blueberries will be planted. Apply sulfur to the entire field intended for blueberry production prior to planting.

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 9.1 for converting amounts per acre to amounts needed for smaller areas.

Table 6.2.1. Approximate amounts of sulfur (lb/Acre) required to lower soil pH to 4.5.

Current pH	Soil type		
	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***; powdered sulfur takes 6 to 9 months. 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. Peat must be well-saturated before incorporation into soil to prevent desiccation of newly set plants. For more information consult Blueberries: Organic Production.

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 9.1.1, 9.1.2, and 9.1.3 in Section 9.1 for converting amounts per acre to amounts needed for smaller areas and for measuring and mixing small amounts.

In established plantings, base fertilizer amounts on leaf analysis. See Table 6.3.1 for organic sources of potassium (K). Potassium is basic and will tend to increase soil pH, but it is important for

Table 6.3.1. Available Potassium in Organic Fertilizers

Sources	Pounds of Fertilizer/Acre to Provide given Pounds of K_2O per acre:				
	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[1] 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)[2]	8000	16000	24000	32000	40000
Potassium sulfate 50% K_2O	40	80	120	160	200

[1]Only non-GMO sources of alfalfa may be used. Check with your certifier.
[2]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.

Magnesium (Mg) 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 (B) 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. **Note**: Boron testing is not included in most standard soil test packages and should be selected as an added test for blueberry soils.

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 (P) requirements in berry crops are relatively low, and phosphorus is usually not required in established plantings. Table 6.3.2 lists some organic fertilizer sources of phosphorus.

Table 6.3.2. Available Phosphorous in Organic Fertilizers

Sources	Pounds of Fertilizer/Acre to Provide given Pounds of P_2O_5 Per Acre				
	20	40	60	80	100
Bone meal 15% P_2O_5	130	270	400	530	670
Rock Phosphate 30% total P_2O_5 (x4)[1]	270	530	800	1100	1300
Fish meal 6% P_2O_5 (also contains 9% N)	330	670	1000	1330	1670

[1] 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.

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, 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.

Table 6.4.1. 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 *Nutrient management for fruit and vegetable crop production: Using manure and compost as nutrient sources for vegetable crops* by Carl Rosen and Peter Bierman and The Penn State Agronomy Guide. 2021-2022.

To create a robust organic fertility management plan, develop a plan for estimating the amount of nutrients that will be released from soil organic matter, cover crops, compost, and manure. A strategy for doing this is outlined in section 6.3. As these practices are integrated into field and farm management, the goal is to support diverse microbial communities that will help release nutrients from the organic matter additions. To assess overall impact of these practices on soil health, consider selecting a few target or problem fields for soil health monitoring over time via the Cornell Standard Soil Health Analysis Package. This suite of eight tests complements a standard soil chemical nutrient analysis by focusing on biological and physical soil health indicators. While the test results will provide feedback on how the soil sample compares to other New York soils, the real power is in the baseline readings for comparison in the future after implementing new soil health management strategies.

Management of N and ensuring 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 6.4.1. 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 6.1.1). 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 6.4.2). 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.

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.

Table 6.4.2. 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

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.

Table 6.4.3. 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)[a], 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)[a]	200	400	600	800	1000

[a] Application rates for some materials are multiplied to adjust for their slow to very slow release rates.

The annual nitrogen guidelines for blueberries are outlined in Table 6.4.2. 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 6.4.1 and 6.4.3). 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 6.4.3 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 Analytical Lab and Maine Soil Testing Service.

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 national Pesticide Environmental Stewardship website for more information.
8. Develop a thorough knowledge of the blueberry pests you are likely to encounter during the year. This includes basic pest biology, symptoms and/or damage, whether they are a primary or secondary pest, scouting thresholds, and the best time to implement 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 Integrated Pest Management: Fruits website: https://nysipm.cornell.edu/agriculture/fruits/
Cornell Fruit Resources: www.fruit.cornell.edu
Cornell Cooperative Extension Pesticide Safety Education Program (CCE-PSEP): psep.cce.cornell.edu
Pesticide Environmental Stewardship. Center for Integrated Pest Management. https://pesticidestewardship.org/
Elements of IPM for Blueberries in New York State: https://ecommons.cornell.edu/handle/1813/42718
Network for Environment and Weather Applications (NEWA): newa.cornell.edu
Berry Diagnostic Tool: https://blogs.cornell.edu/berrytool/

7.2 Weed Management

Weeds are part of the blueberry planting ecosystem where they can interfere with planting operations; provide alternate hosts for pests; compete for water and nutrients; and contaminate mechanically harvested fruits. Excessive weed growth within the strawberry canopy can also alter the microclimate around plants by interfering with sunlight penetration and air movement, leading to higher disease pressure and increasing the risk of spring frost. Managing weeds requires that the positive aspects of weed growth and any ecosystem services they provide are balanced with their negative effects in the planting. Some level of weed control is essential in blueberries, as described in Table 7.2.1., because of the low competitive ability of the crop. . In mature plantings, productivity of shallow-rooted blueberry bushes can be severely limited due to weed competition within the row. Managing weeds within the row may be one of the most difficult, yet essential, tasks in the production of organic blueberries (Table 7.2.1). Between the rows, the row middles, weed management or cover crop growth can be a powerful tool for minimizing soil erosion and improving equipment access in wet seasons. For more information on cover crops, refer to Section 4.

Table 7.2.1. Weed management without herbicides in a blueberry planting.

Year	Month	Non-herbicidal options
Planting year[1]	**April**	Till to prepare for planting unless planting into killed sod.
	April - May	Hand weed.
	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.

[1]CRITICAL TIME FOR REDUCING WEEDS

Good preplant preparation, plant establishment, and use of permanent cover crops in the alleyways/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. Without herbicides, eliminating perennial weeds can take several years. Refer to Sections 3 and 4 for more information.

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, so use it sparingly and not when soils are wet. 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, cultivating to shallow (1-2") depths only, and cultivating with the goal of reducing, rather than completely eliminating, weed or cover crop growth.

Grasses (ryegrass, fescue) can be planted in the row middles and managed with regular mowing. Sod minimizes weeds within the planting, provides winter cover for row middles, and is 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 *Highbush Blueberry Production Guide.* In addition to mowing row middles, it is important to keep areas around the field mowed to prevent weed seeds from blowing into the planting.

Within the row, a 4-inch layer of mulch greatly aids in weed management in blueberries. Shredded bark, wood chips, 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. Oftentimes road crews will look to dispose of chipped vegetation from right-of-ways, and aged chipped product also works well as a mulch for blueberries. Check that wood chips sourced from these locations have no carry-over from right-of-way herbicides or undesirable weed seeds and that your certifier approves this use.

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 shredded bark, wood chips or sawdust mulch. According to USDA NOP standards in sections 205.601 and 205.206, the following mulches can be used as weed barriers in organic production:

- Fully biodegradable materials such as wood chips, leaves, or straw
- Newspaper or other recycled paper, without glossy or colored inks
- Plastic mulch and covers provided they are pulled up at the end of the growing/harvest season and that they are petroleum-based but not polyvinyl chloride (PVC)
- Biodegradable biobased mulch film as defined in USDA NOP section 205.2 and produced without organisms or feedstock derived from excluded methods. Mulch film meeting these requirements is not currently commercially available.

Although agricultural plastic should be recycled if recycling is available, most agricultural plastics in New York State, especially difficult to clean plastic films used as weed barriers, are currently going to the landfill. China's market demand for the plastic ended in 2018, and alternative disposal solutions are not yet widely available. See the *Agricultural Plastics Recycling in New York State Case Study* pdf document for a summary of agricultural plastic recycling successes and challenges, with a 2019 update at the end. Burning or on-farm burying of agricultural plastic is prohibited according to the *USDA National Organic Program Regulations & NOFA-NY Certified Organic, LLC Guidance and Policy Manuals* pdf document. For a discussion about the reasoning behind the NOP rules that allow organic growers to use plastic but not biodegradable mulch at this time, see the *Allowed Mulches on Organic Farms and the Future of Biodegradable Mulch* pdf document.

There are a number of mechanical, thermal and animal measures that can be used to limit the effects of weeds under the plant row. Mechanical and thermal options include weed whackers, fixed hoes, rotary cultivators, flamers, steamers, and hot water applicators. As a reminder, blueberry root systems are very shallow so deep cultivation can damage roots. 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 should only be used after harvest in fall or during the planting (non-bearing) year. These animals do not like to eat all weed species so some clean-up of weeds is required after their use.

Organic Herbicide Considerations:

An organic herbicide strategy can be a useful part of a robust and diversified weed management program. If relied on alone, organic herbicides may require frequent re-applications for sustained weed control. Organic herbicides do not prevent weed seeds from germinating, rather they burn back to the ground small, established weeds. If these weeds have perennial roots, they will regrow. Best results are obtained in situations where small, annual weeds have germinated around the crop, rather than situations where perennial weeds are established. Because organic herbicides are non-selective, post emergent, contact herbicides, they also have the potential to damage the crop plants (leaves, green stems, flowers, fruit, etc.) if the spray contacts the crop. Therefore, using a hooded sprayer may help to prevent crop contact and associated injury. Herbicides are sprayed in a 4 foot strip under the plant. High spray volumes are required to get sufficient spray coverage for good weed control. Note that you may need to use up to 100 gallons of solution per sprayed acre to ensure sufficient herbicide coverage. Consult the pesticide label for specifics on how to apply the product, paying particular attention to the weeds controlled, the product's solubility in water, the need for agitation to ensure thorough mixing, and the need for spray adjuvants.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.2.2 Organic Herbicides Labeled for Management of Weeds in Blueberry

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
AVENGER AG OPTIMA BURNDOWN (d-limonene)	7-10% v/v. See label for details.	7	4	?	
Axxe (ammonium nonanoate)	See label for details. 6-15% v/v.	-	4	?	
Ecoblend Weed and Grass Burndown (soybean oil)	32-64 oz/gal water	-	-	?	
Ecoblend Weed Control Pro (soybean oil, citric acid)	5-32 oz/gal water	-	-	?	
Finalsan Herbicidal Soap (ammoniated soap of fatty acids.)	5.0-16.7% v/v. See label for details.	-	24	?	
Fireworxx Herbicide (capric acid, caprylic acid)	3-9% v/v. See label for details.	-	24	?	
Green Gobbler 20% Vinegar Weed Killer (acetic acid)	15-30 gal/acre	2	48	?	
Harris 20% Vinegar Weed Killer (acetic acid)	44-88 fl oz/1000 sq ft	2	48	?	
HomePlate Non-Selective Herbicide (capric acid, caprylic acid)	3-9% v/v. See label for details.	-	24	?	
Suppress Herbicide EC (capric acid, caprylic acid)	3-9% v/v. See label for details.	-	24	?	

[1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

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, and 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.
- Consider the use of insect exclusion netting to manage spotted-wing drosophila in late season varieties; this netting also provides exclusion for birds.

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 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, there are few consistently reliable biological control products that have been developed for managing blueberry diseases, although there are numerous biopesticides that are available and effective in low disease pressure situations.
- 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.

7.4.1 PHOMOPSIS CANKER (*Phomopsis vaccinii*)

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 the fungus Phomopsis is common in NY blueberry plantings and may not require chemical intervention.

Phomopsis Canker Management Options	
Scouting/thresholds	None established.

Phomopsis Canker Management Options	
Variety susceptibility	'Bluetta', 'Chippewa', 'Northsky', 'Rubel' and 'Elliot' are reportedly resistant. 'Bluejay', 'Duke', 'Hannah's Choice', 'Legacy', 'Coville', 'Spartan' 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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.4.1 Pesticides Labeled for Management of Phomopsis Canker

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Badge X2 (copper hydroxide, copper oxychloride)	1-2.5 lb/acre	0	48	1	
ChampION++ (copper hydroxide)	1-2.25 lb/acre	0	48	1	
CS 2005 (copper sulfate pentahydrate)	25.6-51.2 oz/acre	-	48	1	
Cueva Fungicide Concentrate (copper octanoate)	0.5-2 gal/acre	UDH	4	1	
Cuproxat FL (basic copper sulfate)	1.5-3.5 pt/acre	0	48	1	Dormant spray.
ET-F Algicide/ Bactericide/ Fungicide (copper sulfate pentahydrate)	25.6-51.2 fl oz/acre	-	48	?	
Kalmor (copper hydroxide)	1-2.25 lb/acre	0	48	1	
Kentan DF (copper hydroxide)	2-5 lb/acre	-	48	1	
Kocide 2000-O (copper hydroxide)	2-4 lb/acre	0	48	1	
Kocide 3000-O (copper hydroxide)	1-2.25 lb/acre	0	48	1	
LALSTOP K61 WP (Streptomyces grieoviridis strain K61)	1.75-16 oz/acre banded or side-dressed	0	4	?	Foliar sprays are not allowed.
LALSTOP K61 WP (Streptomyces grieoviridis strain K61)	1.75-32 oz/acre drip irrigation rate	0	4	?	Foliar sprays are not allowed.
Mastercop (copper sulfate pentahydrate)	1-2 pt/acre	UDH	48	1	Dormant spray.
Milstop (potassium bicarbonate)	2-5 lb/acre	0	1	?	Do not mix with other pesticides or fertilizers. Not compatible with alkaline solutions.
Serenade ASO (Bacillus subtilis str QST 713)	2-4 qt/acre	0	4	?	

