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Organic Production and IPM Guide for Raspberries and Blackberries

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2022 Organic Production and IPM Guide for **Raspberries and Blackberries**

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INTRODUCTION

This guide for organic raspberry and blackberry 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, raspberries and blackberries are among the most challenging for organic production. Gray mold on fruit is particularly troublesome if weather is damp during flowering and fruiting. Growing these berries under high tunnels can dramatically reduce disease pressure on raspberries and blackberries, and tunnel production is becoming the norm in most areas of the world that produce berries for wholesale. A second troublesome pest is spotted-winged drosophila which prefer raspberries and blackberries over most other food sources. Early-fruiting raspberries mostly avoid this pest, but those that fruit later are more vulnerable. Growing under fine nets is the only effective way of avoiding damage in late season berries. Another challenge is weed management. Sustained weed pressure during the planting year can negatively affect yield for several subsequent years. Once weeds grow within the row, it is difficult to mechanically remove weeds growing among the canes. The high price for organically-grown raspberries and blackberries encourages growers to enter this market, despite the challenges.

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 *Raspberry and Blackberry Production Guide for the Northeast, Midwest and Eastern Canada* (NRAES-55) and the *Brambles: Organic Production* guide for more information For those interested in greenhouse or high-tunnel production we suggest: the *Greenhouse Raspberry Production Guide* and the *High Tunnel Production Guide for Raspberries and Blackberries*.

More research on growing perennial crops organically is needed, especially in the area of pest management. This guide attempts to compile the most current information available, but acknowledges that effective means of organic control are not available for some pests.

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 Center for Appropriate Technology, ATTRA Sustainable Agriculture, 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 including the certifying agent.

2. SOIL HEALTH

Healthy soil is the basis of organic farming. Decomposing plant materials incorporated before planting berries 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. Regular additions of organic matter in the form of cover crops, compost, or manure create a soil that is biologically active, with good structure and capacity to hold nutrients and water. 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. Always maximize the time between the application of raw manure and harvest. It is important to never side dress with raw manure or use straw that has been used as animal bedding.

Organic growers must attend to the connection between soil, nutrients, pests, and weeds to succeed. *Berry Soil and Nutrient Management - A Guide for Educators and Growers* is an excellent resource for information on managing soils for health, and includes an extensive discussion of the role of organic matter. This website also links to 14 webinars on soil and nutrient management in berry crops. Another excellent resource 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.

3. SITE SELECTION

For organic raspberry and blackberry production, the importance of proper site selection and preparation cannot be over-emphasized. Raspberry and blackberry plantings typically reach full productivity in the fourth year and can last for 10 to 15 years in organic production systems. This approach maximizes yields while soil nitrogen content and soil pathogens remain at acceptable levels for production. Consider that an ideal site should be close to your markets, be of sufficient acreage to allow for crop rotation, have available water of acceptable quality for irrigation and frost protection, have well-drained soil, and have good air drainage (slopes of 3-4% preferably facing north and away from prevailing winter winds). Sites should not have recently been cropped to plants susceptible to Verticillium wilt.

Conduct needed site improvements prior to planting. Once raspberries and blackberries are planted it is very difficult to make major changes to improve soil and air drainage, or to modify soil tilth, pH, or nutrient status. Improving soil structure or eliminating soil compaction layers in a planting becomes less feasible once the plants have become established.

Weather plays a critical role in site selection, as well. The macroclimate, mesoclimate and microclimate of a raspberry and blackberry 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. More detailed information on the site selection information presented here also can be found in the *Raspberry and Blackberry Production Guide for the Northeast, Midwest and Eastern Canada*, NRAES-35.

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 raspberry and blackberry production must begin at least one year in advance of planting. 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 and frosts.

Raspberries and blackberries need good internal soil drainage to grow and do best on a well-drained sandy loam. Wet soils restrict root growth and respiration, resulting in weak growth and reduced yields. Coarse-textured 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. Perennial crops often require more intensive drainage than annual row crops because plant roots persist during late fall and early spring when soils tend to be the wettest. Planting on raised beds or on berms can be useful to improve soil drainage in the rooting zone and reduce root diseases. Raised beds may be more prone to drying out, so the ability to provide an adequate water supply is also critical.

Air drainage is an important consideration in choosing a raspberry or blackberry field site. Cold air, like water, runs down hill, and collects in low areas or areas where trees or hedgerows obstruct airflow. These 'frost pockets' increase the risk of both mid-winter cold injury and spring frost damage. Selecting a site with a gentle slope (3-4%) and good air drainage will reduce the risk of cold or frost injury. Overhead irrigation, where available is also a frost protection option. Good air drainage will also promote faster drying of foliage, flowers and fruit which will reduce the duration and frequency of disease infection periods. Good air drainage is essential to an organic disease management strategy.

Although raspberries and blackberries can be grown on a variety of soils, shallow soils have less water holding capacity and will limit root development, resulting in smaller plants with smaller crops. Rooting depth of 18 inches or more is considered important for adequate plant 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.

3.3 Soil Testing

Knowing all you can about the soil of a potential raspberry and blackberry 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 of 6.0 to 6.5 is suggested for most raspberry and blackberry varieties. A Comprehensive Assessment of Soil Health from the Cornell Soil Health Lab 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 plants. Also, the row middles are not irrigated with drip systems and this reduces weed pressure and conserves resources. Raspberries and blackberries 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 raspberries and blackberries 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. The irrigation system should be in place prior to planting to ensure availability of water to new plants. 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 7.0 or below, and should also have a low salt content (<2.0 ds/m; preferably <1.0 ds/m) as raspberries and blackberries are salt-sensitive fruit crops. Always check with your certifier on the products used for lowering irrigation water pH. Water contaminated with sewage or manure should not be used for crop irrigation. Use only potable water to irrigate raspberries

and blackberries during bloom and harvest. For more information on irrigation see: *Raspberry and Blackberry Production Guide for the Northeast, Midwest and Eastern Canada*, NRAES-35.

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

4.1 Goals and Timing for Preplant Cover Crops

Cover crops play an important role in a raspberry or blackberry planting, especially during 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 reduce nematode populations. The cover crop might best achieve some of these goals if it is in place for an entire growing season and incorporated into the soil prior to plant establishment.

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 early spring before planting. Certain cover crops are considered biofumigants (marigold, sudangrass, 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 (annual rye, 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.

Some growers may plant raspberries and blackberries into a mowed or killed sod of annual rye, rather than planting into bare soil. A sod residue suppresses weeds for several weeks while the raspberry or blackberry row becomes established, and minimal soil disturbance results in reduced weed seed germination. To use this system, seed grain rye in autumn, and mow it (at 18 inches) in spring when the rye plants start to flower. Wait a couple of days then plant into the rye residue. With this system, creating bare soil suitable for weed growth is minimized. Weeds may be controlled for 6 to 8 weeks after planting.

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. Cover crops such as grasses with low nitrogen content should be plowed under in the fall to allow time for decomposition prior to planting. Legumes, which contain more nitrogen and decompose more quickly, can be plowed under within a month of planting.

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 raspberry and blackberry 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. In some areas prone to spring frost, bare soil middles provide greater protection because the dark soil holds more heat. However, even without planting a specific cover crop between rows, the middle vegetation will need to be managed, either by regular mowing or cultivating. Permanent row-middle alleyways require regular mowing as well, but the advantages are improved traction for equipment, reduced soil rutting and compaction, little dust, mud, and erosion, biodiversity for the planting agroecosystem, and increased soil organic matter. Growers like the ability to work in the fields shortly after a rain, which may not be possible with bare or weedy alleyways.

The types of sods suggested for permanent row middles are several species of fescues, or perennial ryegrass (Table 4.1.1). These species are relatively tolerant of low fertility, drought, and disease, compete with weeds effectively, and do not spread into planting rows. These sods are often sold in companion mixes to ensure rapid establishment and sustained competitive ability.

Table 4.1.1 Cover Crops for Raspberries and Blackberries: Cultural Requirements and Crop Benefits

Species	Use Timing	Planting Dates	Life Cycle	Soil Type Preference	Seeding (Lb/A)	Comments
Alfalfa [1]	Preplant	early April-late May	Perennial	Well-drained, high pH (6.0-7.0)	14	+May be difficult to incorporate if allowed to overwinter +Inoculate seed with nitrogen-fixing bacteria, if seeded in a field for the first time
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	45-55	+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	55-115	+Most cold-tolerant cover crop +Excellent allelopathic weed control +Good catch crop, rapid germination & growth +Mow or incorporate before seed formation +Temporary nitrogen (N) 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 +Can be incorporated preplant +Tall fescue has high vigor, requires more frequent mowing, and has moderately high water use +Fine fescues have low vigor, require less frequent mowing, and have moderate water use
Marigold	Preplant	Late May-June	Annual	Most	5	+Will winter kill +Biofumigant properties
Ryegrass	Row middles	August-early Sept.	Winter annual OR short-lived perennial	Most	9-16	+Temporary N tie-up when turned under +Rapid growth +Good catch crop +Heavy N & moisture users
Sorghum-Sudangrass	Preplant	June-August	Summer annual	NI	10-35	+Tremendous biomass producers in hot weather +Good catch or smother crop +Biofumigant properties
Spring Cereals (oats, barley)	Preplant	Mid-August to September	Summer annual	Silt and clay loams	90-115	+Incorporate in late June when planted in the spring +Rapid growth +Ideal quick cover crop
Vetch [1]	Preplant	August	Annual / biennial	Most	30-40	+Does not need added nitrogen +Mow or incorporate before seed formation
Wheat	Preplant	September-October	Winter annual	Most	75-120	+Mow or incorporate before seed formation

Adapted from M. Sarrantonio. 1994. Northeast Cover Crop Handbook; the Mid-Atlantic Berry Guide for Commercial Growers. 2008. Penn State Univ; the Pest Management Guidelines for Berry Crops. 2009. Cornell Univ.; and L. Bushway, M. Pritts and D. Handley, eds. 2008. *Raspberry and Blackberry Production Guide for the Northeast, Midwest and Eastern Canada* (NRAES-55

[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.

Although perennial grasses are preferred, it is possible to plant different species, such as legumes, in the row middles. These species should be able to outcompete most weeds and have low water use requirements. Bear in mind that both cover crops and weed species may become infected with and serve as reservoirs of the soilborne ringspot viruses (Tomato ringspot virus and Tobacco ringspot virus) which, in the presence of the nematode vector, can infect raspberries and blackberries, leading to a slow decline in vigor or plant death.

Some growers consider tilling strips into existing sod and planting into those strips. The intention is to avoid seeding a permanent cover in the row middles and adding amendments 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 may not be desirable. 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 modify 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

Raspberries and blackberries are classified as floricane (summer) or primocane (fall) bearing varieties depending on the age of the canes that fruiting bodies will appear. These two types of production can further be classified into early, mid-season, and late season varieties depending on when fruit ripens. Consider the needs of your market when selecting raspberry and blackberry 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. By planting multiple cultivars it is now possible to have fruit from mid to late June until frost in much of NY, with only a short decrease in production during the late summer.

In organic raspberry and blackberry production, the variety's relative resistance or susceptibility to fungal diseases can be an important decision 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, raspberry and blackberry varieties should be vigorous enough to tolerate marginal conditions, weed competition, and be less prone to fruit rots.

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

Floricane (summer) bearing:

Early season: Prelude, Killarney

Mid-season: Nova, Double Gold (golden fruit)

Late season: K81-6, Royalty (purple fruit), Brandywine (purple fruit)

Black raspberries: Bristol, Jewel, MacBlack

Blackberries: Chester, Triple Crown

Primocane (fall) bearing:

Early season: Polka

Mid-season: Caroline, Joan J

Late season: Heritage, Josephine, Crimson Treasure, Double Gold (golden fruit)

Varieties vary widely in their susceptibility to fungal diseases and some may be less susceptible to insects. A variety of fruit colors is widely available for production in the Northeast. These include cultivars of black, purple, red, orange and golden raspberries. Different colored cultivars may be more susceptible to disease or winter damage. Black raspberries, for example, may winter kill if temperatures drop to -5°F in combination with dry winds and have a shorter harvest season than red raspberries. They are also quite susceptible to viral infections, Verticillium wilt, powdery mildew, and rusts but less susceptible to Phytophtora root rot. Blackberries are less susceptible to root rots in general but can have problems with downy mildew which is not common in rasbperries. If susceptible varieties are planted, the importance of site, sanitation and cultural practices will increase in accordance to the variety's susceptibility.

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, raspberry and blackberry growers will likely be able justify the use of non-organic sources to their certifying agency.

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. Restrictions in any one of the needed nutrients will slow growth and can reduce crop quality and yields. In

raspberry and blackberry plantings, the key considerations when managing nutrition organically include preplant soil pH and nutrient adjustments; nutrition in established plantings; and understanding carbon to nitrogen ratios to deliver appropriate amounts of nitrogen to the crop. Also, nutrient management under tunnels is different from the open field where there is usually adequate moisture to facilitate organic matter decomposition and some leaching of nutrients occurs. Inside the tunnel, moisture can be limited because there is no rainfall. Good site preparation is essential because nutrients applied under the tunnel after planting are unlikely to get down into the root zone without rainfall unless the covering is removed for winter. Periodically removing the plastic covering (e.g. every third winter) to allow leaching of salts from the root zone is good practice for tunneled sites.

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 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 more prone to winter injury, diseases and insect feeding, and produce fewer, softer fruit. Organic raspberry and blackberry 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 leaf and fruit development in spring when reserve nutrients carried over from the previous year have been depleted and the plant is actively growing. Plant age, vegetative growth, and fruit yield are the deciding factors in determining the need for nutrients during the growing season.

Refer also to 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 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. 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	
University of Massachusetts Soil and Plant Nutrient Testing Laboratory 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 raspberry and blackberry 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 leaves.

		Target values (ppm, unless otherwise noted)		
Nutrient	**Symbol**	**Deficient Below**	**Sufficient**	**Excess Above**
Nitrogen	N	1.90%	2.00-3.00%	4.00%
Phosphorus	P	0.20%	0.25-0.40%	0.50%
Potassium	K	1.30%	1.50-2.50%	3.50%
Calcium	Ca	0.50%	0.60-2.00%	2.50%
Magnesium	Mg	0.25%	0.60-0.90%	1.00%
Sulfur	S	0.35%	0.40-0.60%	0.80%
Boron	B	23	30-70	90
Iron	Fe	40	60-250	350
Manganese	Mn	35	50-200	350
Copper	Cu	3	6-20	30
Zinc	Zn	10	20-50	80

Adapted from: Pritts (2008) Soil and Nutrient Management. Chpt 7 In: *Raspberry and Blackberry Production Guide for the Northeast, Midwest and Eastern Canada* (NRAES-55). L. Bushway, M. Pritts and D. Handley (eds.). NRAES-35. Ithaca, NY.
Note: ppm is parts per million. % by dry weight of leaf

6.2 Soil pH

Maintaining a soil pH range of 6.0 to 6.5 is recommended for raspberries and blackberries. Use the soil test results to determine the appropriate amount of lime (raise pH) or sulfur (lower pH) to apply. The lime or sulfur requirement will depend on soil texture, current pH, and organic matter content. Follow the recommendations of the soil test and apply and incorporate sufficient lime or sulfur prior to planting. It typically takes one year for the applied lime or sulfur to raise or lower the soil pH, respectively. The slightly acid soil pH of 6.0-6.5 is required to help avoid micronutrient deficiencies.

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. Likewise, finely ground lime is more difficult to work with, but it will raise the soil pH faster than coarse particles.

6.3 Managing Nutrients

Follow the recommendations of the soil test when adding nutrients to prepare a site for planting. Pay particular attention to the soil test results for potassium, phosphorus, magnesium, calcium, and boron. 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. When preplant recommendations are followed, additional potassium and phosphorus likely will not be required unless the soil is very sandy. However, potassium (K) demand by raspberry and blackberry plants is relatively high, so make certain there is sufficient available potassium in the soil before planting. Boron is frequently low in fruit plantings throughout the Northeast. 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.

Table 6.3.1. Available Potassium in Organic Fertilizers

	Pounds of Fertilizer/Acre to Provide given Pounds of K_2O per acre:				
Sources	**20**	**40**	**60**	**80**	**100**
Sul-Po-Mag 22% K_2O also contains 11% Mg	90	180	270	360	450
Wood ash (dry, fine, grey) 5% K_2O, also raises pH	400	800	1200	1600	2000
Alfalfa meal[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.

In established plantings, base fertilizer amounts on leaf analysis. In the event that potassium is required, a reasonable amount of potassium to apply, preferably in the fall, is up to 100 lb/acre. See table 6.3.1 for organic sources of potassium. Pay attention to the K/Mg ratio and if it is above 4, then additional magnesium should be applied with the potassium fertilizer to prevent inducing a magnesium deficiency: the K/Mg ratio should be less than 5.

Magnesium (Mg) deficiency in raspberries and blackberries is relatively common, especially on sandy or acidic soils. Factors that influence magnesium availability include soil pH and excess potassium. 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.

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.

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. The best time to apply boron is prior to fruiting in primocane-fruiting varieties and mid-summer for other types. Check with your certifier for information on allowable sources of magnesium and boron.

Phosphorus (P) demand by raspberries and blackberries is relatively low, and phosphorus is usually not required in established plantings. In most cases excess P is more of a concern. Table 6.3.2 lists some organic fertilizer sources of P.

6.4 Preparing a Nitrogen Budget

The carbon to nitrogen (C/N) ratio in compost can provide a guide for nitrogen release into the soil solution. When a decomposing material has a low C/N ratio (a lot of nitrogen) microbes release the excess nitrogen into the soil solution. When a material undergoing decomposition has an initially high C/N ratio (very little nitrogen), microbes will use whatever nitrogen is available for their own growth, leaving little for plants. This can result in temporary nitrogen deficiency. Once the decomposition process begins to slow and those microbes die off, they will release their nitrogen back into the soil where it will become available to plants. The rule of thumb is that if the C/N ratio is less than 20 or the material's nitrogen content is greater than 2.5%, then there will be enough nitrogen available for both decomposer microbes and plants. If the C/N ratio is above 20, then nitrogen will likely be immobilized until sufficient decomposition has taken place. One reason that additional nitrogen is recommended for plantings mulched with sawdust or wood chips (plantings with a high C/N ratio) is to help overcome the temporary nitrogen deficiency that occurs during the decomposition of 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 during the season by comparing them to the nitrogen guidelines for raspberries and blackberries (Table 6.4.2). These N release rates apply to the field – breakdown of N inside high tunnels is much slower, so plan accordingly.

Table 6.4.2. Annual Nitrogen Guidelines for Raspberries and Blackberries.

Planting Age (years)	Amount Actual N (lbs/Acre)	Timing
Floricane (summer) bearing		
0	25-35	4 weeks after planting
1	35-55[a]	May or split between May and June
2+	40-80[a]	May or split between May and June
Primocane (Fall) bearing		
0	25	4 weeks after planting and in August
1	50-80[a]	Split between May and June
2+	70-100[ab]	Split between May and June

[a] Use higher amount on sandier soils or if irrigation is used
[b] Adjust amount based on leaf analysis.

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 raspberry and blackberry plantings.

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

Add together the various N values from these different organic sources to estimate the N supplying potential of the soil. There is no guarantee that these amounts will actually be available in the season, since soil temperatures, water, and crop physiology all impact the release and uptake of these soil nutrients. If early in the organic transition, a grower may consider increasing the N budget supply by 25%, to help reduce some of the risk of N being limiting to the crop. Remember that with a long-term approach to organic soil fertility, the N mineralization rates of the soil will increase. This means that more N will be available from organic amendments because of increased soil microbial activity and diversity. Feeding different types of organic matter to these organisms 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)*, also contains 2% P and 3% K_2O	500	1000	1500	2000	2500
Fish meal 9% N, also contains 6% P_2O_5	220	440	670	890	1100
Alfalfa meal 2.5% N also contains 2% P and 2% K_2O	800	1600	2400	3200	4000
Feather meal 15% N (x 1.5)*	200	400	600	800	1000

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

The annual nitrogen guidelines for raspberries and blackberries 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 over the plant row, splitting applications between May and early June. Be aware that spring applications of nitrogen can greatly increase the risk of gray mold fruit rot infections.

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 RASPBERRY AND BLACKBERRY IPM

Organic production of raspberries and blackberries is 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 high quality organic raspberries and blackberries. In particular, growing raspberries and blackberries under tunnels dramatically reduces disease pressure and often insect pressure as well. Two-spotted spider mites tend to increase under the tunnel environment, but other pests diminish. Scouting for mites and applying predators at the appropriate time makes it possible to grow these fruits without spraying (Section 7.6.9). 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 and even plant losses in particular years. Successful IPM is essential to the sustainable production of organic raspberries and blackberries.

7.1 Developing a Raspberry and Blackberry IPM Strategy

1. Examine your raspberry and blackberry operation closely. Break it down into specific plantings, or "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 or the *Raspberry and Blackberry Production Guide for the Northeast, Midwest and Eastern Canada*, NRAES-35.
8. Develop a thorough knowledge of the raspberry and blackberry pests you are likely to encounter during the year. This includes basic pest biology, symptoms or damage, whether they are a primary or secondary pest, scouting thresholds, and the best time to apply management practices.
9. Choose a pest management strategy for the planting (or block) that is based on all of the information you've gathered. Use the options that make the most sense for your operation.
10. Continue your pest management education.