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.4.2 FUSICOCCUM CANKER (*Fusicoccum putrefaciens*)

This fungus causes reddish spots to 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' and 'Rubel' are resistant. Moderately susceptible varieties are 'Coville', 'Berkeley', 'Blueray', 'Burlington', and 'Rubel'. Very susceptible varieties are 'Bluecrop', 'Coville', 'Jersey' and 'Earliblue'.
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.

7.4.3 BOTRYTIS BLOSSOM AND TWIG BLIGHT (*Botrytis cinerea*)

After several days of rainy or foggy weather, young shoots may die, turn brown, and become covered with a dusty gray mass of fungus spores. 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.

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 and support sporulation.
Chemical treatment	See below.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.4.3 Pesticides labeled for Management of Botrytis Blossom and Twig Blight

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Actinovate AG (Streptomyces Lydicus WYEC 108)	3-12 oz/acre	0	4	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.
BotryStop (Ulocladium oudemansii (U3 Strain))	2-4 lb/acre	-	4	?	
Carb-o-nator (potassium bicarbonate)	2.5-5 lb/100 gal water	0	4	?	
Cinnerate (cinnamon oil)	13-32 fl oz/100 gal water	0	-	?	25(b) pesticide. Check for phytotoxicity before applying to whole crop. See label for volumes to apply.
Companion Maxx Biological Fungicide (Bacillus amyloliquefaciens ENV503)	32-96 fl oz/acre	0	4	?	
Cueva Fungicide Concentrate (copper octanoate)	0.5-2 gal/acre	UDH	4	2	

Table 7.4.3 Pesticides labeled for Management of Botrytis Blossom and Twig Blight

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Dart Fungicide EC (capric acid, caprylic acid)	0.2-0.35 % W/W	UDH	24	?	
Double Nickel 55 (Bacillus amyloliquefaciens str. D747)	0.25-3 lb/acre	0	4	1	Re-apply every 3 to 10 days when conditions favor disease development.
Double Nickel LC (Bacillus amyloliquefaciens str. D747)	0.5-6 qt/acre	0	4	1	
Ecoworks EC (cold pressed neem oil)	1-4 pt/acre	0	4	?	
Howler (Pseudomonas chloroaphis strain AFS009)	5-15 lb/acre	0	4	?	
LALSTOP G46 WG (Gliocladium catenulatum str J1446)	See label	0	4	?	Rate used depends on volume applied per acre. See label.
LALSTOP K61 WP (Streptomyces grieoviridis strain K61)	1.75-16 oz/acre banded or side-dressed	0	4	?	Suppression only. Foliar sprays are not allowed.
LALSTOP K61 WP (Streptomyces grieoviridis strain K61)	1.75-32 oz/acre drip irrigation rate	0	4	?	Suppression only. Foliar sprays are not allowed.
LifeGard WG (Bacillus mycoides isolate J*)	1-4.5 oz/acre	0	4	1	
Milstop (potassium bicarbonate)	2-5 lb/acre	0	1	2	Do not mix with other pesticides or fertilizers. Not compatible with alkaline solutions.
OSO 5% SC Fungicide (polyoxin D zinc salt)	6.5 - 13 fl oz/acre	0	4	1+	
PerCarb (sodium carbonate peroxyhydrate)	3-4 lb/100 gal water dormant spray	0	Until Dry	?	Apply in early and late dormancy prior to bud break. Do not apply to blooming crops. See label for volumes to apply.
PERpose Plus (hydrogen peroxide)	1 fl oz/ gal. Initial/curative.	-	Until Dry	?	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.25-0.33 fl oz/ gal. Weekly/preventative.	-	Until Dry	?	See label for specific, curative or preventative, use directions.
Regalia (Reynoutria sachalinensis)	1-4 qt/acre	0	4	1	Apply every 7-14 days at the first signs of disease. Some sensitive blueberry varieties have exhibited fruit spotting as a result of application. Spray a test strip to confirm your variety is not susceptible to spotting before spraying.
Regalia CG (Reynoutria sachalinensis)	1-4 qt/acre	0	4	1	Some sensitive blueberry varieties have exhibited fruit spotting as a result of application. Spray a test strip to confirm your variety is not susceptible to spotting before spraying.
Romeo (Saccharomyces cerevisiae)	0.45-0.68 lb/acre	0	4	?	
Serenade ASO (Bacillus subtilis str QST 713)	2-4 qt/acre	0	4	1	Begin application prior to disease development and repeat on a 2-10 day interval or as needed. For improved performance, add an organic-approved surfactant to improve coverage.

Table 7.4.3 Pesticides labeled for Management of Botrytis Blossom and Twig Blight					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
Serenade MAX (Bacillus subtilis str QST 713)	1-3 lb/acre	0	4	1	For improved performance, add an organic-approved surfactant to improve coverage.
Serenade Opti (Bacillus subtilis str QST 713)	14-20 oz/acre	0	4	1	
Serifel (Bacillus amyloliquefaciens str. MBI 600)	4-16 oz/acre	0	4	1	
Sil-Matrix (potassium silicate)	0.5-1% vol/vol solution	0	4	?	Repeat applications no sooner than every 7 days. Mix 2-4 qts in 100 gallons of water and apply at 20 gallons finished spray/acre.
Sil-Matrix LC (potassium silicate)	1-4 qt/100 gal water	UDH	4	?	Repeat applications no sooner than every 7 days. Mix 1-4 qts in 100 gallons of water and apply at 50-250 gallons finished spray/acre.
Stargus (Bacillus amyloliquefaciens str. F727)	1-4 qt/100 gal water	0	4	1	
Taegro 2 (Bacillus subtilis var. amyloliquefaciens str. FZB2)	2.6-5.2 oz/acre	-	4	?	Suppression only.
TerraNeem EC (cold pressed neem oil)	1-1.5 % solution	0	4	?	See label for specific volumes of water to use.
Timorex Act (tea tree oil)	13-35 fl oz/acre	2	4	?	
Triathlon BA (Bacillus amyloliquefaciens str. D747)	0.5-6 qt/acre	0	4	?	
Trilogy (neem oil)	1% solution	UDH	4	?	See label for specific volumes of water to use. Maximum labeled use of 2 gal/acre/application

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.4.4 ANTHRACNOSE FRUIT ROT AND BLOSSOM BLIGHT (*Colletotrichum acutatum*)

This disease 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	'Elliot', 'Weymouth', 'Hannah's Choice', 'Legacy' and 'Brigitta' are reportedly resistant. 'Aurora', 'Bluegold', 'Bluejay', 'Bluetta', 'Bonus', 'Cara's Choice', 'Duke', 'Earliblue', 'Jersey', 'Nelson', 'Northland', 'Sierra' and 'Toro' are reportedly susceptible. Particularly susceptible varieties include 'Bluecrop', 'Blueray', 'Bluetta','Chanticleer', 'Spartan' 'Berkeley', and 'Coville'.

Anthracnose Fruit Rot and Blossom Blight Management Options	
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 and cool with refrigeration. Reducing overwintering inoculum and prompt harvest of ripe fruit is probably the best approach to organic disease management.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.4.4 Pesticides Labeled for Management of Anthracnose Fruit Rot and Blossom Blight

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
CS 2005 (copper sulfate pentahydrate)	25.6-51.2 oz/acre	-	48	1	
Dart Fungicide EC (capric acid, caprylic acid)	0.2-0.35 % W/W	UDH	24	1	
Double Nickel 55 (Bacillus amyloliquefaciens str. D747)	0.25-3 lb/acre	0	4	1	
Double Nickel LC (Bacillus amyloliquefaciens str. D747)	0.5-6 qt/acre	0	4	1	
Fungout (citric acid)	1.2% v:v	0	-	1	25(b) pesticide.
Howler (Pseudomonas chloroaphis strain AFS009)	5-15 lb/acre	0	4	1	
LALSTOP G46 WG (Gliocladium catenulatum str J1446)	See label	0	4	?	Rate used depends on volume applied per acre. See label.
Milstop (potassium bicarbonate)	2-5 lb/acre	0	1	?	Do not mix with other pesticides or fertilizers. Not compatible with alkaline solutions.
OSO 5% SC Fungicide (polyoxin D zinc salt)	6.5 - 13 fl oz/acre	0	4	1	Suppression only.
PERpose Plus (hydrogen peroxide)	1 fl oz/ gal. Initial/curative.	-	Until Dry	?	Hydrogen peroxide products effective in 0/1 trial. See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.25-0.33 fl oz/ gal. Weekly/preventative.	-	Until Dry	?	See label for specific, curative or preventative, use directions.
Regalia (Reynoutria sachalinensis)	1-4 qt/acre	0	4	2	Apply at green tip then every 7-10 days. Some sensitive blueberry varieties have exhibited fruit spotting as a result of application. Spray a test strip to confirm your variety is not susceptible to spotting before spraying.
Regalia CG (Reynoutria sachalinensis)	1-4 qt/acre	0	4	?	Some sensitive blueberry varieties have exhibited fruit spotting as a result of application. Spray a test strip to confirm your variety is not susceptible to spotting before spraying.
Serenade ASO (Bacillus subtilis str QST 713)	2-4 qt/acre	0	4	1	Begin application prior to disease development and repeat on a 2-10 day interval or as needed. For improved

Table 7.4.4 Pesticides Labeled for Management of Anthracnose Fruit Rot and Blossom Blight					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
					performance, add an organic-approved surfactant to improve coverage.
Serenade MAX (Bacillus subtilis str QST 713)	1-3 lb/acre	0	4	1	
Serenade Opti (Bacillus subtilis str QST 713)	14-20 oz/acre	0	4	1	For suppression, begin application prior to disease development and repeat on a 2-10 day interval or as needed.
Serifel (Bacillus amyloliquefaciens str. MBI 600)	4-16 oz/acre	0	4	1	
Sporan EC2 (rosemary oil, clove oil, peppermint oil, thyme oil)	1-3 pt/acre	0	-	?	
Stargus (Bacillus amyloliquefaciens str. F727)	1-4 qt/100 gal water	0	4	1	
TerraNeem EC (cold pressed neem oil)	1-1.5 % solution	0	4	?	See label for specific volumes of water to use.
Timorex Act (tea tree oil)	13-35 fl oz/acre	2	4	?	
Triathlon BA (Bacillus amyloliquefaciens str. D747)	0.5-6 qt/acre	0	4	1	
Trilogy (neem oil)	1% solution	UDH	4	?	See label for specific volumes of water to use. Maximum labeled use of 2 gal/acre/application

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.4.5 MUMMY BERRY (*Monilinia vaccinii-corymbosi*)

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 Disease.

Mummy Berry Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Shoot phase: 'Bluejay, "Duke', 'Elliot', 'Toro', Jersey', 'Darrow', 'Rubel', 'Bluetta', and 'Dixi' are most resistant to this disease in the shoot phase of infection. The most susceptible varieties at the shoot infection phase are 'Bluegold', 'Legacy', 'Coville', 'Northblue', 'Earliblue' and 'Blueray'. Fruit phase: 'Northsky', 'Reka', 'Northblue', 'Bluegold', 'Bluejay', 'Weymouth' and 'Patriot' are more resistant to the fruit infection phase. 'Berkley', 'Herbert', 'Lateblue', 'Bluehaven', and 'Elliot' are most susceptible at the fruit infection phase.

Mummy Berry Management Options	
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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.4.5 Pesticides Labeled for Management of Mummy Berry

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Actinovate AG (Streptomyces Lydicus WYEC 108)	3-12 oz/acre	0	4	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.
*Brandt Lime Sulfur (calcium polysulfide)	8 gal/100 gal water 200-300 gal spray/ac	-	48	?	
Carb-o-nator (potassium bicarbonate)	2.5-5 lb/100 gal water	0	4	?	
Dart Fungicide EC (capric acid, caprylic acid)	0.2 - 0.35 % W/W	UDH	24	?	
Double Nickel 55 (Bacillus amyloliquefaciens str. D747)	0.25-3 lb/acre	0	4	1	Suppression only.
Double Nickel LC (Bacillus amyloliquefaciens str. D747)	0.5-6 qt/acre	0	4	1	Suppression only.
LALSTOP G46 WG (Gliocladium catenulatum str J1446)	See label.	0	4	?	Rate used depends on volume applied per acre. See label.
LifeGard LC (Bacillus mycoides isolate J)	1 gal/100 gal water	0	4	?	
LifeGard WG (Bacillus mycoides isolate J*)	1-4.5 oz/acre	0	4	2	
Milstop (potassium bicarbonate)	2-5 lb/acre	0	1	?	Do not mix with other pesticides or fertilizers. Not compatible with alkaline solutions.
OSO 5% SC Fungicide (polyoxin D zinc salt)	6.5 - 13 fl oz/acre	0	4	1+	
Regalia (Reynoutria sachalinensis)	1-4 qt/acre	0	4	2	Begin application at bud break stage, repeat on a 7-10 day interval or as needed. Some sensitive blueberry varieties have exhibited fruit spotting as a result of application. Spray a test strip to confirm your variety is not susceptible to spotting before spraying.
Regalia CG (Reynoutria sachalinensis)	1-4 qt/acre	0	4	2	Some sensitive blueberry varieties have exhibited fruit spotting as a result of application. Spray a test strip to confirm your variety is not susceptible to spotting before spraying.