Other resources available online, include:

New York State Integrated Pest Management: Fruits website: nysipm.cornell.edu/fruits/
Cornell Fruit Resources: www.fruit.cornell.edu
Cornell Cooperative Extension Pesticide Safetyt Education Program: psep.cce.cornell.edu
Pesticide Environmental Stewardship. Center for Integrated Pest Management. https://pesticidestewardship.org/
Elements of IPM for Raspberries in New York State: https://ecommons.cornell.edu/handle/1813/42721
Network for Environment and Weather Applications (NEWA): newa.cornell.edu
Berry Diagnostic Tool: https://blogs.cornell.edu/berrytool/raspberries/

7.2 Weed Management

Weeds are part of the raspberry and blackberry planting ecosystem where they can interfere with planting operations; provide alternate hosts for pests; and compete for water and nutrients. Excessive weed growth within the raspberry and blackberry canopies can also alter the microclimate around plants by interfering with sunlight penetration and air movement, leading to higher spotted-wing drosophila and disease pressure. 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. Tables 7.2.1 and 7.2.2 outline weed management practices in raspberry and blackberry plantings. In mature plantings, productivity of raspberry and blackberry bushes can be limited due to weed competition. Eliminating weeds within the row with mulching and pulling weeds by hand help maintain weed-free plantings, as outlined in Tables 7.2.1 and 7.2.2. 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.

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.

Table 7.2.1 Weed management without herbicides in floricane-fruiting (summer fruiting) raspberries and blackberries.

Year	Month	Non-herbicidal options
Planting year*	**April**	Till to prepare for planting unless planting into killed sod.
	April - June	Hand weed in-row and apply mulch. Mow row middles and planting borders to keep weeds from producing seeds.
	After planting	Hand weed in-row. Mow row middles and borders.
Fruiting years		Hand weed in-row. Mow row middles and borders.
	June-August	Hand weed in-row. Mow row middles and borders.
		Remove floricanes. Mow row middles and borders.

*CRITICAL TIME FOR REDUCING WEEDS.

Year	Month	Non-herbicidal options
Planting year*	**April**	Till to prepare for planting, unless planting into killed sod.
		Hand weed in-row and apply mulch. Mow row middles and planting borders.
Fruiting years		Mow canes to ground before new canes emerge. Hand weed in-row. Mow row middles and borders.
	June -October	Mow between rows or hand weed only.
		Mow rows to the ground in late fall or in early spring before new primocanes emerge.

*CRITICAL TIME FOR REDUCING WEEDS.

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 raspberry and blackberry 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. See section 4 for more information on appropriate ground covers for raspberry and blackberry plantings or consult the *Raspberry and Blackberry Production Guide for the Northeast, Midwest and Eastern Canada* (NRAES-35). 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.

Managing weeds within the row may be one of the most difficult tasks in the production of organic raspberries and blackberries, yet it is essential because of the low competitive ability of the crop. Organic mulches used as tools for weed management are most effective in the planting year and in sites with low soil moisture and fertility. Potential organic mulches for use within the row include straw, hay, sawdust and wood chips. In raspberries and blackberries, mulches are only recommended for the first few months after planting because prolonged mulching can create conditions favorable for root diseases. Straw mulch may serve as a major source of weed seed; be sure to inspect straw before purchase. Use of straw mulch between the rows for suppression of weed growth is not recommended.

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 at the end of the season. 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 fixed hoes, rotary cultivators, flamers, steamers, and hot water applicators. Animal weeders have also been used with some success in organic plantings across the United States. The use of weeder geese, guinea fowl, and sheep have some effectiveness, but due to food safety concerns regarding microbial contamination of food crops from manure, they 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 labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

Table 7.2.3 Organic Herbicides labeled for Management of Weeds in Raspberries and Blackberries

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)	6-15% v/v. See label for details.	-	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 raspberry and blackberry 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/or considerable insect damage will occur.

Pruning and trellising practices can promote plant health in the raspberry or blackberry planting, some key considerations include:

- Prevent horizontal growth of canes
- Keep fruit off the ground
- Promote air drainage
- Keep plant row middles open to allow for mowing and air flow
- Allow for ease of harvest

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 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 raspberry and blackberry pathogens and arthropod (insect and mite) pests.
- Avoid planting raspberries and blackberries in proximity to other crops or habitats that harbor large pathogen and/or pest populations.
- Plant raspberries and blackberries under covered production to avoid outside sources of disease inoculum.

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 plants to eradicate pathogen and pest populations. Destruction of this material is accomplished through burning, chipping, burying, and composting.
- Several biological control alternatives are available for insect suppression for raspberry and blackberry crops including products based on formulated *Bacillus thuringiensis* and insectary-reared predatory mites. Currently, there are few consistently reliable biological control products that have been developed for managing raspberry diseases, although there are numerous biopesticides that are available and effective in low disease pressure situations.
- Chemical application of fungicides, insecticides, and miticides may reduce pathogen and pest populations below damage thresholds, but will rarely eradicate them.

Protection:

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

- Plant raspberry and blackberry varieties that are disease resistant or less susceptible to diseases of concern.
- 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, insecticides, or miticides may protect susceptible tissues from disease and insect damage.
- Plant raspberries and blackberries under covered production to protect against rainfall, which is the primary factor driving infection and spread of disease.

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 ANTHRACNOSE *(Elsinoe veneta)*

Infections lead to the production of small, purple spots scattered over young canes appear in the spring. The spots enlarge to about one eighth inch in diameter, become sunken in the center, and turn gray with a purple border. Many spots can run together to form large sunken diseased areas on the cane. This disease is generally much more severe on black and purple raspberries than on red varieties. The disease can infect the canes, leaves, fruit, and stems of berry clusters. Infected canes become more susceptible to winter injury and other diseases than healthy canes.

Anthracnose Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No known resistant varieties. 'Boyne', 'Killarney', and 'Bristol' (black) are particularly susceptible varieties. 'Blackhawk' (black) and 'Jewel' (black) may be less susceptible. Red raspberry and blackberry are generally less susceptible than black raspberry varieties.
Cultural management	Remove and burn any diseased canes before new canes emerge in the spring. Prune bushes to maintain good air circulation. Further promote air circulation by controlling weeds and establishing narrowing fruiting rows. Single-cropping systems may reduce the disease prevalence compared to double-cropping.
Chemical Treatment	Apply a delayed dormant spray[1] of lime sulfur or copper. This "delayed dormant" application has always been the most important spray for the control of the major cane diseases. Thorough coverage is essential for control; therefore, this spray should be applied on a calm day and in a sufficient amount of water to soak the canes completely. Sprays applied after half inch green-tip may burn the leaves, particularly in warm weather. Note: On fall-bearing red raspberries, this application is not necessary if the previous year's canes are mowed and removed from the planting or thoroughly shredded.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.g

Table 7.4.1 Pesticides Labeled for Management of Anthracnose

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Badge X2 (copper hydroxide, copper oxychloride)	1.75 lb/acre	0	48	1	Use 1-2.25 lb/acre when leaf buds begin to open and then again when flower buds show white. Use 1.75-3.5 lb/acre in the fall after harvest. Delayed dormant spray.
Basic Copper 53 (basic copper sulfate)	2-3.7 lb/acre	UDH	48	1	Post-harvest sprays permitted.
*Brandt Lime Sulfur (calcium polysulfide)	6-12 gal/acre	-	48	?	Dormant or delayed dormant spray.
Carb-o-nator (potassium bicarbonate)	2.5-5 lb/100 gal water	0	4	?	
Champ WG (copper hydroxide)	2 or 4 lbs/acre	-	48	1	May cause crop injury under some conditions. Use 2 lb/A when leaf buds begin to open and again when flower buds show white. Use 4 lb/A for fall application after harvest. Do not apply after bloom. Post-harvest sprays permitted. Use with oil; see label for specific type.

Table 7.4.1 Pesticides Labeled for Management of Anthracnose

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
ChampION++ (copper hydroxide)	.75-1.75 lb/acre	0	48	?	
CS 2005 (copper sulfate pentahydrate)	19.2 or 32 oz/acre	0	48	1	Use 19.2 oz/A when leaf buds begin to open and again when flower buds show white. Use 32 oz/A for fall application after harvest.
Cueva Fungicide Concentrate (copper octanoate)	0.5-2 gal/acre	UDH	4	1	
Cuproxat FL (basic copper sulfate)	3 pt/acre	0	48	1	
Ecoworks EC (cold pressed neem oil)	1-4 pt/acre	0	4	?	
ET-F Algicide/ Bactericide/ Fungicide (copper sulfate pentahydrate)	19.2 or 32 fl oz/acre	-	48	1	Use 19.2 oz/A when leaf buds begin to open and again when flower buds show white. Use 32 oz/A for fall application after harvest.
Kalmor (copper hydroxide)	0.75-1.75 lb/acre	0	48	1	
Kentan DF (copper hydroxide)	2-4 lb/acre	-	48	1	
Kocide 2000-O (copper hydroxide)	1.5-3 lb/acre	0	48	1	
Kocide 3000-O (copper hydroxide)	0.75-1.75 lb/acre	0	48	1	
Mastercop (copper sulfate pentahydrate)	0.5-2 pt/acre	UDH	48	1	
Milstop (potassium bicarbonate)	2-5 lb/acre	0	1	1	Do not mix with other pesticides or fertilizers. Not compatible with alkaline solutions.
Nordox 75 WG (cuprous oxide)	1.25 to 6.5 lb/acre	-	12	1	See label for specific rates and application timing.
Nu-Cop 50 WP (copper hydroxide)	4 lb/acre	1	24	1	Delayed dormant spray. Add 1 qt crop oil/A. Post-harvest sprays permitted.
Nu-Cop 50DF (copper hydroxide)	2 or 4 lbs/acre	1	48	1	See label for specific rates and application timing.
Nu-Cop HB (copper hydroxide)	1-4 lb/acre	-	48	1	See label for specific rates and application timing. Discontinue use if signs of phytotoxicity appear.
OSO 5% SC Fungicide (polyoxin D zinc salt)	6.5 - 13 fl oz/acre	0	4	1	Suppression only.
Oxidate 5.0 (hydrogen peroxide, peroxyacetic acid)	1:256 dilution, curative	0	Until Dry	1	See label for specific use directions.
Oxidate 5.0 (hydrogen peroxide, peroxyacetic acid)	1:100 dilution, rescue	0	Until Dry	1	See label for specific use directions.
PERpose Plus (hydrogen peroxide)	1 fl oz/gal initial/curative	-	See label	?	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.33 fl oz/gal preventative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.
TerraNeem EC (cold pressed neem oil)	1-1.5% solution	0	4	?	See label for specific volumes of water to use. Do not apply sulfur or sulfur-containing products within 14 days of treatment.

Table 7.4.1 Pesticides Labeled for Management of Anthracnose					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
Trilogy (neem oil)	1% solution	UDH	4	?	Maximum labeled use of 2 gal/acre/application. Do not apply while bees are actively visiting.

*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 SPUR BLIGHT *(Didymella applanata)*

Chocolate brown or purple blotches centered on individual buds appear on canes in mid to late summer. Buds within the discolored areas either fail to grow or produce weak shoots the following year. Wet conditions during the early spring favor disease development. The disease is more severe on red raspberries than on black raspberries. Summer fruiting cultivars are also more susceptible to infection.