Table 7.4.5 Pesticides Labeled for Management of Mummy Berry

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Serenade ASO (Bacillus subtilis str QST 713)	2-4 qt/acre	0	4	1	For suppression, begin application at bud break stage, 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 str QST 713)	1-3 lb/acre	0	4	1	For improved performance, add an organic-approved surfactant to improve coverage. For suppression, begin application at bud break stage, and repeat on a 7-10 day interval or as needed.
Serenade Opti (Bacillus subtilis str QST 713)	14-20 oz/acre	0	4	1	For suppression, begin application at bud break stage, and repeat on a 7-10 day interval or as needed.
Serifel (Bacillus amyloliquefaciens str. MBI 600)	4-16 oz/acre	0	4	1	
Stargus (Bacillus amyloliquefaciens str. F727)	1-4 qt/100 gal water	0	4	1	
Timorex Act (tea tree oil)	13-35 fl oz/acre	2	4	?	
Triathlon BA (Bacillus amyloliquefaciens str. D747)	0.5-6 qt/acre	0	4	1	

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.5 Other diseases of note

7.5.1 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, 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.

7.5.2 CROWN GALL (*Agrobacterium tumefaciens*)

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 soilborne 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.

7.5.3 WITCHES' BROOM (*Pucciniastrum goeppertianum*)

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 500 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.

7.5.4 POWDERY MILDEW *(Microsphaera vaccinii)*

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', 'Coville', 'Earliblue' and 'Ivanhoe' are moderately resistant to 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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.5.4 Pesticides labeled for Management of Powdery Mildew

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Acoidal (sulfur)	6-15 lb/acre	-	24	1	Do not use within 2 weeks of an oil treatment. Begin when new shoots are 6 inches long and before blossoms open. Repeat at 10 day intervals or as necessary.
Auron DF (sulfur)	6-15 lb/acre	-	24	1+	Begin when new shoots are 6 inches long and before blossoms open.
Carb-o-nator (potassium bicarbonate)	2.5-5 lb/100 gal water	0	4	1	
Cinnerate (cinnamon oil)	13-32 fl oz/100 gal water	0	-	?	25(b) pesticide. Check for phytotoxicity before applying to whole crop. See label for volumes to apply.
Damoil (mineral oil)	0.75-1.5 gal/100 gal water	-	4	1	
Defend DF (sulfur)	6-15 lb/acre	-	24	1	Do not use within 2 weeks of an oil treatment. Begin when new shoots are 6 inches long and before blossoms open. Repeat at 10 day intervals or as necessary.
DES-X (insecticidal soap)	2% solution sprayed at 75-200 gallons/acre	1/2	12	?	Do not mix with sulfur. Do not use within 3 days of a sulfur application.
Drexel Suffa (sulfur)	1-2.5 gal/acre	UDH	24	1+	Do not apply when temperatures exceed or are likely to exceed 90°F. Do not use sulfur with oil or within 14 days of an oil spray.
EcoSwing Botanical Fungicide (extract of Swinglea glutinosa)	1.5-2 pts/acre	0	4	1	
Ecoworks EC (cold pressed neem oil)	1-4 pt/acre	0	4	?	
Glacial Spray Fluid (mineral oil)	.75-1.5 gal/100 gal water	UDH	4	1	See label for specific application volumes and equipment.
JMS Stylet-Oil (mineral oil)	3-6 qt/100 gal water	0	4	1	
Kaligreen (potassium bicarbonate)	2.5-3 lb/acre	1	4	1	Do not mix with highly acidic products or nutrients.
KOPA Insecticidal Soap (potassium salts of fatty acids)	2 gal/100 gal water	1/2	12	?	See label for specific application volumes.

Table 7.5.4 Pesticides labeled for Management of Powdery Mildew

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
LALSTOP G46 WG (Gliocladium catenulatum str J1446)	See label.	0	4	?	Rate used depends on volume applied per acre. See label.
Microthiol Disperss (sulfur)	6-15 lb/acre	-	24	1	Do not use within 2 weeks of an oil treatment.
Mildew Cure (garlic oil, cottonseed oil, corn oil)	1 gal/100 gal water	-	-	?	25(b) pesticide. Conduct phytotoxicity test prior application.
Milstop (potassium bicarbonate)	2-5 lb/acre	0	1	1	Do not mix with other pesticides or fertilizers. Not compatible with alkaline solutions.
M-Pede (insecticidal soap)	1-2 % vol/vol solution	0	12	1	Do not mix with sulfur. Do not use within 3 days of a sulfur application.
Nuke Em (citric acid)	1 fl oz /32 fl oz water. Normal strength.	0	-	?	25(b) pesticide.
Omni Supreme Spray (mineral oil)	0.75-1.5 gal/acre	-	12	1	Use at least 200 psi spray pressure for fungal diseases.
OSO 5% SC Fungicide (polyoxin D zinc salt)	6.5 - 13 fl oz/acre	0	4	1+	
PerCarb (sodium carbonate peroxyhydrate)	1-3 lb/100 gal water	0	Until Dry	?	
PerCarb (sodium carbonate peroxyhydrate)	3-4 lb/100 gal water dormant spray	0	Until Dry	?	Apply in early and late dormancy prior to bud break. Do not apply to blooming crops.
PERpose Plus (hydrogen peroxide)	1 fl oz/ gal. Initial/curative.	-	Until Dry	?	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.25-0.33 fl oz/ gal. Weekly/preventative.	-	Until Dry	?	See label for specific, curative or preventative, use directions.
PureSpray Green (white mineral oil)	.75-1.5 gal/100 gal water (dilute spray); 1.5-3 gal/A (concentrate spray)	UDH	4	?	For concentrate spray, apply in a minimum of 50 gals water per acre. Use at least 200 psi spray pressure for fungal diseases. For dilute spray, apply in 100 gals water per acre.
Romeo (Saccharomyces cerevisiae)	0.45-0.68 lb/acre	0	4	?	
Serifel (Bacillus amyloliquefaciens str. MBI 600)	4-16 oz/acre	0	4	1	
Sil-Matrix (potassium silicate)	0.5-1% vol/vol solution	0	4	?	Mix 2-4 qts in 100 gallons of water and apply at 20 gallons finished spray/acre.
Sil-Matrix LC (potassium silicate)	1-4 qt/100 gal water	UDH	4	1	Repeat applications no sooner than every 7 days. Mix 1-4 qts in 100 gallons of water and apply at 50-250 gallons finished spray/acre.
Solawit 80DF (sulfur)	6-15 lb/acre	-	24	1+	Do not apply if temperatures during or within 3 days after application are expected to exceed 90°F. Do not use within 2 weeks of an oil spray except for dormant, delayed dormant or post-harvest applications.
Sporan EC2 (rosemary oil, clove oil, peppermint oil, thyme oil)	1-3 pt/acre	0	-	?	
SuffOil-X (mineral oil)	1-2 gal/100 gal water	UDH	4	?	Apply as needed.
Sulfur 80 WDG (sulfur)	6-15 lb/acre	-	24	1	

Table 7.5.4 Pesticides labeled for Management of Powdery Mildew

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Taegro 2 (Bacillus subtilis var. amyloliquefaciens str. FZB2)	2.6-5.2 oz/acre	-	4	1	Suppression only.
TerraNeem EC (cold pressed neem oil)	1-1.5 % solution	0	4	?	See label for specific volumes of water to use.
Thiolux (sulfur)	6-15 lb/acre	-	24	1	Apply beginning when disease first appears. Repeat at a 7- to 10-day interval or as necessary. Do not use within 2 weeks of an oil treatment.
Timorex Act (tea tree oil)	13-35 fl oz/acre	2	4	?	
Trilogy (neem oil)	1% solution	UDH	4	?	See label for specific volumes of water to use. Maximum labeled use of 2 gal/acre/application
Ultra-Pure Oil (mineral oil)	0.75-1.5 gal/100 gal water	UDH	4	?	Do not use this material if it does not emulsify. Do not apply micronized sulfur within 10 days of an oil application and do not apply oil within 14 days of an application of wettable or dusting sulfur. See label for specific application volumes.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.5.5 BLUEBERRY LEAF RUST (*Naohidemyces vaccinii* or *Pucciniastrum vaccinii*)

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 ¼ mile (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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.5.5 Pesticides Labeled for Management of Blueberry Leaf Rust

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Damoil (mineral oil)	0.75-1.5 gal/100 gal water	-	4	2	
Glacial Spray Fluid (mineral oil)	.75-1.5 gal/100 gal water	UDH	4	2	See label for specific application volumes and equipment.
JMS Stylet-Oil (mineral oil)	3-6 qt/100 gal water	0	4	2	
Omni Supreme Spray (mineral oil)	0.75-1.5 gal/acre	-	12	2	Use at least 200 psi spray pressure for fungal diseases.
PerCarb (sodium carbonate peroxyhydrate)	3-4 lb/100 gal water dormant spray	0	Until Dry	?	Apply in early and late dormancy prior to bud break. Do not apply to blooming crops.
PERpose Plus (hydrogen peroxide)	1 fl oz/ gal. Initial/curative.	-	Until Dry	?	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.25-0.33 fl oz/ gal. Weekly/preventative.	-	Until Dry	?	See label for specific, curative or preventative, use directions.
PureSpray Green (white mineral oil)	.75-1.5 gal/100 gal water (dilute spray);	UDH	4	2	For concentrate spray, apply in a minimum of 50 gals water per acre. Use at least 200

Table 7.5.5 Pesticides Labeled for Management of Blueberry Leaf Rust					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
	1.5-3 gal/A (concentrate spray)				psi spray pressure for fungal diseases. For dilute spray, apply in 100 gals water per acre.
SuffOil-X (mineral oil)	1-2 gal/100 gal water	UDH	4	2	Apply as needed.
TerraNeem EC (cold pressed neem oil)	1-1.5 % solution	0	4	?	See label for specific volumes of water to use.
Trilogy (neem oil)	1% solution	UDH	4	?	See label for specific volumes of water to use. Maximum labeled use of 2 gal/acre/application
Ultra-Pure Oil (mineral oil)	0.75-1.5 gal/100 gal water	UDH	4	?	Do not use this material if it does not emulsify. Do not apply micronized sulfur within 10 days of an oil application and do not apply oil within 14 days of an application of wettable or dusting sulfur.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

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.

7.6.1 BLUEBERRY MAGGOT *(Rhagoletis mendax)*

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. They have one generation a year, overwintering as pupae in the soil. They emerge from overwintering over an extended time period starting in mid-June.

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 in the blueberry canopy 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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.6.1 Pesticides Labeled for Management of Blueberry Maggot					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	2	
AzaGuard (azadirachtin)	10-16 fl oz/acre	0	4	2	Apply with OMRI approved spray oil.

Table 7.6.1 Pesticides Labeled for Management of Blueberry Maggot

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
*AzaSol (azadirachtin)	6 oz/acre	0	4	2	
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
Cinnerate (cinnamon oil)	13-32 fl oz/100 gal water	0	-	?	25(b) pesticide. Check for phytotoxicity before applying to whole crop. See label for volumes to apply.
Ecoworks EC (cold pressed neem oil)	1-4 pt/acre	0	4	?	
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	2	
Entrust (spinosad)	1.25-2 oz/acre	3	4	2	2(ee) recommendation. User must have a copy of the recommendation in their possession at the time of application.
Entrust SC (spinosad)	4-6 fl oz/acre	1	4	2	2(ee) recommendation. User must have a copy of the recommendation in their possession at the time of application.
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
Grandevo CG (Chromobacterium subtsugae str. PRAA4-1)	3-4.25 Tbsp/1000 sq ft	0	4	?	
Grandevo WDG (Chromobacterium subtsugae str. PRAA4-1)	2-3 lb/acre	0	4	?	
Molt-X (azadirachtin)	10 oz/acre	0	4	2	Plus 0.25 to 1.0% non-phytotoxic crop oil.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	3	
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	3	
Surround WP (kaolin clay)	25-50 lb/acre	UDH	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.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.6.2 CHERRY FRUITWORM *(Grapholita packardi)*

The adults (moths) of the cherry fruitworm appear during late May and early June when bloom is nearing completion 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.
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 during 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.