Spur Blight Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No known resistant varieties. Particularly susceptible varieties include 'Royalty', 'Canby', and 'Williamette'. Less susceptible varieties include 'Brandywine', 'Killarney', and 'Latham'.
Cultural management	Prune and burn or remove diseased canes before new canes emerge in the spring. Maintain good air circulation by controlling weeds and establishing narrow fruiting rows. Avoid application of excess nitrogen to decrease excessively vigorous plantings.
Chemical Treatment	**Apply a delayed dormant spray of lime sulfur or copper.** This "delayed dormant" application has always been the most important spray for the control of the major cane diseases. Thorough coverage is essential for control; therefore, this spray should be applied on a calm day and in a sufficient amount of water to soak the canes completely. Sprays applied after half inch green-tip may burn the leaves, particularly in warm weather. Note: This treatment is not necessary for fall-bearing red raspberries, if the previous year's canes are mowed and removed from the planting or thoroughly shredded.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.4.2 Pesticides Labeled for Management of Spur Blight					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
*Brandt Lime Sulfur (calcium polysulfide)	12 gal/acre at green bud or two sprays at 10 gal/acre before buds break and show silver	-	48	1	Delayed dormant spray.
LALSTOP G46 WG (Gliocladium catenulatum str J1446)	See label	0	4	?	Rate used depends on volume applied per acre. See label.
PERpose Plus (hydrogen peroxide)	1 fl oz/gal initial/curative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.33 fl oz/gal preventative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.

*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.

7.4.3 CANE BLIGHT OR SPOT *(Leptosphaeria coniothyrium)*

The disease causes weak growth of some or all of the fruiting laterals, followed by wilting of the leaves above the blighted area. Dark brown or purple cankers appear on the main cane or on laterals below the wilt symptoms, often extending several inches along the cane. Cane tissue in the infected region is weak and breaks easily. Infection sites are usually associated with pruning wounds or other injuries, but they are not always obvious. Compared to spur blight, cane blight is more likely to involve whole canes and is not strictly confined to the areas

surrounding buds. It is most common in black and purple raspberries because of tipping practices, although red raspberries are reported to be equally susceptible. Infections most often occur from late April to early May making summer fruiting cultivars more susceptible.

Cane Blight or Spot Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No known resistant varieties.
Cultural management	Remove and burn diseased canes before new canes emerge in the spring. If the disease appears on red varieties, try to determine and eliminate the source of injury.
Chemical Treatment	Apply a delayed dormant spray of lime sulfur or copper. This "delayed dormant" application has always been the most important spray for the control of the major cane diseases. Thorough coverage is essential for control; therefore, this spray should be applied on a calm day and in a sufficient amount of water to soak the canes completely. Sprays applied after half inch green-tip may burn the leaves, particularly in warm weather. **Note**: This treatment is not necessary for fall-bearing red raspberries, if the previous year's canes are mowed and removed from the planting or thoroughly shredded.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the 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 Cane Blight or Spot

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Badge X2 (copper hydroxide, copper oxychloride)	0.75 lb/acre	0	48	1	
*Brandt Lime Sulfur (calcium polysulfide)	6-12 gal/acre	-	48	1	Delayed dormant spray.
Oxidate 5.0 (hydrogen peroxide, peroxyacetic acid)	1:256 dilution, curative	0	Until Dry	?	See label for specific use directions.
Oxidate 5.0 (hydrogen peroxide, peroxyacetic acid)	1:100 dilution, rescue	0	Until Dry	?	See label for specific use directions.
PERpose Plus (hydrogen peroxide)	1 fl oz/gal initial/curative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.33 fl oz/gal preventative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.

*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 POWDERY MILDEW *(Sphaerotheca macularis)*

Infected leaves are covered with a white powdery layer of mycelium and spores and may curl upwards. Some cultivars simply develop chlorotic blotches on the leaf surfaces. Severely infected developing shoots may become long and spindly with stunted leaves. Raspberries grown under tunnels or in greenhouses are particularly susceptible to infection. Black raspberry cultivars are generally more susceptible than red. Blackberries are not prone to powdery mildew.

Powdery Mildew Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Particularly susceptible varieties include 'Canby', 'Nantahala', 'Royalty', 'Reveille', and 'Latham' and most black raspberry varieties grown under tunnels. Less susceptible varieties include 'Prelude', 'Encore', 'K81-6', 'Moutere', 'Killarney', 'Crimson Giant', 'Crimson Treasure', 'Heritage', 'Autumn Britten', 'Autumn Bliss', 'Jaclyn', 'Joan J', 'Caroline', 'Polka', and 'Himbo Top'.
Cultural management	Prune to maintain good air circulation within the planting and remove late-developing primocanes that may be infected. The disease is best managed by avoiding susceptible varieties. This disease

Powdery Mildew Management Options	
	may be more problematic in covered production (tunnels) where air circulation is reduced and relative humidity is higher.
Chemical Treatment	Generally, chemical control for powdery mildew is not warranted, however there are fungicides labeled for use. Chemical applications may also provide protection against gray mold, anthracnose, spur blight, and cane blight.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the 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 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 on sulfur sensitive varieties.
*Brandt Lime Sulfur (calcium polysulfide)	6-12 gal/acre	-	48	1	Dormant or delayed dormant spray.
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 specific application volumes.
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 on sulfur sensitive varieties.
DES-X (insecticidal soap)	2% formulation sprayed at 75-200 gallons/acre	1/2	12	?	
Drexel Suffa (sulfur)	1-2.5 gal/acre	UDH	24	1+	Do not use sulfur with oil or within 14 days of an oil spray. Do not apply when temperatures exceed or are likely to exceed 90°F.
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)	0.75-1.5 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	A high volume of water is needed for through coverage. Many common pesticides are phytotoxic when applied with or close to oil sprays (e.g., sulfur). Check label for restrictions.
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	?	
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	1	

Table 7.4.4 Pesticides Labeled for Management of Powdery Mildew

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Microthiol Disperss (sulfur)	6-15 lb/acre	-	24	1	Not recommended within 2 weeks of an oil application nor if temperatures are expected to exceed 90 degrees within 3 days following the application.
Mildew Cure (garlic oil, cottonseed oil, corn oil)	1 gal/100 gal water	-	-	?	25(b) pesticide. Conduct phytotoxicity test prior application.
Milstop (potassium bicarbonate)	2.5-5 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	?	Works by contact. Good coverage is important
Nuke Em (citric acid)	Normal: 1 fl oz/32 fl oz water	0	-	?	25(b) pesticide.
Omni Supreme Spray (mineral oil)	0.75-1.5 gal/acre	-	12	1	See label for specific precautions.
OSO 5% SC Fungicide (polyoxin D zinc salt)	6.5 - 13 fl oz/acre	0	4	1+	
Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid)	1 gal/100 gal water curative	0	Until Dry	1	See label for specific use directions.
Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid)	32-64 fl oz/100 gal water preventative	0	Until Dry	1	See label for specific use directions.
Oxidate 5.0 (hydrogen peroxide, peroxyacetic acid)	1:256 dilution, curative	0	Until Dry	1+	See label for specific use directions.
Oxidate 5.0 (hydrogen peroxide, peroxyacetic acid)	1:100 dilution, rescue	0	Until Dry	1+	See label for specific use directions.
PerCarb (sodium carbonate peroxyhydrate)	1-3 lb/100 gal water	0	Until Dry	1+	See label for specific application volumes.
PerCarb (sodium carbonate peroxyhydrate)	3-4 lb/100 gal water dormant spray	0	Until Dry	1+	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	-	1 hr or until dry	1	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.33 fl oz/gal preventative	-	1 hr or until dry	1	See label for specific, curative or preventative, use directions.
PureSpray Green (white mineral oil)	Dilute: 0.75-1.5 gal/100 gal water. Concentrate: 1.5-3 gals/acre	UDH	4	1	
Regalia (Reynoutria sachalinensis)	1-4 qt/acre	0	4	1	
Regalia CG (Reynoutria sachalinensis)	1-4 qt/acre	0	4	1	
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% solution	0	4	1	Mix 2-4 qts in 100 gallons of water and apply at 20 gallons finished spray/acre.

Table 7.4.4 Pesticides Labeled for Management of Powdery Mildew

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Sil-Matrix LC (potassium silicate)	1-4 qt/100 gal water	UDH	4	1	Mix 1-4 qts in 100 gallons of water and apply at 50-250 gallons finished spray/acre.
Solawit 80DF (sulfur)	6-12 lb/acre	-	24	1+	Do not use within 2 weeks of an oil spray except for dormant, delayed dormant or post-harvest applications. Do not apply if temperatures during or within 3 days after application are expected to exceed 90°F.
Sporan EC2 (rosemary oil, clove oil, peppermint oil, thyme oil)	1-3 pt/acre	0	-	?	In raspberries, do not exceed 3 pts/ acre
SuffOil-X (mineral oil)	1-2 gal/100 gal water	UDH	4	1	Do not use in combination with or immediately before or after spraying with fungicides containing sulfur.
Sulfur 80 WDG (sulfur)	6-15 lb/acre	-	24	1	
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. Do not apply sulfur or sulfur-containing products within 14 days of treatment.
Thiolux (sulfur)	6-12 lb/acre	-	24	1	Begin application before blossoms open and repeat at a 10-day interval as necessary.
Timorex Act (tea tree oil)	13-35 fl oz/acre	2	4	?	
Trilogy (neem oil)	1% solution	UDH	4	?	Maximum labeled use of 2 gal/acre/application. Do not apply while bees are actively visiting.
TriTek (mineral oil)	1-2 gal/100 gal water	UDH	4	1	Do not use in combination with or immediately before or after spraying with fungicides containing sulfur.
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.

7.4.5 BOTRYTIS FRUIT ROT/GRAY MOLD *(Botrytis cinerea)*

Gray mold is the most common cause of fruit rot of brambles. Ripening fruit becomes rotten, and some or all of the individual fruitlets are covered with a gray fuzzy mass of fungal conidia (spores) and mycelium, hence the common name "gray mold". Gray mold can cause extensive crop losses in years when wet, warm, and humid weather prevails during bloom. Fruit may become infected at any time during development, but initial infections often occur during bloom. Cultivars with an open canopy tend to develop less gray mold.

Botrytis Fruit Rot/Gray Mold Management Options	
Scouting/thresholds	None established.