Cherry Fruitworm Management Options	
Chemical treatment	See below.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.6.2 Pesticides Labeled for Management of Cherry Fruitworm

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	2	
AzaGuard (azadirachtin)	8-16 fl oz/acre	0	4	2	Apply with OMRI approved spray oil.
*AzaSol (azadirachtin)	6 oz/acre	0	4	2	
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
Bioprotec Plus (Bacillus thuringinensis subsp. Kurstaki)	0.8-1.5 pt/acre	0	4	1	Treat larvae when they are newly hatched and actively feeding.
BT NOW (Bacillus thuringinensis subsp. Kurstaki)	1.5-2.2 pts/acre	0	4	?	
Cinnerate (cinnamon oil)	13-32 fl oz/100 gal water	0	-	?	25(b) pesticide. Check for phytotoxicity before applying to whole crop.
Deliver (Bacillus thuringiensis, var. kurstaki)	0.25-1.5 lb/acre	0	4	1	No concern with bee toxicity.
Dipel DF (Bacillus thuringinensis subsp. Kurstaki)	0.5-2 lb/acre	0	4	1	No concern with bee toxicity.
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	?	25(b) pesticide. Target small caterpillars
Ecotrol Plus (rosemary oil, peppermint oil, geraniol)	1-4 pts/acre	0	-	?	25(b) pesticide. Target small caterpillars
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	2	
Entrust (spinosad)	1.25-2.0 oz/acre	3	4	1	
Entrust SC (spinosad)	4-6 fl oz/acre	1	4	?	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
Grandevo CG (Chromobacterium subtsugae str. PRAA4-1)	1.5-4.25 Tbsp/1000 sq ft	0	4	?	
Grandevo WDG (Chromobacterium subtsugae str. PRAA4-1)	1-3 lb/acre	0	4	?	
Javelin WG (Bacillus thuringiensis, var. kurstaki)	0.25-1.0 lb/acre	0	4	1	No concern with bee toxicity.
Mantis EC (rosemary oil, soybean oil, peppermint oil)	1-8 pt/100 gal water	0	-	?	25(b) pesticide. Target small caterpillars
Molt-X (azadirachtin)	8 oz/acre	0	4	2	Plus 0.25 to 1.0% non-phytotoxic crop oil.
Neemix 4.5 (azadirachtin)	4-10 fl oz/acre	0	4	2	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	

Table 7.6.2 Pesticides Labeled for Management of Cherry Fruitworm					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	?	
Venerate XC (Burkholderia spp. str A396)	1-2 qt/acre	0	4	1	In New York State, application is prohibited within 100 feet of any surface water.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found. PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.6.3 CRANBERRY FRUITWORM *(Acrobasis vaccinii)*

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 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.
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 during 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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.6.3 Pesticides Labeled for Management of Cranberry Fruitworm					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	2	
AzaGuard (azadirachtin)	8-16 fl oz/acre	0	4	2	Apply with OMRI approved spray oil.
*AzaSol (azadirachtin)	6 oz/acre	0	4	2	
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
Bioprotec Plus (Bacillus thuringinensis subsp. Kurstaki)	0.8-1.5 pt/acre	0	4	1	Treat larvae when they are newly hatched and actively feeding.
BT NOW (Bacillus thuringinensis subsp. Kurstaki)	1.5-2.2 pts/acre	0	4	?	
Cinnerate (cinnamon oil)	13-32 fl oz/100 gal water	0	-	?	25(b) pesticide. Check for phytotoxicity before applying to whole crop.
Dipel DF (Bacillus thuringinensis subsp. Kurstaki)	0.5-2 lb/acre	0	4	1	No concern with bee toxicity.
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	?	25(b) pesticide. Target small caterpillars

Table 7.6.3 Pesticides Labeled for Management of Cranberry Fruitworm					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
Ecotrol Plus (rosemary oil, peppermint oil, geraniol)	1-4 pts/acre	0	-	?	25(b) pesticide. Target small caterpillars
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	2	
Entrust (spinosad)	1.25-2.0 oz/acre	3	4	1	
Entrust SC (spinosad)	4-6 fl oz/acre	1	4	1	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
Grandevo CG (Chromobacterium subtsugae str. PRAA4-1)	1.5-4.25 Tbsp/1000 sq ft	0	4	?	
Grandevo WDG (Chromobacterium subtsugae str. PRAA4-1)	1-3 lb/acre	0	4	?	
Mantis EC (rosemary oil, soybean oil, peppermint oil)	1-8 pt/100 gal water	0	-	?	25(b) pesticide. Target small caterpillars
Molt-X (azadirachtin)	8 oz/acre	0	4	2	Plus 0.25 to 1.0% non-phytotoxic crop oil.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	?	
Venerate XC (Burkholderia spp. str A396)	1-2 qt/acre	0	4	?	In New York State, application is prohibited within 100 feet of any surface water.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.6.4 JAPANESE BEETLES (Popillia japonica)

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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.6.4 Pesticides Labeled for Management of Japanese Beetles					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
Acti-Min FE Crop Protectant (kaolin)	12.5-37.5 lb/acre	up to harvest	4	?	Suppression only. Apply only to fruits to be used for processing.

Table 7.6.4 Pesticides Labeled for Management of Japanese Beetles

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	Plus 0.25 to 1.0% non-phytotoxic crop oil.
AzaGuard (azadirachtin)	8-16 fl oz/acre	0	4	?	Apply with OMRI approved spray oil.
*AzaSol (azadirachtin)	6 oz/acre	0	4	?	Reported to have some repellent effect against beetles.
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	?	See container label for specific rates used.
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	?	25(b) pesticide.
Ecoworks EC (cold pressed neem oil)	1-4 pt/acre	0	4	?	
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	?	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
Grandevo CG (Chromobacterium subtsugae str. PRAA4-1)	3-4.25 Tbsp/1000 sq ft	0	4	?	Suppression only.
Grandevo WDG (Chromobacterium subtsugae str. PRAA4-1)	2-3 lb/acre	0	4	?	Suppression only.
Mantis EC (rosemary oil, soybean oil, peppermint oil)	1-8 pt/100 gal water	0	-	?	25(b) pesticide.
Molt-X (azadirachtin)	8 oz/acre	0	4	?	Plus 0.25 to 1.0% non-phytotoxic crop oil.
Neemix 4.5 (azadirachtin)	7-16 fl oz/acre	0	4	?	
PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97)	1-2 lb/acre soil treatment	-	4	?	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	?	
Surround WP (kaolin clay)	25-50 lb/acre	UDH	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.
TerraNeem EC (cold pressed neem oil)	0.5-1.5 % solution	0	4	?	See label for specific volumes of water to use.
Venerate XC (Burkholderia spp. str A396)	4-8 qt/acre broadcast	0	4	?	Target larvae in the soil. In New York State, application is prohibited within 100 feet of any surface water. Broadcast soil application or band application to established plants.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.6.5 SPOTTED WING DROSOPHILA (Drosophila suzukii)

Spotted Wing Drosophila (SWD) is an invasive vinegar or fruit fly that was first detected in NY in 2011 and spread across NY in 2012. There is potential for significant impact from this pest, for midseason and late season blueberries because this is when populations tend to increase. SWD appears to have the capability to survive winter conditions. However, populations at the start of the growing season tend to

be quite low indicating high mortality over the winter. Adult flies are 2-3 mm in length, with red eyes and a tan-colored body with darker bands on the abdomen. Males have characteristic single spots at the leading edge of the tip of the wing and two dark spots on their front legs. Females lack wing spots and leg spots, but are distinguished by a saw-toothed ovipositor (visible under magnification). Larvae are white, nondescript and legless. Female SWD can lay eggs in ripening and marketable fruit.

Monitoring can be useful for managing this pest. Traps and baits are now commercially available for monitoring SWD. Or homemade traps and baits, based on a fermenting mixture of yeast, sugar, water, and whole wheat flour with an apple cider vinegar drowning solution can be constructed. See Spotted Wing Drosophila (SWD) Monitoring Traps for more information. Talk to your local extension educator about a monitoring program. Traps should be checked weekly. Fruit should also be inspected for evidence of larval feeding (see below).

Fruit destined for a processing market may be at risk of rejection due to presence of larvae. Home canning and processing may generate complaints from customers that notice SWD larvae. **Maintain a good cold chain between harvest and sale.** Display farm market fruit in a cooler— refrigeration slows or stops SWD development in fruit. Regular fruit sampling will help identify problems in the field. Fruit can be inspected for evidence of larval feeding. Small pinholes in berries may leak juice when the berry is gently squeezed; this is especially diagnostic on blueberry. Immersing fruit in a salt solution (1 Tbsp. table salt/cup water (14.8 cc/236.6 ml)) may cause larvae to float to surface. At least 100 fruit per block per harvest should be observed for infestation.

For more information, consult the Spotted Wing Drosophila website on Cornell Fruit Resources.

Spotted Wing Drosophila Management Options	
Scouting/thresholds	Not specifically established but customer tolerance for infested fruit is likely to be very low. Home-made traps baited with an apple cider vinegar drowning solution plus an ampule containing a yeast bait floating in the cider vinegar have proven successful in capturing adult SWD. See Spotted Wing Drosophila (SWD) Monitoring Traps for instructions. There are also traps and lures commercially available that are effective and easier to use. Traps should be checked daily or at least once per week, because many other insects will be caught.
Variety susceptibility	No known resistant varieties.
Cultural management	Excellent sanitation will reduce SWD populations. Fruit should be harvested frequently and completely to prevent the buildup of ripe and over-ripe fruit. Unmarketable fruit should be removed from the field and either frozen, "baked" in clear plastic bags placed in the sun, or disposed of in bags off-site. This will kill larvae, remove them from your crop, and prevent them from emerging as adults. Canopy and water management will make the environment less favorable. Prune to maintain an open canopy, increase sunlight and reduce humidity. This will make plantings less attractive to SWD and will improve spray coverage. Repair leaking drip lines and avoid overhead irrigation when possible. Allow the ground and mulch surface to dry before irrigating. Cool berries immediately. Chilling berries immediately after harvest to 32-33F will slow or stop the development of larvae and eggs in the fruit. U-Pick customers should be encouraged to follow this strategy to improve fruit quality at home. If the planting includes late season varieties, consider using insect exclusion netting on these to protect fruit; if establishing a new planting, focus on early to mid-season varieties to minimize the need for SWD management.
Chemical treatment	A few insecticides have recently been granted 2ee label exemptions for control of SWD. SWD adults appear sensitive to several different chemistries, although their high reproductive rate, short generation time, and mobility may necessitate multiple applications for control. Insecticide sprays will kill SWD adults and thereby reduce egg laying. Insecticide treatments should begin either when regional monitoring alerts the first SWD trap catch has occurred or when highly susceptible fruit crops begin to ripen. Treatments should be applied at least every seven days and repeated in the event of rain. Choose the most effective insecticides with pre-harvest intervals that work for your picking schedule. Rotate insecticides according to their modes of action.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.6.5 Pesticides Labeled for Management of Spotted Wing Drosophila

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	2	
AzaGuard (azadirachtin)	10-16 fl oz/acre	0	4	2	Apply with OMRI approved spray oil.
*AzaSol (azadirachtin)	6 oz/acre	0	4	2	

Table 7.6.5 Pesticides Labeled for Management of Spotted Wing Drosophila

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	?	See container label for specific rates used.
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	?	25(b) pesticide. Target maggot stage
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	2	
Entrust (spinosad)	1.25-2.0 oz/acre	3	4	1	2(ee) recommendation. User must have a copy of the recommendation in their possession at the time of application. Do not make more than 6 applications per calendar year or 3 applications per crop. Do not make applications less than 6 days apart. Do not make more than 2 consecutive applications of Group 5 insecticides (spinetoram and spinosad). If additional treatments are required after 2 consecutive applications of Group 5 insecticides rotate to another class of effective insecticides for at least one application.
Entrust SC (spinosad)	4-6 fl oz/acre	1	4	1	Do not make more than 6 applications per calendar year or 3 applications per crop. Do not make applications less than 6 days apart. Do not make more than 2 consecutive applications of Group 5 insecticides (spinetoram and spinosad). If additional treatments are required after 2 consecutive applications of Group 5 insecticides rotate to another class of effective insecticides for at least one application.
Grandevo CG (Chromobacterium subtsugae str. PRAA4-1)	3-4.25 Tbsp/1000 sq ft	0	4	2	
Grandevo WDG (Chromobacterium subtsugae str. PRAA4-1)	2-3 lb/acre	0	4	2	Begin applications as soon as adult flies are active and continue until adult activity is no longer present. Use in rotation with other products labeled for spotted wing drosophila.
Mantis EC (rosemary oil, soybean oil, peppermint oil)	1-8 pt/100 gal water	0	-	?	25(b) pesticide. Target maggot stage
Molt-X (azadirachtin)	8 oz/acre	0	4	2	
Neemix 4.5 (azadirachtin)	7-16 fl oz/acre	0	4	2	Larvae only.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	3	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	3	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.

Table 7.6.5 Pesticides Labeled for Management of Spotted Wing Drosophila

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Venerate XC (Burkholderia spp. str A396)	2-4 qt/acre broadcast	0	4	?	In New York State, application is prohibited within 100 feet of any surface water. Rotation or tank-mixing with other insecticides labeled for spotted wing drosophila is recommended.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

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.

7.7.1 ANTS *(various species)*

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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.7.1 Pesticides Labeled for Management of Ants

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	?	See container label for specific rates used. See label for ant species.
DEsect CROP (silicon dioxide)	1 lb/1000 sq ft	-	12	?	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water. Spray at 10 gallons of mix per acre.	-	-	?	25(b) pesticide. Repellent.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	?	Excluding fire and pharaoh ants.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.7.2 BLUEBERRY STEM BORER *(Oberea myops)*

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.

7.7.3 BLUEBERRY TIP BORER *(Hendecaneura shawiana)*

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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.7.3 Pesticides Labeled for Management of Blueberry Tip Borer

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	2	
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	2	See container label for specific rates used.
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	2	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
Molt-X (azadirachtin)	10 oz/acre	0	4	2	Plus 0.25 to 1.0% non-phytotoxic crop oil.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	Target petal fall and first cover. Caution: do not use when bees are active in the planting.
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	?	Target petal fall and first cover. Caution: do not use when bees are active in the planting.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.7.4 INSECT STEM GALL *(Hemadas nubilipennis)*

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.

7.7.5 LEAFROLLERS *(various species)*

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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.7.5 Pesticides Labeled for Management of Leafrollers

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	2	
AzaGuard (azadirachtin)	8-16 fl oz/acre	0	4	2	Apply with OMRI approved spray oil.
*AzaSol (azadirachtin)	6 oz/acre	0	4	2	
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	2	See label for leafroller species controlled. See container label for specific rates used.
Biobit HP (Bacillus thuringiensis, var. kurstaki)	1/2-1 lb/acre	0	4	2	See label for leafroller species controlled.
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
Cinnerate (cinnamon oil)	13-32 fl oz/100 gal water	0	-	?	25(b) pesticide. Check for phytotoxicity before applying to whole crop. See label for volumes to apply.
Deliver (Bacillus thuringiensis, var. kurstaki)	0.25-1 lb/acre	0	4	1	See label for leafroller species controlled. Apply by ground equipment only.

Table 7.7.5 Pesticides Labeled for Management of Leafrollers

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Dipel DF (Bacillus thuringinensis subsp. Kurstaki)	0.5-2 lb/acre	0	4	1	See label for leafroller species controlled.
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	?	25(b) pesticide. Target small caterpillars
Ecotrol Plus (rosemary oil, peppermint oil, geraniol)	1-4 pts/acre	0	-	?	25(b) pesticide. Target small caterpillars
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	2	
Entrust (spinosad)	1.25-2.0 oz/acre	3	4	1	
Entrust SC (spinosad)	4-6 fl oz/acre	1	4	1	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
Grandevo CG (Chromobacterium subtsugae str. PRAA4-1)	1.5-4.25 Tbsp/1000 sq ft	0	4	?	
Grandevo WDG (Chromobacterium subtsugae str. PRAA4-1)	1-3 lb/acre	0	4	?	
Javelin WG (Bacillus thuringiensis, var. kurstaki)	0.25-1.0 lb/acre	0	4	1	No concern with bee toxicity. See label for leafroller species controlled.
Molt-X (azadirachtin)	8 oz/acre	0	4	2	Plus 0.25 to 1.0% non-phytotoxic crop oil.
Neemix 4.5 (azadirachtin)	7-16 fl oz/acre	0	4	2	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	?	
Surround WP (kaolin clay)	25-50 lb/acre	UDH	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.
Venerate XC (Burkholderia spp. str A396)	1-2 qt/acre	0	4	?	In New York State, application is prohibited within 100 feet of any surface water.
XenTari (Bacillus thuringiensis, var. aizawai)	0.5-1.5 lb/acre	0	4	1	See label for leafroller species controlled.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.7.6 PLUM CURCULIO *(Conotrachelus nenuphar)*

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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.7.6 Pesticides Labeled for Management of Plum Curculio

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	
*AzaSol (azadirachtin)	6 oz/50 gal/acre	0	4	?	Larvae only.
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	?	See container label for specific rates used.
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	?	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
Molt-X (azadirachtin)	8 oz/acre	0	4	?	
Mycotrol ESO (Beauvaria bassiana)	0.25-1 qt/acre	0	4	?	Begin treatment when insects first appear; typically a 7-10 day interval occurs before control is seen.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	?	
Surround WP (kaolin clay)	25-50 lb/acre	UDH	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.
Venerate XC (Burkholderia spp. str A396)	1-2 qt/acre	0	4	?	Rotation or tank-mixing with other insecticides labeled for plum curculio is recommended. Begin applications when adults are active and prior to start of oviposition. In New York State, application is prohibited within 100 feet of any surface water.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

7.7.7 SCALE INSECTS *(various species)*

A number of species of scale insects, including Oystershell, terrapin, 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.

At the time this guide was produced, the following materials were available 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.7.7 Pesticides Labeled for Management of Scale Insects

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	
*AzaSol (azadirachtin)	6 oz/acre	0	4	?	Target crawler stage.
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	?	See container label for specific rates used.
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
Cinnerate (cinnamon oil)	13-32 fl oz/100 gal water	0	-	?	25(b) pesticide. Check for phytotoxicity before applying to whole crop. See label for volumes to apply.

Table 7.7.7 Pesticides Labeled for Management of Scale Insects

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Damoil (mineral oil)	0.75-1.5 gal/100 gal water	-	4	?	
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	?	25(b) pesticide. Target crawler stage.
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	?	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
Golden Pest Spray Oil (soybean oil)	3 gal/100 gal water	-	4	1	Dormant spray.
KOPA Insecticidal Soap (potassium salts of fatty acids)	2 gal/100 gal water	1/2	12	?	See label for specific application volumes.
Mantis EC (rosemary oil, soybean oil, peppermint oil)	1-8 pt/100 gal water	0	-	?	25(b) pesticide. Target crawler stage.
Molt-X (azadirachtin)	10 oz/acre	0	4	?	Plus 0.25 to 1.0% non-phytotoxic crop oil.
M-Pede (insecticidal soap)	1-2 % vol/vol solution	0	12	?	Labeled for crawlers only.
Neemix 4.5 (azadirachtin)	7-16 fl oz/acre	0	4	?	Target crawler stage.
PureSpray Green (white mineral oil)	.75-1.5 gal/100 gal water (dilute). 1.5-3 gal oil/acre (concentrate)	UDH	4	1	For concentrate spray, apply in a minimum of 50 gals water per acre. For dilute spray, apply in 100 gals water per acre.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	?	
SuffOil-X (mineral oil)	1-2 gal/100 gal water	UDH	4	1	Apply as needed. Target crawler stage in spring/early summer. Can cause phytotoxicity if applied too close to a sulfur application.
TerraNeem EC (cold pressed neem oil)	0.5-1.5 % solution	0	4	?	See label for specific volumes of water to use.
Trilogy (neem oil)	1-2% solution	UDH	4	?	Maximum labeled use of 2 gal/acre/application. Apply spray solution in sufficient amounts of water to achieve complete coverage of foliage. Soft scales only.

*Restricted-use pesticide. [1]Efficacy: 1-effective in some research studies, 2-inconsistent efficacy results, 3-not effective, ?-efficacy unknown or no data found.
PHI - pre-harvest interval, REI - restricted entry interval, - = pre-harvest interval isn't specified on label, UDH = up to day of harvest.

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. Sound devices such as exploders, alarms, or recorded devices with bird distress calls may provide limited short-term control. For sound devices to be effective, their location and the frequency of sounds should be changed daily. They also should be in place just before the fruit ripens. Some towns have passed ordinances regulating the use of sound devices, so make sure you are in compliance with local laws. Netting is the most effective way to limit bird damage to blueberries and other small fruits.

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. However, if netting is not supported on wires or a frame, it may tear off fruit when it is removed for harvest, or birds may be able to access fruit through the netting. Most netting is expensive, but it can be reused for many years. For more information see: *Bird Damage Prevention for Northern New England Fruit Growers* by Alan Eaton, UNH Cooperative Extension.

Various rodents can damage a small-fruit planting, especially as they feed on bark under snow cover 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. It is possible to trap and remove voles from plantings with inexpensive snap-back mouse traps, but numbers will eventually rebound if there are suitable habitats adjacent to the planting. It is best to reduce vole habitat with regular mowing between rows.

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. Fencing is the best way to keep deer and other mammals out of berry plantings. Some deer repellents are registered for use on fruit crops during the non-bearing season.

When using dogs and invisible fencing 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.

Table 7.8.1. 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[1].
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 operator.
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 operator.
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 Deer Management Assistance Program (DMAP) or Deer Damage 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 operator.

[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. For more information see *Wasp and Bee Management, A Common Sense Approach* (https://ecommons.cornell.edu/handle/1813/67191) (2011) by Jody Gangloff-Kaufman.

During harvest much can be done to reduce disease and insect pressure by eliminating damaged, diseased and infested 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 and spotted wing drosophila (through the removal of overripe or infested fruit), cherry fruitworm and cranberry fruitworm (through the removal of infested fruit before larvae 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 infested 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, spotted wing drosophila, 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.

Cooling fruit to close to 32°F as soon as possible after harvest will greatly extend shelf-life of berries. Selling them in smaller, shallow containers is better than large, deep containers or buckets if the goal is to store for as long as possible. Do not wash berries before storage as this will encourage fruit rot.

8. FOOD SAFETY

Implementing practices that reduce microbial risks to produce crops that are eaten raw is important to consumer safety and farm economic viability. Produce-associated foodborne illness outbreaks have caused consumer illnesses and deaths resulting in increased buyer food safety requirements and the first ever produce safety regulations as part of the Food Safety Modernization Act (FSMA). Pathogens can contaminate fruits and vegetables during all phases of production, harvesting, and packing. Wild and domesticated animals, soil amendments, agricultural water, improperly trained workers, unclean picking and packing containers, and ineffective sanitation programs can all result in fresh produce contamination. The FSMA Produce Safety Rule (i.e., 21 CFR Parts 11, 16, and 112 Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption) requires at least one supervisor or responsible party from each covered farm to have successfully completed food safety training recognized as adequate by the Food and Drug Administration and to be in compliance with relevant food safety practices. The Produce Safety Alliance provides training that meets the training requirement and has created many educational materials to help growers understand and implement required practices. In addition, the National Good Agricultural Practices (GAPs) Program website provides educational materials and offers trainings for growers who are new to food safety and may need help beginning the process of developing a farm food safety plan. Regardless of whether a farm is subject to the FSMA Produce Safety Rule, GAPs can be used to identify and reduce microbial risks. This is critically important because many valuable markets and buyers require that growers have a farm food safety plan in order to buy their commodities.

Implementing a few simple practices can reduce risks significantly. Assessing risk on the farm to identify areas where microbial contamination occurs is the first step. For crops that are harvested by hand, such as blueberries, implementing an effective worker-training program and providing clean, well-stocked toilet and handwashing facilities will always be important to food safety. Train all workers to scrub their hands with soap for 20 seconds, rinsing with water that has no detectable *E.coli*, and drying with single-use towels before beginning work, after using the toilet, taking breaks, smoking and any other time they are unclean. Do not allow workers who are ill to handle produce. Train workers to never harvest produce that is contaminated with animal feces and prevent wild and domesticated animals from entering production fields. Assess the quality of any agricultural water that contacts the edible portion of the crop by testing it for quantified generic *E.coli*. Assess all soil amendments to determine if they contain biological soil amendments of animal origin (BSAAOs) such as manure. BSAAOs should only be applied before planting so it can be incorporated into the soil. For fall-fruiting berries, using composted BSAAOs will reduce microbial risks if there is a need to apply soil amendments in the spring. The key is to maximize the time from application of BSAAO to harvest of the crop. Ensure that picking containers are clean and free from any animal fecal contamination. Following these steps can dramatically reduce risks of human pathogen contamination.

The Food Safety Modernization Act (FSMA) Produce Safety Rule (PSR) applies to farms that grow, harvest, pack or hold covered fruits and vegetables when those fruits and vegetables are in an unprocessed state (i.e., Raw Agricultural Commodities (RACs)) and that meet income thresholds. FSMA PSR practices are focused on preventing microbial contamination of fresh produce and include requirements for managing agricultural water, worker training, soil amendments, wild and domesticated animals, and sanitation of equipment, tools and buildings. The final FSMA PSR was released on November 27, 2015 but several subparts and guidance are still evolving. Updates and information are available at the United States Food and Drug Administration's FSMA Final Rule on Produce Safety website.

NOTE: Application of postharvest agricultural water is not recommended for soft fruits such as berries, because they can greatly promote mold growth by wetting the fruit.