Botrytis Fruit Rot/Gray Mold Management Options	
Variety susceptibility	Most varieties show susceptibility but softer ones are especially problematic including 'Nova' and 'Anne' (golden). Open canopy varieties such as 'Heritage' and 'Crimson Treasure' provide less opportunity for infection. Early summer and late fall vareties often have less infection due to less favorable conditions for the disease. Black raspberries are generally more resistant than red raspberries.
Cultural management	Harvest and cool all ripe fruit promptly. Prune bushes to promote air circulation and minimize disease spread (e.g. pruning and weed management) within the canopy and the plantings. Plant in covered production to mimize gray mold infection and spread.
Chemical Treatment	Fungicide sprays are most important during prolonged wet weather during bloom. Treatment may prove important for red and purple raspberries, particularly if air circulation is limited and the gray mold has been problematic in previous seasons.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration Current NY pesticide registrations can be checked on the 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 Botrytis Fruit Rot / Gray Mold

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	Label recommends use of a spreader sticker.
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	-	1	25(b) pesticide. Check for phytotoxicity before applying to whole crop.
Companion Biological Fungicide (Bacillus amyloliquefaciens)	1/2 - 1 1/2 lb/acre	0	4	?	
Companion Maxx Biological Fungicide (Bacillus amyloliquefaciens ENV503)	32-96 fl oz/acre	0	4	2	
Cueva Fungicide Concentrate (copper octanoate)	0.5-2 gal/acre	UDH	4	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	
Ecoworks EC (cold pressed neem oil)	1-4 pt/acre	0	4	?	
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.

Table 7.4.5 Pesticides Labeled for Management of Botrytis Fruit Rot / Gray Mold

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Milstop (potassium bicarbonate)	2-5 lb/acre	0	1	?	
OSO 5% SC Fungicide (polyoxin D zinc salt)	6.5 - 13 fl oz/acre	0	4	1+	
Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid)	1 gal/100 gal water curative	0	Until Dry	1	See label for specific use directions.
Oxidate 2.0 (hydrogen dioxide, peroxyacetic acid)	32-64 fl oz/100 gal water preventative	0	Until Dry	?	See label for specific use directions.
Oxidate 5.0 (hydrogen peroxide, peroxyacetic acid)	1:256 dilution, curative	0	Until Dry	1	See label for specific use directions.
Oxidate 5.0 (hydrogen peroxide, peroxyacetic acid)	1:100 dilution, rescue	0	Until Dry	1	See label for specific use directions.
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	-	1 hr or until dry	2	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.33 fl oz/gal preventative	-	1 hr or until dry	2	See label for specific, curative or preventative, use directions.
Promax (thyme oil)	up to 1 gal/acre soil treatment	0	-	?	
Regalia (Reynoutria sachalinensis)	1-4 pts/acre	0	4	2	Initiate at first sign of disease then reapply every 7-14 days
Regalia CG (Reynoutria sachalinensis)	1-4 qt/acre	0	4	2	
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 2-10 day interval or as needed. Add a surfactant to improve spray coverage.
Serenade MAX (Bacillus subtilis str QST 713)	1-3 lb/acre	0	4	1	Begin application prior to disease development and repeat on 2-10 day interval or as needed. Add a surfactant to improve spray 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	
Sporan EC2 (rosemary oil, clove oil, peppermint oil, thyme oil)	1-3 pt/acre	0	-	?	In raspberries, do not exceed 3 pts/ acre
Stargus (Bacillus amyloliquefaciens str. F727)	1-4 qt/100 gal water	0	4	1	

Table 7.4.5 Pesticides Labeled for Management of Botrytis Fruit Rot / Gray Mold

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	?	Suppression only.
TerraNeem EC (cold pressed neem oil)	1-1.5% solution	0	4	?	See label for specific volumes of water to use. Do not apply sulfur or sulfur-containing products within 14 days of treatment.
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	2	
Trilogy (neem oil)	1% solution	UDH	4	?	Maximum labeled use of 2 gal/acre/application. Do not apply while bees are actively visiting.

*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.

7.4.6 MOSAIC VIRUS COMPLEX

Signs of infection are variable, depending on which virus or mixture of viruses is involved. The disease is generally severe only on black raspberries. The leaves are mottled, with yellowish or light green blotches on a darker green background. The leaves are also usually smaller than normal and are frequently deformed or cupped. Leaf symptoms are most apparent in the spring, but higher summer temperatures can suppress virus activity and, in turn, suppress symptoms. On black and purple raspberries, young shoot tips may die, becoming black and bent. Infected plants are gradually stunted and produce dry, poor-quality fruit.

Mosaic Virus Complex Management Options	
Scouting/thresholds	None established.
Variety susceptibility	More resistant varieties include 'Titan', 'Festival', 'Tulameen', and 'Royalty' (purple). Susceptible varieties include 'Taylor', 'Summit', and black raspberry varieties in general.
Cultural management	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 raspberries or wild brambles by at least 150 to 200 yards if practical. Remove and destroy obviously infected plants as they appear.
Chemical Treatment	Management of aphid vector with insecticides may slow disease spread within a field but is unlikely to prevent introduction.

7.4.7 CRUMBLY BERRY *(Tomato Ringspot Virus)*

"Crumbly berry" is a symptom associated with a variety of problems, though one of the most common causes is infection by Tomato Ringspot Virus. This disease occurs only on red raspberries and is widely distributed throughout North America. Infected plants appear healthy but produce small, crumbly berries that fall apart when picked. The virus is spread by the American dagger nematode. These microscopic roundworms feed on plant roots and can pick up the virus from infected weeds or host crop plants. Infected plants occur in patches that enlarge over time as the disease is spread by the nematode.

Crumbly Berry Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known.
Cultural management	Plant only certified (virus-indexed) nursery stock. Do not replant sites from which crumbly berry plants have been removed. Analyze new planting site or suspected problem sites for the dagger nematode. If detected, select another site or rotate with a biofumigant cover crop (see Table 4.1).

Crumbly Berry Management Options	
Chemical Treatment	If nematode testing indicates high population levels of the vector, a biofumigant cover crop may be beneficial (see Table 4.1).

7.4.8 ORANGE RUST *(Arthuriomyces peckianus)*

This is a serious fungal disease that occurs only on black and purple raspberries, red raspberries are immune. New canes arising from infected plants in the spring are weak, spindly, and thornless and have misshapen, pale leaves. In contrast to single, new canes arising from a healthy crown, infected canes usually arise in bunches. The lower surfaces of new leaves are covered first with large orange pustules that erupt several weeks after the leaves unfold.

Orange Rust Management Options	
Scouting/thresholds	Established plantings should be examined for orange rust every year during the first weeks of the growing season when symptoms are easiest to observe.
Variety susceptibility	Red raspberries are immune to the disease.
Cultural management	Do not establish new plantings next to wooded areas or fence rows unless wild brambles are first eradicated. Examine new plants about one month after planting or when canes are 12-18 inches tall. Also check them for rust each following year. Identify infected plants before spores have the opportunity to infect neighboring plants. Dig up and burn all infected plants immediately, taking care to remove the roots as well.
Chemical Treatment	Fungicides will not effectively manage this disease. Infected plants need to be eradicated.

7.4.9 RASPBERRY LEAF AND CANE SPOT *(Septoria rubi)*

Circular brown spots, approximately less than one sixteenth of an inch in diameter, appear on the leaves in summer. The spots enlarge and coalesce during the season. Defoliation can occur during severe infections. Inconspicuous cane lesions may also develop near the bases of canes. Black raspberries are generally more resistant to leaf spot than red raspberries.

Raspberry Leaf and Cane Spot Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Black raspberries are generally more resistant to leaf spot than red raspberries. Susceptible red varieties include, 'Killarney', 'Reveille', 'Canby', 'Boyne', and 'Brandywine' (purple). Less susceptible red varieties include 'Latham', 'Heritage', and 'Fallgold'.
Cultural management	Manage weeds and prune to promote air circulation and minimize disease spread. Fruiting canes should be removed immediately after harvest, and fallen leaves raked or cultivated before bud break to reduce fungal inoculum.
Chemical Treatment	Apply a delayed dormant spray of copper. This "delayed dormant" application has always been the most important spray for the control of the major cane diseases. Thorough coverage is essential for control; therefore, this spray should be applied on a calm day and in a sufficient amount of water to soak the canes completely. Sprays applied after half inch green-tip may burn the leaves, particularly in warm weather. **Note**: This treatment is not necessary for fall-bearing red raspberries, if the previous year's canes are mowed and removed from the planting or thoroughly shredded.

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Table 7.4.9 Pesticides Labeled for Management of Raspberry Leaf and Cane Spot

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Badge X2 (copper hydroxide, copper oxychloride)	1-3.5 lb/acre	0	48	1	Use 1-2.25 lb/acre when leaf buds begin to open and then again when flower buds show white. Use 1.75-3.5 lb/acre

Table 7.4.9 Pesticides Labeled for Management of Raspberry Leaf and Cane Spot

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
					in the fall after harvest. May cause crop injury under some conditions.
Basic Copper 53 (basic copper sulfate)	2-3.7 lb/acre	UDH	48	1	May cause crop injury under some conditions. Post-harvest sprays permitted.
Champ WG (copper hydroxide)	2 or 4 lbs/acre	-	48	1	May cause crop injury under some conditions. Use 2 lb/A when leaf buds begin to open and again when flower buds show white. Use 4 lb/A for fall application after harvest. Do not apply after bloom. Post-harvest sprays permitted.
ChampION++ (copper hydroxide)	.75-1.75 lb/acre	0	48	?	
CS 2005 (copper sulfate pentahydrate)	19.2 or 32 oz/acre	0	48	1	Use 19.2 oz/A when leaf buds begin to open and again when flower buds show white. Use 32 oz/A for fall application after harvest.
Cueva Fungicide Concentrate (copper octanoate)	0.5-2 gal/acre	UDH	4	1	
Cuproxat FL (basic copper sulfate)	3 pt/acre	0	48	1	
ET-F Algicide/ Bactericide/ Fungicide (copper sulfate pentahydrate)	19.2 or 32 fl oz/acre	-	48	?	Use 19.2 oz/A when leaf buds begin to open and again when flower buds show white. Use 32 oz/A for fall application after harvest.
Kalmor (copper hydroxide)	0.75-1.75 lb/acre	0	48	1	
Kentan DF (copper hydroxide)	2-4 lb/acre	-	48	1	
Kocide 2000-O (copper hydroxide)	1.5-3 lb/acre	0	48	1	
Kocide 3000-O (copper hydroxide)	0.75-1.75 lb/acre	0	48	1	
Mastercop (copper sulfate pentahydrate)	0.5-2 pt/acre	UDH	48	1	
Milstop (potassium bicarbonate)	2-5 lb/acre	0	1	?	Do not mix with other pesticides or fertilizers. Not compatible with alkaline solutions.
Nordox 75 WG (cuprous oxide)	1.25 to 6.5 lb/acre	-	12	1	See label for specific rates and application timing.
Nu-Cop 50 WP (copper hydroxide)	4 lb/acre	1	24	1	Delayed dormant spray. Add 1 qt crop oil/A. Post-harvest sprays permitted.
Nu-Cop 50DF (copper hydroxide)	2 or 4 lbs/acre	1	48	1	See label for specific rates and application timing. Discontinue use if signs of phytotoxicity appear.
Nu-Cop HB (copper hydroxide)	1-4 lb/acre	-	48	1	See label for specific rates and application timing. Discontinue use if signs of phytotoxicity appear.
PERpose Plus (hydrogen peroxide)	1 fl oz/gal initial/curative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.33 fl oz/gal preventative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.