At the time this guide was produced, the following materials were available in New York State as sanitizers 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 (NYSDEC) to be used legally in NY. However, pesticides meeting the federal requirements for minimum-risk (25(b)) pesticides do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 8.1.1 Rates for Sanitizers Labeled for Postharvest Facilities

Product name *active ingredient*	**Food contact surfaces**[1]	**Hard surface, non-food contact**[1]
CDG Solution 3000 *chlorine dioxide*	25-50 ppm solution	110-500 ppm dilution
Oxine[2] *chlorine dioxide*	100 ppm solution	500 ppm solution
Pro Oxine[2] *chlorine dioxide*	50-200 ppm solution	500 ppm solution
Enviroguard Sanitizer *hydrogen peroxide/peroxyacetic acid*	-	2.5-20 fl oz/5 gal water
Jet Oxide 15 *hydrogen peroxide/peroxyacetic acid*	0.33-1.87 fl oz/5 gal water	-
Oxonia Active *hydrogen peroxide/peroxyacetic acid*	1.0-1.4 oz/4 gal water	1.0 -2.5 oz/8 gal water
Peraclean 5 *hydrogen peroxide/peroxyacetic acid*	1.0-1.5 fl oz/5 gal water	-
Peraclean 15 *hydrogen peroxide/peroxyacetic acid*	0.33-1.87 fl oz/5 gal water	-
Perasan 'A' *hydrogen peroxide/peroxyacetic acid*	1.0-6.1 fl oz/6 gal water	-
Per-Ox *hydrogen peroxide/peroxyacetic acid*	1-5.6 fl oz/5 gal water	1-17 fl oz/15 gal water
SaniDate 5.0 *hydrogen peroxide/peroxyacetic acid*	1.6-5.4 fl oz/ 5 gal water	1.6-5.4 fl oz/ 5 gal water
San-I-King No. 451 *sodium hypochlorite*	6 oz/10 gal water followed by 2 oz/10 gal water rinse – porous surfaces 1 oz/10 gal water or 2 oz/10 gal (see label) – non-porous surfaces	6 oz/10 gal water – porous surfaces 2 oz/10 gal water – non-porous surfaces
Shield-Brite PAA 15.0 *hydrogen peroxide/peroxyacetic acid*	0.7-3.8 fl oz/10 gal water	-
StorOx 2.0 *hydrogen peroxide/- acid*	0.5 fl oz/1 gal water	0.5 fl oz/1 gal water
VigorOx 15 F & V *hydrogen peroxide/peroxyacetic acid*	0.31-0.45 fl oz/5 gal water-	1.1-9.5 fl oz/5 gal water
VigorOx LS-15 *hydrogen peroxide/peroxyacetic acid*	0.31-0.45 fl oz/5 gal water	1.1-9.5 fl oz/5 gal water

1. Thoroughly clean all surfaces and rinse with potable water prior to treatment.
2. Requires acid activator.

9. SMALL-SCALE SPRAYER TECHNOLOGY

9.1 Spraying Small Blueberry Plantings:

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

To ensure even distribution throughout the 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 and the fruiting zone. Water sensitive cards (available from TeeJet, Gemplers, or other retailers) or Surround, kaolin clay, (Engelhard) may be used 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 plants that you can spray on both sides with the water in the spray tank (e.g. 48 plants covered with the 2 gallons of water).
3. Determine the total number of plants per acre (e.g. 968 plants per acre).
4. Calculate the spray volume required per acre using this formula and the above numbers:

Spray volume/acre **=** (plants per acre ÷ plants covered per spray tank) **x** volume applied in spray tank
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 (100 sq ft) on concrete or other hard surface.
3. Fill sprayer to a known level and mark the fill level.
4. Spray the marked-off, 100 sq ft area.
5. Refill sprayer with water to the fill level mark, noting how much water was added.
6. The amount of water added to the spray tank is the amount of spray applied per 100 sq ft. Compare this to the desired amount.

STATIC CALIBRATION

1. Select correct nozzle and pressure.
2. Fill the sprayer with clean water.
3. Measure and mark off an area 10 feet x 10 feet (100 sq ft) on concrete or other hard surface.
4. Spray the marked-off, 100 sq ft area, while recording the time taken to spray the area.
5. Carry out a static run of the same time it took to spray the 100 sq ft area, operating the spraying without moving and collecting the liquid into a graduated measuring jug.
6. Compare the quantity collected in the jug with nozzle chart and desired amount.

CALCULATING THE AMOUNT OF PESTICIDE TO USE

Some pesticides give application rates on a per acre basis but may need to be used on smaller areas. When converting a known quantity per acre to spray a smaller area, the first step is to measure the area to be sprayed with a tape measure or other measuring device. Divide the number of square feet measured by 43,560 (the number of square feet in an acre) to obtain the acreage you plan to treat (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 amounts of pesticide to use when treating smaller areas with smaller spray volumes.

Powders and granules

Example: The label says to use 3 lbs of powdered product per 100 gallons but you will use a backpack sprayer with a 5-gallon tank. Using Table 9.1.1, locate the amount of powdered product the label requires per 100 gallons and read across the 3 lb row to the 5 gallons column to find you need to use $2^{3}/_{8}$ oz of powder. Use clean weighing scales to provide the correct amount of powder. NEVER use a volumetric measure (e.g. measuring cup) because the bulk density of dry formulations varies between products affecting the amount of pesticide added to the tank.

Table 9.1.1 Amount of powder or granules to use

Volume of liquid			
100 gallons	***25 gallons***	***5 gallons***	***1 gallon***
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

Liquids

Example: The label says to use 4 pts of liquid product per 100 gallons of spray but you will use a backpack sprayer with a 5-gallon tank. Using Table 9.1.2, locate the amount of liquid product the label requires per 100 gallons and read across the 4 pts row to the 5 gallons column to find you need to mix 3¼ fl oz of liquid product. Use a clean measuring cylinder, cup or spoon to provide the correct amount of liquid.

Table 9.1.2. Amount of liquid to use

	Volume of liquid		
100 gallons	***25 gallons***	***5 gallons***	***1 gallon***
1 gal	2 pt	6 ½ oz	1 ¼ oz
4 pt	1 pt	3 ¼ oz	5/8 oz
2 pt	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

Dilutions

Some labels call for a dilution rate of the applied product. Use Table 9.1.3 for dilution rates for smaller total volumes. For example, a dilution rate of 1 gallon in 100 gallons would be the same as ¾ cup + 5 tsp in 5 gallons for a backpack sprayer with a 5-gallon tank.

Table 9.1.3. 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 product bulk density varies between products.

Safety.

When measuring, mixing or applying pesticides, be sure to use the protective clothing and equipment listed on the pesticide label. Also, be careful to avoid contaminating water when measuring and mixing pesticides.

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

There are many important points to consider before purchasing a sprayer, including the area to spray, proximity to the local supplier, and the size of the sprayer, amongst others. Sprayers for small plantings range 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 fill hole at the top is also important.

There are three factors affecting application rate - forward speed, pressure, and nozzle tip size. Normally output increases or decreases according to the pressure in the system, (which is dependent upon how vigorous you pump the handle up and down). Unfortunately, most inexpensive backpack sprayers have no pressure gauge to monitor this. It is suggested that you purchase a backpack sprayer that includes a pressure gauge. Another option is to purchase a spray pressure valve to install on the spray wand, such as a CF valve. These pressure valves will ensure a constant output irrespective of hand pump action.

An alternative to the hand-operated backpack sprayer is a battery-powered backpack sprayer. Maximum pressure is relatively low and it is easier than using a traditional hand pump sprayer when spraying many rows of plants.

Portable mist and air blower backpacks

These are ideal where canopy penetration is required, such as for denser, vigorous plantings. These sprayers have a small gas engine that drives a fan blower creating an airstream through a hand-held tube (similar to a leaf blower). The tube has a nozzle mounted at the end that adds spray to the airstream. The operator directs the spray towards the canopy by pointing the hand-held tube at the plants to be treated. To protect the applicator from the spray mist, it is advised to point the tube backwards to avoid walking into the spray. Engine speed can

be reduced, slowing airspeed to match smaller, early-season canopies. Airflow from these sprayers rustle the canopy, allowing for good penetration and deposition. Some drawbacks to these sprayers are that they are heavy and the engines are noisy, requiring ear protection. Also note that the airflow from the sprayer can increase pesticide drift off the target.

Portable engine-driven gas sprayers
A number of manufacturers offer sprayers with a small gas engine and a 10 to 12 gallon tank. Larger capacity tanks (14 to 100 gallons) are also available. These sprayers can be pulled by a lawn tractor, ATV/UTV, or small tractor.

Small, mounted sprayers
Small, 15 to 25 gallon sprayers, are available that can be mounted to the carrier rack of an ATV. These sprayers use a small electric pump to provide pressures of up to 70 psi. When equipped with a hand wand and a hose, they can be used to spray short rows and for spot spraying. The same system is ideal for weed control.

Large, skid mounted sprayers
These are larger sprayers that fit in the back of a pick-up truck. Skid mounted sprayers have a tank capacity of 35 to 200 gallons and use a gas engine as a power source.

Small, trailered 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. However, be very careful that if these sprayers are used for herbicides in addition to other pesticides, there is no herbicide residue in the sprayer. Therefore, clean these sprayer out thoroughly before using them to apply pesticides other than herbicides. Alternatively, have a dedicated herbicide-only sprayer to avoid cross-contamination.

Controlled Droplet Applicators (CDA)
The use of CDA's will considerably reduce the need to carry vast amounts of water. Controlled Droplet Applicators use a battery-powered spinning disc that produces 95% of the same-size droplets, thus reducing herbicide volumes by at least 50% and water amounts by 75%. Herbi and Mantis are two examples of hand-held CDA's. ATV- or tractor-mounted shielded CDA's are also available that reduce spray rates while shielding the plants from the spray.

Wick wipers
Where occasional weeds and driving over wet land are a problem, a hand-held wick wiper is an easy-to use, effective option. Wick wipers consist of a small tank to hold the liquid (usually part of the handle) that soaks a rope wick or a sponge. The rope or sponge is wiped against the weeds.

For further information on pesticide application technology visit the Pesticide Environmental Stewardship website.

10. PESTICIDES MENTIONED IN THIS PUBLICATION

Table 10.1 Fungicides and Bactericides

Product Name	Active Ingredient	EPA Reg. No.
Acoidal	Sulfur	62562-4
Actinovate AG	Streptomyces Lydicus WYEC 108	73314-20
Auron DF	Sulfur	62562-4-94100
Badge X2	copper hydroxide, copper oxychloride	80289-12
BotryStop	Ulocladium oudemansii (U3 Strain)	75747-2-68539
*Brandt Lime Sulfur	calcium polysulfide	61842-30-48813
Carb-o-nator	potassium bicarbonate	70051-117
ChampION++	copper hydroxide	55146-115
Cinnerate	cinnamon oil	25(b) pesticide
Companion Maxx Biological Fungicide	Bacillus amyloliquefaciens ENV503	94485-4

Table 10.1 Fungicides and Bactericides		
Product Name	**Active Ingredient**	**EPA Reg. No.**
CS 2005	copper sulfate pentahydrate	66675-3
Cueva Fungicide Concentrate	copper octanoate	67702-2-70051
Cuproxat FL	basic copper sulfate	55146-151
Damoil	mineral oil	19713-123
Dart Fungicide EC	capric acid, caprylic acid	51517-11
Defend DF	sulfur	62562-8
DES-X	insecticidal soap	67702-22-70051
Double Nickel 55	Bacillus amyloliquefaciens str. D747	70051-108
Double Nickel LC	Bacillus amyloliquefaciens str. D747	70051-107
Drexel Suffa	Sulfur	19713-39
EcoSwing Botanical Fungicide	extract of Swinglea glutinosa	10163-357
Ecoworks EC	cold pressed neem oil	89152-4
ET-F Algicide/ Bactericide/ Fungicide	copper sulfate pentahydrate	64962-5
Fungout	citric acid	25(b) pesticide
Glacial Spray Fluid	mineral oil	34704-849
Howler	Pseudomonas chloroaphis strain AFS009	91197-3-92488
JMS Stylet-Oil	mineral oil	65564-1
Kaligreen	potassium bicarbonate	11581-2
Kalmor	copper hydroxide	91411-11-59807
Kentan DF	copper hydroxide	80289-2
Kocide 2000-O	copper hydroxide	91411-10-70051
Kocide 3000-O	copper hydroxide	91411-11-70051
KOPA Insecticidal Soap	potassium salts of fatty acids	67702-11-59807
LALSTOP G46 WG	Gliocladium catenulatum str J1446	64137-13
LALSTOP K61 WP	Streptomyces grieoviridis strain K61	64137-5
LifeGard LC	Bacillus mycoides isolate J	70051-126
LifeGard WG	Bacillus mycoides isolate J*	70051-119
Mastercop	copper sulfate pentahydrate	55272-18-66222
Microthiol Disperss	sulfur	70506-187
Mildew Cure	garlic oil, cottonseed oil, corn oil	25(b) pesticide
Milstop	potassium bicarbonate	70870-1-68539
M-Pede	insecticidal soap	10163-324
Nuke Em	citric acid	25(b) pesticide
Omni Supreme Spray	mineral oil	5905-368
OSO 5% SC Fungicide	polyoxin D zinc salt	68173-4-70051
PerCarb	sodium carbonate peroxyhydrate	70299-15
PERpose Plus	hydrogen peroxide	68539-15
PureSpray Green	white mineral oil	69526-9
Regalia	Reynoutria sachalinensis	84059-3
Regalia CG	Reynoutria sachalinensis	84059-3

Table 10.1 Fungicides and Bactericides		
Product Name	**Active Ingredient**	**EPA Reg. No.**
Romeo	Saccharomyces cerevisiae	91810-2
Serenade ASO	Bacillus subtilis str QST 713	264-1152
Serenade MAX	Bacillus subtilis str QST 713	264-1151
Serenade Opti	Bacillus subtilis str QST 713	264-1160
Serifel	Bacillus amyloliquefaciens str. MBI 600	71840-18
Sil-Matrix	potassium silicate	82100-1
Sil-Matrix LC	potassium silicate	70051-127
Solawit 80DF	Sulfur	93745-1
Sporan EC2	rosemary oil, clove oil, peppermint oil, thyme oil	25(b) pesticide
Stargus	Bacillus amyloliquefaciens str. F727	84059-28
SuffOil-X	mineral oil	48813-1-68539
Sulfur 80 WDG	Sulfur	19713-674
Taegro 2	Bacillus subtilis var. amyloliquefaciens str. FZB2	70127-12
TerraNeem EC	cold pressed neem oil	88760-5
Thiolux	Sulfur	34704-1079
Timorex Act	tea tree oil	86182-3-88783
Triathlon BA	Bacillus amyloliquefaciens str. D747	70051-107-59807
Trilogy	neem oil	70051-2
Ultra-Pure Oil	mineral oil	69526-5-499
*Restricted-use pesticide; may be purchased and used only by certified applicators or used by someone under the direct supervision of a certified applicator.		

Table 10.2 Insecticides and Miticides		
Product Name	**Active Ingredient**	**EPA Reg. No.**
Acti-Min FE Crop Protectant	Kaolin	92942-1
Aza-Direct	Azadirachtin	71908-1-10163
AzaGuard	Azadirachtin	70299-17
*AzaSol	azadirachtin	81899-4-74578
Azera	azadirachtin, pyrethrins	1021-1872
Biobit HP	Bacillus thuringiensis, var. kurstaki	73049-54
BioLink Insect & Bird Repellant	garlic juice	25(b) pesticide
Bioprotec Plus	Bacillus thuringinensis subsp. Kurstaki	89046-12
BT NOW	Bacillus thuringinensis subsp. Kurstaki	89046-12-70299
Cinnerate	cinnamon oil	25(b) pesticide
Damoil	mineral oil	19713-123
Deliver	Bacillus thuringiensis, var. kurstaki	70051-69
DEsect CROP	silicon dioxide	7655-1
Dipel DF	Bacillus thuringinensis subsp. Kurstaki	73049-39
Ecotec Plus	rosemary oil, peppermint oil, geraniol	25(b) pesticide
Ecotrol Plus	rosemary oil, peppermint oil, geraniol	25(b) pesticide
Ecoworks EC	cold pressed neem oil	89152-4

Table 10.2 Insecticides and Miticides

Product Name	Active Ingredient	EPA Reg. No.
Ecozin Plus 1.2% ME	Azadirachtin	5481-559
Entrust	Spinosad	62719-282
Entrust SC	Spinosad	62719-621
Garlic Barrier AG+	garlic juice	25(b) pesticide
Golden Pest Spray Oil	soybean oil	57538-11
Grandevo CG	Chromobacterium subtsugae str. PRAA4-1	84059-27
Grandevo WDG	Chromobacterium subtsugae str. PRAA4-1	84059-27
Javelin WG	Bacillus thuringiensis, var. kurstaki	70051-66
KOPA Insecticidal Soap	potassium salts of fatty acids	67702-11-59807
Mantis EC	rosemary oil, soybean oil, peppermint oil	25(b) pesticide
Molt-X	Azadirachtin	68539-11
M-Pede	insecticidal soap	10163-324
Mycotrol ESO	Beauvaria bassiana	82074-1
Neemix 4.5	Azadirachtin	70051-9
PFR-97 20% WDG	Isaria fumosorosea Apopka str. 97	70051-19
PureSpray Green	white mineral oil	69526-9
PyGanic EC 1.4 II	Pyrethrins	1021-1771
PyGanic EC 5.0 II	Pyrethrins	1021-1772
SuffOil-X	mineral oil	48813-1-68539
Surround WP	kaolin clay	61842-18
TerraNeem EC	cold pressed neem oil	88760-5
Trilogy	neem oil	70051-2
Venerate XC	Burkholderia spp. str A396	84059-14
XenTari	Bacillus thuringiensis, var. aizawai	73049-40

*Restricted-use pesticide; may be purchased and used only by certified applicators or used by someone under the direct supervision of a certified applicator.

Table 10.3 Herbicides

Product Name	Active Ingredient	EPA Reg. No.
AVENGER AG OPTIMA BURNDOWN	d-limonene	92967-4
Axxe	ammonium nonanoate	70299-23
Ecoblend Weed and Grass Burndown	soybean oil	25(b) pesticide
Ecoblend Weed Control Pro	soybean oil, citric acid	25(b) pesticide
Finalsan Herbicidal Soap	ammoniated soap of fatty acids.	67702-8
Fireworxx Herbicide	capric acid, caprylic acid	67702-54-59807
Green Gobbler 20% Vinegar Weed Killer	acetic acid	85208-1-93489
Harris 20% Vinegar Weed Killer	acetic acid	85208-1-3
HomePlate Non-Selective Herbicide	capric acid, caprylic acid	67702-54-70051
Suppress Herbicide EC	capric acid, caprylic acid	51517-9

Table 10.4 Sanitizers		
Product Name	**Active Ingredient**	**EPA Reg. No.**
CDG Solution 3000	chlorine dioxide	75757-2
Enviroguard Sanitizer	hydrogen peroxide/peroxyacetic acid	63838-1-527
Jet Oxide 15	hydrogen peroxide/peroxyacetic acid	54289-4-81803
Oxine	chlorine dioxide	9804-1
Oxonia Active	hydrogen peroxide/peroxyacetic acid	1677-129
Peraclean 5	hydrogen peroxide/peroxyacetic acid	54289-3
Peraclean 15	hydrogen peroxide/peroxyacetic acid	54289-4
Perasan 'A'	hydrogen peroxide/peroxyacetic acid	63838-1
Per-Ox	hydrogen peroxide/peroxyacetic acid	833-4
Pro Oxine	chlorine dioxide	9804-9
SaniDate 5.0	hydrogen peroxide/peroxyacetic acid	70299-19
San-I-King No. 451	sodium hypochlorite	2686-20001
Shield-Brite PAA 15.0	hydrogen peroxide/peroxyacetic acid	63838-2-64864
StorOx 2.0	hydrogen peroxide/peroxyacetic acid	70299-7
VigorOx 15 F & V	hydrogen peroxide/peroxyacetic acid	65402-3
VigorOx LS-15	hydrogen peroxide/peroxyacetic acid	65402-3

10.1 Pesticide use in organic blueberry production

Organic production primarily focuses on cultural, biological, and mechanical techniques to manage pests on the farm, but in some cases pesticides, which include repellents, allowed for organic production are needed. 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 section 7.3 Principles of Insect and Disease Management, 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.

Some organic-approved pesticide products that contain aromatic active ingredients, such as essential oils or garlic, could potentially affect fruit flavor or wine quality. Therefore, these should be used in a manner that avoids covering fruit with spray residue close to harvest.

10.2 Biopesticides

Biopesticides are materials with pesticidal properties that originate from natural living organisms, including microorganisms, plants, and animals. The United States Environmental Protection Agency (USEPA) defines two types of biopesticides that may be used in organic production. These include naturally occurring substances that control pests (biochemical/herbal pesticides) and microorganisms that control pests (microbial pesticides). Microbial pesticides contain fungi, bacteria, or viruses that control pests. These biopesticides may contain living, dead, or inactivated microbes. Biochemical pesticides contain substances naturally occurring in the environment to control pests. These biopesticides may include botanical extracts or insect pheromones that interfere with mating. When using biopesticides, follow the same steps for safe and legal use as for non-biological pesticides. Read and follow the label. The USEPA maintains a list of Biopesticide Active Ingredients.

Biopesticides are most likely to be effective if used while pest populations are low and when combined with other IPM strategies. Especially if they contain living microorganisms, biopesticides may require special storage, may lose efficacy if stored too long prior to use, or may be incompatible with other pesticides. Some biopesticides may be most effective within certain temperature ranges, or when applied at certain times of day. Read the label and consult the manufacturer with questions. While many biopesticides are permitted in organic production, not all of them are. Always check with your certifier before using a new product.

10.3 Pesticide Regulatory Considerations

Pesticides mentioned in this organic production guide are registered by the USEPA or meet the USEPA requirements for a "minimum risk" pesticide. At the time of publication, pesticides mentioned in this guide also meet New York State Department of Environmental Conservation (NYSDEC) registration requirements for use in New York State. See NYSDEC Bureau of Pesticides Management – Information Portal for pesticides currently registered for use in NYS. Additional products may be available for use in other states.

To maintain organic certification, products applied must also comply with the National Organic Program (NOP) regulations as set forth in the USDA NOP standards, sections 205.600-606. The Organic Materials Review Institute (OMRI) is one organization that reviews products for compliance with the NOP regulations and has a searchable database of compliant products, but other entities also make product assessments. The authors relied mainly on the OMRI list for pesticides to include. Organic growers are not required to use only OMRI listed materials, but the list is a good starting point when searching for allowed pesticides.

Finally, farms grossing more than $5,000 per year and labeling products as organic must be certified by a NOP accredited certifier who must approve any material applied for pest management. ALWAYS check with the certifier before applying any pest control products. Some certifiers will review products for NOP compliance.

Note that "home remedies" may not be used. Home remedies are substances commonly found around the home that may have pest control properties. Examples include beer used to reduce slug damage in strawberries or a dilute dish detergent solution used to reduce aphids on plants. Home remedies are not regulated as pesticides, are not exempt from registration, and are therefore not legal to use.

Do you need to be a certified pesticide applicator? Pesticides are classified as general-use or restricted use by either the USEPA or the NYSDEC. For those producing agricultural commodities, pesticide applicator certification is required to purchase and use restricted-use pesticides. Restricted-use pesticides mentioned in this guide are marked with an asterisk (*). Farmers who purchase and use only general-use pesticides in producing an agricultural commodity on property they own or rent do not need to be a certified pesticide applicator. However, we encourage agricultural producers who use pesticides to become certified. Find more information on pesticide applicator certification from the list of State Pesticide Regulatory Agencies or, in New York State, on the NYSDEC Pesticide Applicator/Technician Certification website.

Worker Protection Standard training. If the farm has employees who will be working in fields treated with a pesticide, they must be trained as workers or handlers as required by the federal government under Title 40 Protection of Environment, Part 170 Worker Protection Standard. Training materials must be approved by the USEPA and all trainers must be qualified either by having a pesticide applicator certification or by completing a USEPA-approved train-the-trainer course. For more information on complying with the Worker Protection Standard (WPS) see *How to Comply with the 2015 Revised Worker Protection Standard for Agricultural Pesticides* manual published by the USEPA or online at http://pesticideresources.org/wps/htc/index.html.

10.4 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. Adjuvants can be found on OMRI's searchable product database using the Filter function.

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.

Pesticide resistance may develop in pathogens, insects, mites, etc. following repeated exposure to the same or similar mode-of-action materials and result in reduced or complete loss of pesticide efficacy against the resistant pest. During the growing season and across growing seasons, pesticides of one mode-of-action should be alternated with those of different modes-of-action to lower the risk of pests developing resistance to the pesticides. See the product label for more information.

11. REFERENCES AND RESOURCES

- *A Practical Guide to the Application of Compost in Vineyards – Fall 2003*. Travis, J., et al. www.arec.vaes.vt.edu/alson-h-smith/grapes/viticulture/extension/growers/documents/compost-application.pdf
- *Agricultural Plastics Recycling in New York State Case Study*. 2019. Jean Bonhotal and Marley Bonacquist-Currin. Cornell Waste Management Institute. NYS Recycling Agricultural Plastics Program (no longer funded). Cornell University. https://ecommons.cornell.edu/bitstream/handle/1813/69518/CaseStudyRAPP.pdf?sequence=3&isAllowed=y
- Allowed Mulches on Organic Farms and the Future of Biodegradable Mulch. United States Department of Agriculture. Agricultural Marketing Service. National Organic Program. https://www.ams.usda.gov/sites/default/files/media/5%20Mulches%20incl%20biodegradable%20FINAL%20RGK%20V2.pdf
- Analytical Lab and Maine Soil Testing Service. University of Maine. anlab.umesci.maine.edu/.