Table 7.4.9 Pesticides Labeled for Management of Raspberry Leaf and Cane Spot					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
Trilogy (neem oil)	1% solution	UDH	4	?	Maximum labeled use of 2 gal/acre/application. Do not apply while bees are actively visiting.

*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.

7.4.10 PHYTOPHTHORA ROOT ROT *(Phytophthora spp.)*

Infected plants frequently produce few canes, most of which are weak and stunted. Leaves on the canes may be small, turn yellow, or dry and necrotic (scorched) along the edges and between the veins. Infected plants may wilt and collapse just before harvest or during the heat of summer. If spring weather is excessively wet, emerging canes may wilt and die, showing dark "water-soaked" tissue near the soil line. When dug up and examined, many of the roots and the crown are discolored and dead. During the early stages of colonization, infected roots and crowns may have a reddish cast underneath the epidermis. By comparison, healthy roots will be white underneath the epidermis. Plants in low or poorly drained field sites are frequently infected. This disease is often been misdiagnosed as "wet feet" or winter injury. One can distinguish root rot from winter injury based on the fact that primocane emergence following winter injury is usually vigorous, whereas primocane emergence is poor from plants infected with root rot.

Phytopthora Root Rot Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Black raspberry cultivars are generally least susceptible to this disease. Extremely susceptible varieties include 'Titan', 'Lauren', 'Canby', 'Polana', and 'Encore' and should be planted *only* on very well-drained sites. The least susceptible varieties include 'Prelude', 'Anne', 'Latham', 'Nova', 'Boyne', 'Josephine', 'Caroline', 'Jaclyn', 'Moutere', 'Killarney', 'Brandywine' (purple) and 'Royalty' (purple).
Cultural management	The disease is caused by a group of soil-borne, aquatic pathogens that are active only during very wet conditions. Therefore, planting only on well-drained sites and providing supplemental drainage are crucial components of a management program. Establishing raspberries on beds raised 10-14 inches helps promote drainage, and in turn, minimizes the potential for infection. Chemical treatment can provide some benefit, but it is most effective when used in combination with site selection/modification for good drainage and proper selection of cultivars. Highly susceptible cultivars should not be planted on sites where drainage is inadequate. These cultivars are likely to die in such cases, even with raised beds and chemical applications.
Chemical Treatment	Chemical treatment is most effective in combination with cultural management.

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Table 7.4.10 Pesticides Labeled for Management of Phytophthora Root Rot					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
Howler (Pseudomonas chloroaphis strain AFS009)	5-15 lb/acre soil drench	0	4	?	
RootShield PLUS+ Granules (Trichoderma harzianum, Trichoderma virens)	2.5 - 6.0 lb/1/2 ac in-furrow	-	4	1	
RootShield PLUS+ WP (Trichoderma harzianum Rifai T-22, Trichoderma virens str G-41)	0.25-1.5 lb/ 20 gal water, dip or dip in powder	0	4	1	
RootShield WP (Trichoderma harzianum)	0.5-2.5 lb/ 5 gal water, dip or dip in powder	-	4	1	

Table 7.4.10 Pesticides Labeled for Management of Phytophthora Root Rot

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Tenet WP (Trichoderma asperellum str ICC 012, Trichoderma gamsii str ICC 080)	2.5-3 lb/acre banded spray	-	1	1	
Timorex Act (tea tree oil)	13-35 fl oz/acre soil treatment	2	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.

7.4.11 LATE LEAF RUST *(Pucciniastrum americanum)*

Small pale yellow spots develop on the undersides of leaves in late summer/early fall. Spots later turn brown. Heavily infected leaves may drop prematurely, leaving canes bare by September on susceptible varieties. Flowers, petioles, and fruit may also be infected. Because the disease does not develop until late in the summer it is generally only considered a disease of importance for fall fruiting cultivars.

Late Leaf Rust Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Black raspberries and blackberries are reportedly more resistant to late leaf rust. Susceptible varieties include 'Heritage', 'Caroline' and 'Jaclyn'. Less susceptible varieties include 'Nova'.
Cultural management	Use only healthy disease-free planting stock. Inspect material on arrival before planting. Select sites with good air movement and full sun exposure. Cultural practices to increase air circulation (cane thinning, maintaining narrow rows, good weed control). Remove alternate hosts, white spruce (*Picea americanum*) and wild raspberry, within 500ft.
Chemical Treatment	Fungicide options are limited. Although fungicides may be helpful for managing disease on primocane-fruiting cultivars, they are almost never needed on floricane-fruiting cultivars.

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Table 7.4.11 Pesticides Labeled for Management of Late 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	1	
Glacial Spray Fluid (mineral oil)	0.75-1.5 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	A high volume of water is needed for through coverage. Many common pesticides are phytotoxic when applied with or close to oil sprays (e.g., sulfur). Check label for restrictions.
Nu-Cop 50 WP (copper hydroxide)	2 lb/acre	1	24	1	Post-harvest sprays permitted.
Omni Supreme Spray (mineral oil)	0.75-1.5 gal/acre	-	12	1	See label for specific precautions.
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.

Table 7.4.11 Pesticides Labeled for Management of Late Leaf Rust

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
PERpose Plus (hydrogen peroxide)	1 fl oz/gal initial/curative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.33 fl oz/gal preventative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.
PureSpray Green (white mineral oil)	Dilute: 0.75-1.5 gal/100 gal water. Concentrate: 1.5-3 gals/acre	UDH	4	?	
SuffOil-X (mineral oil)	1-2 gal/100 gal water	UDH	4	1	Do not use in combination with or immediately before or after spraying with fungicides containing sulfur.
TerraNeem EC (cold pressed neem oil)	1-1.5% solution	0	4	?	See label for specific volumes of water to use. Do not apply sulfur or sulfur-containing products within 14 days of treatment.
Trilogy (neem oil)	1% solution	UDH	4	?	Maximum labeled use of 2 gal/acre/application. Do not apply while bees are actively visiting.
TriTek (mineral oil)	1-2 gal/100 gal water	UDH	4	?	Do not use in combination with or immediately before or after spraying with fungicides containing sulfur.
Ultra-Pure Oil (mineral oil)	0.75-1.5 gal/100 gal water	UDH	4 or until dry	?	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.

7.5 Other Diseases of Note

7.5.1 FIREBLIGHT *(Erwinia amylovora)*

The most obvious symptoms of this bacterial disease is that cane tips become brownish black and curve downward in a characteristic shepherd's-crook. Cane lesions may produce abundant bacterial ooze. Flowers and fruits may also be infected. Warm temperatures and light rain favor infections.

Fireblight Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Susceptible varieties include 'Boyne', 'K81-6', 'Latham', and 'Fallgold' (golden). Thornless blackberries appear more susceptible to the disease than thorny blackberries.
Cultural management	Remove infected canes by pruning. Encourage rapid drying of canes and foliage.
Chemical Treatment	Fire blight is rare in brambles, and it may be more cost-effective to prune infected canes and remove infected plants instead of applying chemical controls.

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Table 7.5.1 Pesticides Labeled for Management of Fire Blight					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
PERpose Plus (hydrogen peroxide)	1 fl oz/gal initial/curative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.
PERpose Plus (hydrogen peroxide)	0.33 fl oz/gal preventative	-	1 hr or until dry	?	See label for specific, curative or preventative, use directions.

*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.

7.5.2 VERTICILLIUM WILT *(Verticillium sp.)*

Symptoms of infection may develop during the summer of the first year of infection. Leaves wilt, turn yellow, and fall off, starting from the bottom of the cane and progressing toward the top. Severely wilted canes may have diagnostic blue streaks along their length. Symptoms frequently appear on only one side of a cane, or only on one or two canes out of an entire planting. Disease severity will largely depend on the previous cropping history of the field. Potatoes, tomatoes, eggplants, and peppers are particularly susceptible to wilt. This disease is also much more severe on black raspberries than on red varieties.

Verticillium Wilt Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Susceptible varieties include 'Polana'.
Cultural management	The disease is caused by a soil-borne fungus, which also attacks a number of other crops, including potato, tomato, eggplant, pepper, strawberry, cherry, squash, and cucumber. Before planting raspberries on sites where these crops have been grown, non-host crops such as wheat or corn should be grown for at least 2 years prior to planting. Many weeds, particularly nightshade, horse nettle, ground-cherry, redroot pigweed, and lambsquarters, are hosts of the *Verticillium* fungus. These weeds should be strictly controlled in current and future planting sites to keep the Verticillium population low. Plant only certified (virus-indexed) nursery stock.
Chemical Treatment	If rotations and biofumigant cover crops fail to suppress the disease, the pesticide options listed below may be tried or a new site with less risk of diseases carryover planted with new, indexed stock.

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Table 7.5.2 Pesticides Labeled for Management of Verticillium Wilt					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
Bio-Tam 2.0 (trichoderma asperellum str ICC 012, Trichoderma gamsii str ICC 080)	1.5-3 oz/1000 row feet in-furrow	-	4	?	
Bio-Tam 2.0 (trichoderma asperellum str ICC 012, Trichoderma gamsii str ICC 080)	2.5-3 lb/acre band	-	4	?	
Tenet WP (Trichoderma asperellum str ICC 012, Trichoderma gamsii str ICC 080)	2.5-3 lb/acre banded spray	-	1	?	
Timorex Act (tea tree oil)	13-35 fl oz/acre soil treatment	2	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.

7.5.3 RASPBERRY BUSHY DWARF *(Raspberry Bushy Dwarf Virus, RBDV)*

Though the disease is less common in blackberries, RBDV can cause serious losses in susceptible cultivars and it occurs wherever raspberries are grown. The primary symptom of RBDV is crumbly fruit due to poor drupelet set. Leaf chlorosis from very pale to bright

yellow also develops on some cultivars of red raspberry and blackberry, but this has not been observed on black or purple raspberries. In mixed infections with other viruses, dwarfing of the plant may occur and crumbly berry symptoms may be more pronounced. Early investigations of the bushy dwarf disease only recovered RBDV and not the co-infecting virus, Black raspberry necrosis virus, associated with dwarfing. The name "Bushy Dwarf" is misleading—RBDV rarely causes bushy dwarf symptoms by itself.

RBDV is spread from plant to plant by pollen and, therefore, is difficult to control once the virus is present in a field. Bees readily travel up to one-half mile, so isolation from infected plantings is important. In large plantings, blocks of susceptible cultivars can be isolated from other susceptible blocks by planting blocks of resistant cultivars between them. This reduces the movement of pollen between the susceptible cultivars by bees. Because pollination is inefficient across species of *Rubus*, only commercial plantings of black raspberries (*R. occidentalis*) are at risk for RBDV if wild black raspberries are growing nearby. The best strategy for growers is to use planting stock that has tested free of RBDV, especially since infected plants may not show symptoms.

Raspberry Bushy Dwarf Virus Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Susceptible varieties include: 'Autumn Britten', 'Autumn Bliss', 'Cascade Delight', 'Chemainus', 'Malahat', 'Meeker', and 'Tulameen'. Resistant varieties include 'Boyne', 'Killarney', 'Cowichan', 'Bristol' (black) 'Latham', 'Octavia', 'Heritage', 'Dormanred', 'Willamette', 'Moutere', and 'Kiwigold'. 'Marion' blackberries are susceptible; 'Chester', and 'Triple Crown' blackberries are considered resistant.
Cultural management	Use only healthy disease-free planting stock.
Chemical Treatment	None.

7.5.4 CROWN GALL *(Agrobacterium tumefaciens and A. rubi)*

Crown gall can occur on blackberries and red, black, and purple raspberries, as well as many other plant species. Galls are rough, spongy-to-hard, tumorous growths an inch or more in diameter found most often on roots of red raspberries and on the crowns of black and purple raspberries (*A. tumefaciens*). Galls can also occur on the lower portions of the canes (*A. rubi*). Although the disease causes little economic damage, crown galls can stunt and weaken severely infected plants. Crown gall bacteria persist in and on infected plant tissue and in infested soil. The bacterium enters a plant through wounds on the roots or crown caused by growth cracks, insect feeding, winter injury or cultivation.

Crown Gall Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Some varieties may be less susceptible, though any resistance may break down in the presence of lesion nematodes feeding on roots or root and crown injury.
Cultural management	Use only healthy disease-free planting stock. Inspect material on arrival to make sure it is free of galls before planting. Avoid planting into a field with a history of crown gall. Plant into fields in which a non-host crop, such as strawberries or most vegetables, has been grown for two or more years. Minimize root and crown injury during cultivation.
Chemical Treatment	None.

7.6 Insects and Mites of Primary Concern

The insects and mites that are considered major pests in raspberries and blackberries 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 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. 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 raspberry and blackberry plantings.

7.6.1 RASPBERRY FRUITWORM *(Byturus unicolor,* previously *B. rubi)*

In early May fruitworm adults feed on the buds and young leaves, skeletonizing the foliage and hindering fruit development. The small larvae feed inside the flower buds and then bore into the young fruits, which may then dry up or decay and fall off. The full-grown larva is

yellowish white and quarter inch long. The fruitworm adult is a small, light brown beetle. Fruitworms are mostly a problem in weedy fields. Adults become active in early May. Because fruitworm larvae fall to the ground by the end of July, fall-fruiting raspberries often escape injury. Injury by this insect can coincide with that of raspberry sawfly.

Raspberry Fruitworm Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known. Not generally a problem for fall-fruiting raspberries or blackberries.
Cultural management	Cultivation of plant rows during late summer and early fall may kill the larvae and pupae in the soil.
Chemical Treatment	Insecticide sprays should be applied early pre-bloom as blossoms appear and late pre-bloom before blossoms open.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the 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 Raspberry Fruitworm

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	Foliar spray or soil drench
AzaGuard (azadirachtin)	8-16 fl oz/acre	0	4	?	
*AzaSol (azadirachtin)	6 oz/acre	0	4	?	
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.
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)	1-3 pts/acre	0	-	?	25(b) pesticide. Target small caterpillars
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	?	
Entrust SC (spinosad)	4-6 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	?	
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	?	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	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	?	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.
TerraNeem EC (cold pressed neem oil)	0.5-1.5% solution	0	4	?	See label for specific volumes of water to use. Do not apply sulfur or sulfur-containing products within 14 days of treatment.

*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 RASPBERRY SAWFLY *(Monophadnoides geniculatus)*

The sawfly adult is a small, black, thick-bodied insect about ¼ inch long. The sawfly larva is a ¼ inch long, pale green worm that usually feeds on the outer edges of the leaves, later chewing out irregular holes or in severe cases, skeletonizing the foliage. This insect appears in May as leaves begin to unfold. Injury by this insect can coincide with that of raspberry fruitworm.

Raspberry Sawfly Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known. Not generally a problem for fall-fruiting raspberries or blackberries.
Cultural management	Cultivation of plant rows during late summer and early fall may kill the larvae and pupae in the soil.
Chemical Treatment	Insecticide sprays should be applied early pre-bloom as blossoms appear and late pre-bloom before blossoms open.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration Current NY pesticide registrations can be checked on the 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 Raspberry Sawfly

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
*AzaSol (azadirachtin)	6 oz/acre	0	4	?	
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	?	See container label for specific rates used.
Damoil (mineral oil)	0.75-1.5 gal/100 gal water	-	4	?	For sawfly eggs.
Ecozin Plus 1.2% ME (azadirachtin)	15-30 oz/acre	0	4	?	
Entrust (spinosad)	1.25-2 oz/acre	1	4	?	
Entrust SC (spinosad)	4-6 oz/acre	1	4	?	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
Molt-X (azadirachtin)	10 oz/acre	0	4	?	
Neemix 4.5 (azadirachtin)	7-16 fl oz/acre	0	4	?	
PureSpray Green (white mineral oil)	Dilute: 0.75-1.5 gal/100 gal water. Concentrate: 1.5-3 gals/acre	UDH	4	?	For sawfly eggs.
Safer Brand #567 II (potassium laurate, pyrethrins)	6.4 oz/gal water applied at 1 gal mix/ 700 sq ft	Until Dry	12	?	Apply one gallon of mixed spray per 700 sq. ft. of plant surface area. Larvae only.
SuffOil-X (mineral oil)	1-2 gal/100 gal water	UDH	4	?	Do not use in combination with or immediately before or after spraying with fungicides containing sulfur.
TriTek (mineral oil)	1-2 gal/100 gal water	UDH	4	?	Do not use in combination with or immediately before or after spraying with fungicides containing 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.

7.6.3 TARNISHED PLANT BUG *(Lygus lineolaris)*

These insects appear when fruit buds form and plants begin to bloom. Their feeding on buds, blossoms, and developing berries results in deformed and crumbly fruit. Adults are ¼ inch long, oval, somewhat flattened, and greenish-brown with reddish brown marking on the wings. Nymphs are pall green and less than 1/16 inch long. Overwinted adults first become active from late April to mid-May, however two to four generations may occur annually. Populations and damage become more extensive later in the growing season.

Tarnished Plant Bug Management Options	
Scouting/thresholds	For effective tarnished plant bug control, scout for nymphs after petal fall by striking the cane over a flat, low-sided, light-colored dish. Suggested threshold = 10-20% of canes infested.
Variety susceptibility	No resistant varieties known. Highly productive cultivars appear less susceptible to feeding injury.
Cultural management	Minimize proximity to preferred habitat. Tarnished plant bug pressure is often highest in weedy fields or in fields bordered by woody shrubs.
Chemical Treatment	Insecticides should be applied just before blossoms open and later as fruit begins to color.

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Table 7.6.3 Pesticides Labeled for Management of Tarnished Plant Bug

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	
AzaGuard (azadirachtin)	10-16 fl oz/acre	0	4	?	
*AzaSol (azadirachtin)	6 oz/acre	0	4	?	
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	?	See container label for specific rates used.
BioCeres WP (Beauveria bassiana strain ANT-03)	1-2 lb/acre	0	4	?	
Captiva Prime (garlic oil, capsicum oleoresin extract, canola oil)	1-2 pt/acre	0	4	?	
DES-X (insecticidal soap)	2% formulation sprayed at 75-200 gallons/acre	1/2	12	?	
Ecotrol Plus (rosemary oil, peppermint oil, geraniol)	1-3 pts/acre	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.
KOPA Insecticidal Soap (potassium salts of fatty acids)	2 gal/100 gal water	1/2	12	?	
Molt-X (azadirachtin)	10 fl oz/acre	0	4	?	Plus 0.25 to 1.0% non-phytotoxic crop oil.
Mycotrol ESO (Beauvaria bassiana)	0.25-1 qt/acre	0	4	2	Begin treatment when insects first appear; typically a 7-10 day interval occurs before control is seen.
Neemix 4.5 (azadirachtin)	7-16 fl oz/acre	0	4	?	
PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97)	1-2 lb/acre	-	4	?	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.

Table 7.6.3 Pesticides Labeled for Management of Tarnished Plant Bug

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	?	Short residual activity may require multiple applications. 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.

7.6.4 JAPANESE BEETLE *(Popillia japonica)*

Beetle larvae are serious pests of lawns, vegetables, and nursery stock. Adult beetles chew holes in the fruit, making the fruit susceptible to infection. Beetles emerge in July and can cause significant leaf damage, which appears as skeletonization. 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. Japanese beetles prefer, 'Ruby', 'Heritage', 'Reveille', 'Latham', 'Newburgh', 'Southland', and 'Fallgold' over other cultivars.
Cultural management	None established.
Chemical Treatment	Chemical sprays may be needed at late prebloom, just before blossoms open. Japanese beetles may continue to cause problems during and after bloom, however it is more difficult to avoid harming pollinators during this time.

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Table 7.6.4 Pesticides Labeled for Management of Japanese Beetle

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.
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	
AzaGuard (azadirachtin)	8-16 fl oz/acre	0	4	?	
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.
DEsect CROP (silicon dioxide)	1 lb/1000 sq ft	-	12	?	
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.

Table 7.6.4 Pesticides Labeled for Management of Japanese Beetle

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
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	2	
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	?	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	?	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.
Safer Brand #567 II (potassium laurate, pyrethrins)	6.4 oz/gal water applied at 1 gal mix/ 700 sq ft	Until Dry	12	?	Apply one gallon of mixed spray per 700 sq. ft. of plant surface area.
Surround WP (kaolin clay)	20-50 lb/acre	UDH	4	?	Suppression only. Only use before 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. Do not apply sulfur or sulfur-containing products within 14 days of treatment.
Venerate XC (Burkholderia spp. str A396)	4-8 qt/acre	0	4	?	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 STRAWBERRY SAP BEETLE *(Stelidota geminata)*, PICNIC BEETLE *(Glischrochilus fasciatus)*

Sap beetle adults make cavities in ripe and overripe fruit as well as spread spores of decay organisms. The larvae also feed on ripe and overripe fruit and are a source of contamination in harvested fruit. Sap beetles are occasionally found in high numbers in later fruiting raspberry and blackberry plantings throughout the state. Two species feed on raspberry and blackberry fruits: the common picnic beetle, one quarter inch long with four yellow or white spots on the back, and the smaller, brown strawberry sap beetle without distinctive markings. Strawberry sap beetle is the more serious pest because it does not limit its activity to over-ripe fruit. Beetles overwinter at the edge of woodlots and under other perennial fruit crops, such as brambles and blueberries. As raspberries and blackberries ripen, beetles begin feeding and laying eggs.

IPM fact sheet Strawberry Sap Beetle.

Strawberry Sap Beetle/Picnic Beetle Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known. Fall fruiting cultivars may be particularly susceptible to infestation.
Cultural management	Control other damaging insects and promptly harvest ripe berries. Keep the field free of ripe and over-ripe fruit. Good sanitation in berry crops and other fruit crops on the farm will help reduce food resources.
Chemical Treatment	If there is a past history of damage from sap beetles, sprays should be applied as fruit begins to color or as soon as beetles are seen.