- Berry Diagnostic Tool. Pritts, M. and Heidenreich, C. Cornell University. https://blogs.cornell.edu/berrytool/
- *Berry Soil and Nutrient Management - A Guide for Educators and Growers.* 2015. Pritts, M., Heidenreich, C., McDermott, L. and Miller, J. (eds). 2015. NE SARE 174 pp. https://blogs.cornell.edu/berries/productions/berry-soil-and-nutrient-management-a-guide-for-educators-and-growers/.
- Berry Soil and Nutrient Management In-depth Webinar Series. 2011-2012. Pritts, M., Heidenreich, C. North East Sustainable Agriculture Research and Education (NE SARE). https://blogs.cornell.edu/berries/ipm/berry-webinars/
- Biopesticide Active Ingredients. United States Environmental Protection Agency. https://www.epa.gov/ingredients-used-pesticide-products/biopesticide-active-ingredients
- *Bird Damage Prevention for Northern New England Fruit Growers.* 2010. Alan Eaton. Univ. of New Hampshire, Cooperative Extension. 20 pp. extension.unh.edu/resources/files/Resource001797_Rep2514.pdf
- *Blueberries: Organic Production.* 2004. National Sustainable Agriculture Information Service. ATTRA. https://attra.ncat.org/product/blueberries-organic-production/
- *Building Soils for Better Crops, 3rd edition.* 2010. Magdoff, F., and Van Es, H. The Sustainable Agriculture Network, Beltsville, MD. 294 pp. www.sare.org/publications/soils.htm.
- Calculator for Field Use Environmental Impact Quotient (EIQ). New York State Integrated Pest Management. https://nysipm.cornell.edu/eiq/calculator-field-use-eiq/
- *Compendium of Blueberry and Cranberry Diseases.* 1995. Caruso, F., Ramsdell, D., Editors. American Phytopathological Society, APS Press. 87 pp.
- Comprehensive Assessment of Soil Health. Cornell Soil Health Lab. www.hort.cornell.edu/soilhealth/.
- *Comprehensive Assessment of Soil Health: The Cornell Framework, Third Edition.* 2017. Moebius-Clune, B.N., et al. Cornell Soil Health Lab. 134 pp. http://www.css.cornell.edu/extension/soil-health/manual.pdf
- Cornell Fruit Resources. www.fruit.cornell.edu
- Cornell Fruit Resources. Spotted Wing Drosophila. http://fruit.cornell.edu/spottedwing/
- Cornell Fruit Resources: Berries. https://blogs.cornell.edu/berries/
- Cornell Cooperative Extension Pesticide Safety Education Program (CCE-PSEP). psep.cce.cornell.edu.
- Cornell University Plant Disease Diagnostic Clinic. www.plantclinic.cornell.edu
- Cover Crop Guide for New York Growers. Cover Crop Decision Tool. 2019. Björkman, T. Cornell University. http://covercrops.cals.cornell.edu/decision-tool.php
- Dairy One (Cornell Recommendations). https://dairyone.com/services/agronomy-services/about-agronomy-services/
- *Diseases, Pests, and Beneficial Organisms of Strawberry, Raspberry, and Blueberry.* 2013. Lambert, L., Carisse, O., Laplante, G. H. and Vincent, C. https://my.apsnet.org/ItemDetail?iProductCode=02301
- Electronic Code of Federal Regulations. National Organic Program. Title 7 Agriculture. Part 205. www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title07/7cfr205_main_02.tpl
- Electronic Code of Federal Regulations. Title 40 Protection of Environment. Part 170. Worker Protection Standard. https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=b3edef346e5deb639d0bc5598aeab1b4&ty=HTML&h=L&mc=true&n=pt40.24.170&r
- Electronic Code of Federal Regulations. Title 40 Protections of Environment. Part 152.25(b) Exemptions for pesticides of a character not requiring FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) regulation. https://www.ecfr.gov/cgi-bin/text-idx?SID=1e758d7334fa8245d1c4d19a6af9d877&node=pt40.24.152&rgn=div5#se40.26.152_125
- Electronic Code of Federal Regulations. Title 7 Agriculture. Part 205. National Organic Program. §205.600-606. The National List of Allowed and Prohibited Substances. https://www.ecfr.gov/current/title-7/subtitle-B/chapter-I/subchapter-M/part-205/subpart-G
- Electronic Code of Federal Regulations. Title 7 Agriculture. Part 205. National Organic Program. §205.204. Seed and planting stock practice standard. https://www.ecfr.gov/current/title-7/subtitle-B/chapter-I/subchapter-M/part-205/subpart-C/section-205.204
- Electronic Code of Federal Regulations. Title 7 Agriculture. Part 205. National Organic Program. §205.103. Record keeping by certified operations. https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=7f3fb88fbfdfaed19f3107ca4f8c0b06&mc=true&n=sp7.3.205.b&r=SUBPART&ty=HTML#se7.3.205_1103

- Electronic Code of Federal Regulations. Title 7 Agriculture. Part 205. National Organic Program. §205.601. Synthetic substances allowed for use in organic crop production. https://www.ecfr.gov/cgi-bin/text-idx?SID=84e4358ff3279efbd444df9db261e0bf&mc=true&node=se7.3.205_1601&rgn=div8
- Electronic Code of Federal Regulations. Title 7 Agriculture. Part 205. National Organic Program. §205.206. Crop pest, weed, and disease management practice standard. https://www.ecfr.gov/cgi-bin/text-idx?SID=84e4358ff3279efbd444df9db261e0bf&mc=true&node=se7.3.205_1206&rgn=div8)
- Electronic Code of Federal Regulations. Title 7 Agriculture. Part 205. National Organic Program. §205.2. Terms defined. https://www.ecfr.gov/cgi-bin/text-idx?SID=84e4358ff3279efbd444df9db261e0bf&mc=true&node=se7.3.205_12&rgn=div8
- *Elements of IPM for Blueberries in New York State*. 2010. NYS IPM Program, Cornell University. https://ecommons.cornell.edu/handle/1813/42718
- FSMA Final Rule on Produce Safety: Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption. Food Safety Modernization Act (FSMA). United States Food and Drug Administration. https://www.fda.gov/food/food-safety-modernization-act-fsma/fsma-final-rule-produce-safety
- *Guidance & Instructions for Accredited Certifying Agents & Certified Operations*. National Organic Program. United States Department of Agriculture: Agricultural Marketing Service (USDA AMS NOP). https://www.ams.usda.gov/rules-regulations/organic/handbook
- *Guide for Organic Crop Producers*. 2012. Pamela Coleman. National Sustainable Agriculture Information Service, ATTRA. https://attra.ncat.org/product/guide-for-organic-crop-producers/
- *Highbush Blueberry Production Guide*. 1992. M.P. Pritts and J.F. Hancock (eds.). NRAES publication #55. https://ecommons.cornell.edu/handle/1813/66931
- *How to Comply with the 2015 Revised Worker Protection Standard for Agricultural Pesticides*. (2016). 146 pp. United States Environmental Protection Agency. USEPA. http://www.pesticideresources.org/wps/htc/htcmanual.pdf also online at http://pesticideresources.org/wps/htc/index.html
- Insect Diagnostic Laboratory at Cornell University. http://idl.entomology.cornell.edu/
- *Instruction Organic System Plans, Organic System Plan Updates, and Notification of Changes*. National Organic Program. United States Department of Agriculture: Agricultural Marketing Service (USDA: AMS). https://www.ams.usda.gov/sites/default/files/media/2615.pdf
- *Mummy Berry Disease*. 1991. Wayne Wilcox. Sheet No. 3. New York State Integrated Pest Management Program. Cornell Cooperative Extension. https://ecommons.cornell.edu/bitstream/handle/1813/43110/mummyberry-FS-NYSIPM.pdf?sequence=1&isAllowed=y
- National Center for Appropriate Technology (NCAT). National Sustainable Agriculture Information Service. (ATTRA) (Formerly named Appropriate Technology Transfer for Rural Areas). https://attra.ncat.org/about-us/
- National Good Agricultural Practices (GAPs) Program. Educational Materials. www.gaps.cornell.edu/educationalmaterials.html
- National Organic Program (NOP). United States Department of Agriculture: Agricultural Marketing Service (USDA: AMS). http://www.ams.usda.gov/nop/NOP/standards/ProdHandPre.html
- National Pesticide Information Center: State Pesticide Regulatory Agency Contact Information (http://npic.orst.edu/mlrDetail.html?lang=en&to=SPE&state=NY#statePesticide)
- Network for Environment and Weather Applications (NEWA). Cornell University. newa.cornell.edu.
- *New York Berry News*. 2002-2018. Archives. Pritts, M. ed. Cornell University. https://blogs.cornell.edu/berries/new-york-berry-news/new-york-berry-news/
- New York State Berry Growers Association. nysbga.org
- New York State Department Environmental Conservation (NYSDEC). Bureau of Pesticides Management – Information Portal – Pesticide Registration Data. https://www.dec.ny.gov/nyspad/products?0
- New York State Integrated Pest Management: Fruits. https://nysipm.cornell.edu/agriculture/fruits/
- *Northeast Cover Crop Handbook*. 1994. Sarrantonio, M. Rodale Institute, PA. Online purchase. www.amazon.com/Northeast-Cover-Crop-Handbook-Health/dp/0913107174
- Northeast Organic Farming Association of New York. http://www.nofany.org/

- Nursery Guide for Berry and Small Fruit Crops. Updated 2015. Cornell University. Cornell University. https://blogs.cornell.edu/berrynurseries/blueberries/
- *Nutrient management for fruit and vegetable crop production: Using manure and compost as nutrient sources for vegetable crops*. 2005. Rosen, C. J. and Bierman, P. M. University of Minnesota. https://conservancy.umn.edu/handle/11299/200639
- Organic Materials Review Institute (OMRI). www.omri.org. OMRI searchable database. https://www.omri.org/omri-search
- Organizations Providing Organic Certification Services. Organic Foods and Farming. New York State Department of Agriculture and Markets. https://agriculture.ny.gov/farming/organic-foods-and-farming
- Penn State Agricultural Analytical Services Laboratory. Pennsylvania State University. https://agsci.psu.edu/aasl
- Pest Management Guidelines for Berry Crops. Updated yearly. Cornell University. https://cropandpestguides.cce.cornell.edu/
- Pesticide Applicator/Technician Certification. New York State Department Environmental Conservation. https://www.dec.ny.gov/permits/45618.html
- Pesticide Environmental Stewardship. Center for Integrated Pest Management. https://pesticidestewardship.org/
- *Pocket Guide to IPM Scouting in Highbush Blueberries*. 2015. Schilder, A., Isaacs, R., Hanson, E., Cline, B. Michigan State University. https://www.canr.msu.edu/resources/a_pocket_guide_to_ipm_scouting_in_highbush_blueberries_e2928
- Produce Safety Alliance. Dept. of Food Science. Cornell University. FDA USDA. https://producesafetyalliance.cornell.edu/
- *Reducing Deer Damage to Home Gardens and Landscape Plantings*. 1994. Paul D. Curtis and Milo E. Richmond. Department of Natural Resources. Cornell University. http://wildlifecontrol.info/wp-content/uploads/2016/04/reducing-deer-damage.pdf
- Rodale Institute. www.rodaleinstitute.org/
- Soil and Plant Nutrient Testing Laboratory. University of Massachusetts Amherst. www.umass.edu/soiltest/
- Soil Health Testing Services. Cornell Soil Health Lab. http://soilhealth.cals.cornell.edu/testing-services/
- *Spotted Wing Drosophila (SWD) Monitoring Traps*. 2016. Juliet Carroll. New York State Integrated Pest Management Program. Cornell Cooperative Extension. https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/0/7265/files/2017/01/SWDTraps_CornellFruit-1vwi4oo.pdf
- *The Mid-Atlantic Berry Guide for Commercial Growers*. 2013-14. Rudisill, A. ed. Penn State Extension. College of Agricultural Sciences. pubs.cas.psu.edu/freepubs/MAberryGuide.htm
- The Penn State Agronomy Guide. 2021-2022. Penn State Extension. College of Agricultural Sciences. extension.psu.edu/agronomy-guide
- *USDA National Organic Program Regulations & NOFA-NY Certified Organic, LLC Guidance and Policy Manuals*. Pdf document. https://nofany.org/wp-content/uploads/2020/04/2020-Regulations-Guidance-Policy-Manuals.pdf
- *Using Organic Nutrient Sources*. Updated 2013. Sánchez, E., Richard, R. Penn State University. https://extension.psu.edu/using-organic-nutrient-sources
- Waypoint Analytical. https://www.waypointanalytical.com/AGServices
- Weed Ecology and Management Laboratory. Cornell University. weedecology.css.cornell.edu/manage/
- *Weeds Of The Northeast*. 1997. Uva, R., J. Neal, and J. DiTomaso. Cornell University Press. 397 pp. https://www.cornellpress.cornell.edu/book/9780801483349/weeds-of-the-northeast/#bookTabs=1

12. GLOSSARY

(Adapted from: 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 buildup 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, and 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.