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Table 7.6.5 Pesticides Labeled for Management of Sap Beetle

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	?	
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.
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.
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.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	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	?	Short residual activity may require multiple applications. 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.

7.6.6 SPOTTED WING DROSOPHILA *(Drosophila suzukii)*

Spotted Wing Drosophila (SWD) is becoming established throughout Northeast; it was first detected in NY in 2011. There is potential for significant impact from this pest, especially for fall-fruiting varieties, when populations tend to increase. Summer fruiting raspberries may escape injury.

SWD looks superficially like your everyday Vinegar Fly *Drosophila melanogaster* of genetics fame, but vinegar flies are generally not a serious economic threat to fruit growers. Female vinegar flies typically lay eggs in damaged and/or overripe fruit and hence, are mostly just a nuisance. On the other hand, female SWD have very robust ovipositors (the rear end portion of the fly used for egg laying) and lay their eggs in ripe, marketable fruit leading to damage and contamination with maggots. SWD appears to have the capability to survive winter conditions in the Northeast. They are found in similarly cold areas of Japan. However, populations at the start of the growing season tend to be quite low indicating high mortality over the winter.

SWD appear similar to other vinegar flies. Adult flies are 2-3 mm in length, with red eyes, tan-colored body with darker bands on 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 robust, serrated ovipositor (visible under magnification). Larvae are white, nondescript and legless maggots.

Monitoring can be helpful for this pest, especially for floricane cultivars. 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. Fruit should also be inspected for evidence of larval feeding. Immersing fruit in a salt solution (1 Tbsp. table salt/cup water (14.8 cc/236.6 ml)) will 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	None specifically established but customer tolerance for infested fruit is likely to be very low. For summer (floricane) raspberry, evidence of any SWD in the area of the planting indicates a significant infestation risk. Monitoring and thresholds for fall (primocane) raspberries is not very helpful since populations are very high at this time anyway.
Variety susceptibility	No resistant varieties known. Primocane berries that bear fruit late in the season appear most susceptible since SWD populations build during the season, although floricane cultivars can experience significant damage.
Cultural management	Good sanitation is very important. 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. Prune to allow for a more open canopy will make the environment less favorable by increasing sunlight, reducing humidity and improving spray coverage. For late season floricane varieties or primocane-fruiting varieties consider using insect exclusion netting, although for primocane varieties you will need to also account for pollinators. Cool berries immediately. Maintain a good cold chain (32°-33°F) between harvest and sale. Display farm market fruit in a cooler— refrigeration (32°-33°F) slows or stops SWD development in fruit.
Chemical Treatment	A few insecticides have recently been granted 2(ee) 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.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.6.6 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	
*AzaSol (azadirachtin)	6 oz/acre	0	4	2	
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	2	See container label for specific rates used.
BioCeres WP (Beauveria bassiana strain ANT-03)	1-2 lb/acre	0	4	?	
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
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	1	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

Table 7.6.6 Pesticides Labeled for Management of Spotted Wing Drosophila

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
					effective insecticides for at least one application.
Entrust SC (spinosad)	4-6 oz/acre	1	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.
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	1	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)	10 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	?	Larvae only.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	2	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	2	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.
Venerate XC (Burkholderia spp. str A396)	1-4 qt/acre	0	4	?	Begin applications as soon as adult flies are active and continue until adult activity is no longer present. Use should be part of an integrated management program that includes tank-mixes and rotation with other products labeled for control of spotted wing drosophila. 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.

7.6.7 BORERS/CANE GIRDLERS *(various species of beetles)*

A number of borers burrow through the canes of brambles; their presence may be indicated by a generally symmetrical swelling in the cane, from 1 to 3 inches long and usually a few inches, but as much has 4 feet, above the ground (i.e. Rednecked cane borer, *Agrilus ruficollis,* bronze cane borer, *Agrilus rubicola*). Some canes may wither and die; in other cases, the affected area is broken off or severed in the region of the swelling. With other borer species, no swelling is evident but the tips of new canes may wilt and blacken (Raspberry cane borer, *Oberea bimaculata*). Adults are active in spring to mid-summer. First observed damage is usually the wilting of cane tips and laterals in early June.

Borer/Cane Girdler Management Options	
Scouting/thresholds	None established.

Borer/Cane Girdler Management Options	
Variety susceptibility	No resistant varieties known. Very susceptible cultivars are 'Heritage' and 'Polka".
Cultural management	As a preventative measure, canes with swellings should be removed and burned during the dormant season. Canes showing withered tips should be clipped several inches below the affected portion during the growing season and the damaged tissue destroyed.
Chemical Treatment	Sprays are directed at adults and are applied at late pre-bloom, just before blossoms open.

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Table 7.6.7 Pesticides Labeled for Management of Borers / Cane Girdlers

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	
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
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	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	?	Short residual activity may require multiple applications. 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.

7.6.8 RASPBERRY CROWN BORER *(Pennisetia marginata)*

The adult of this species is an attractive clear-winged moth, resembling a yellow jacket, which is active during the day. The first indication of injury is wilting and dying of foliage on the affected cane. Several canes of a bush can be weakened by the activity of a single larva in the crown, and the entire bush may be killed. The adults appear in early August and are present during most of September.

Raspberry Crown Borer Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known.
Cultural management	During the growing season, destroy dying canes, including the crown, or any canes showing evidence of infestation. Eradicate wild brambles in the area because they may harbor the pest.
Chemical Treatment	Insecticides are applied as a heavy drench in the early spring to kill larvae, and as a spray between mid-August to September to kill adults.

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Table 7.6.8 Pesticides Labeled for Management of Raspberry Crown Borer

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	
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)	10 oz/acre	0	4	?	
PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97)	1-2 lb/acre	-	4	?	Soil application.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	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	?	Short residual activity may require multiple applications. 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.

7.6.9 TWO-SPOTTED SPIDER MITE *(Tetranychus urticae)*

Mites feed on the undersides of leaves, which may result in white speckling on the upper leaf surfaces. Later, discolored blotches develop. Heavily infested plants look dry and stunted, and their sparse new growth is yellowish and distorted. Damage is first seen and is most prevalent in dry areas of a field. Mild growing areas in New York (Hudson Valley and Long Island) experience problems with mites most frequently. Raspberries in high tunnels appear particularly susceptible to mite outbreaks.

Two-Spotted Spider Mite Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known. Black raspberries are especially susceptible.
Cultural management	Avoid a high rate of fertilization as it encourages mites. Maintain adequate irrigation. Naturally occurring predatory mites can maintain spider mite populations at low levels. Releasing insectary-reared predatory mites has proven effective in managing spider mites in high tunnels. They should be released at first sign of spider mite feeding. Repeat applications may be necessary.
Chemical Treatment	Chemical control of spider mites is often not completely effective because of their high mobility, tendency to reside on the underside of leaves where it is difficult to reach with miticides, high reproductive rate, and resistance to some pesticides. Good coverage of the plants, particularly the undersides of the leaves, is critical for adequate protection. Use adequate water (200 - 300 gal/A) for maximum effectiveness of the miticide. Repeat at 7- to 10-day intervals as necessary unless otherwise noted on label.

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Table 7.6.9 Pesticides Labeled for Management of Two-spotted Spider Mite

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 7.6.9 Pesticides Labeled for Management of Two-spotted Spider Mite

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	?	
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.
Captiva Prime (garlic oil, capsicum oleoresin extract, canola oil)	1-2 pt/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.
Damoil (mineral oil)	0.75-1.5 gal/100 gal water	-	4	?	
DES-X (insecticidal soap)	2% formulation sprayed at 75-200 gallons/acre	1/2	12	?	
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	2	25(b) pesticide.
Ecotrol Plus (rosemary oil, peppermint oil, geraniol)	1-3 pts/acre	0	-	?	25(b) pesticide.
Ecoworks EC (cold pressed neem oil)	1-4 pt/acre	0	4	?	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent
GC-Mite (garlic oil, clove oil, cottonseed oil)	1 gal / 100 gal spray water	-	-	?	25(b) pesticide. Conduct compatibility test prior to application.
Glacial Spray Fluid (mineral oil)	0.75-1.5 gal/100 gal water	UDH	4	?	See label for specific application volumes and equipment
Golden Pest Spray Oil (soybean oil)	1-3 gal/100 gal water	-	4	?	
JMS Stylet-Oil (mineral oil)	3-6 qt/100 gal water	0	4	2	A high volume of water is needed for through coverage. Many common pesticides are phytotoxic when applied with or close to oil sprays (e.g., sulfur). Check label for restrictions.
KOPA Insecticidal Soap (potassium salts of fatty acids)	2 gal/100 gal water	1/2	12	?	
Mantis EC (rosemary oil, soybean oil, peppermint oil)	1-8 pt/100 gal water	0	-	?	25(b) pesticide.
M-Pede (insecticidal soap)	1-2% vol/vol solution	0	12	2	Works by contact. Good coverage is important
Mycotrol ESO (Beauvaria bassiana)	0.25-1 qt/acre	0	4	?	
Nuke Em (citric acid)	Normal: 1 fl oz/32 fl oz water	0	-	?	25(b) pesticide.
Oleotrol-I Bio-Insecticide Concentrate (soybean oil)	43-45 fl oz/100 gal water	-	-	?	25(b) pesticide.
Omni Supreme Spray (mineral oil)	0.75-1.5 gal/acre	-	12	?	See label for specific precautions.

Table 7.6.9 Pesticides Labeled for Management of Two-spotted Spider Mite					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97)	1-2 lb/acre	-	4	?	
PureSpray Green (white mineral oil)	Dilute: 0.75-1.5 gal/100 gal water. Concentrate: 1.5-3 gals/acre	UDH	4	?	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	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	?	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.
Sil-Matrix (potassium silicate)	0.5-1% solution	0	4	?	Mix 2-4 qts in 100 gallons of water and apply at 20 gallons finished spray/acre.
SuffOil-X (mineral oil)	1-2 gal/100 gal water	UDH	4	?	Do not use in combination with or immediately before or after spraying with fungicides containing sulfur.
TetraCURB Max (rosemary oil, clove oil, peppermint oil, castor oil)	32 fl oz/100 gal water preventative	0	0	?	
TetraCURB Max (rosemary oil, clove oil, peppermint oil, castor oil)	64-128 fl oz/100 gal water moderate/heavy infestation	0	0	?	
Trilogy (neem oil)	1% solution	UDH	4	?	Maximum labeled use of 2 gal/acre/application. Do not apply while bees are actively visiting.
TriTek (mineral oil)	1-2 gal/100 gal water	UDH	4	?	Do not use in combination with or immediately before or after spraying with fungicides containing sulfur.
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.

7.6.10 RASPBERRY APHID *(various species)*

The two species of aphids that are most damaging in plantings are the small raspberry aphid (*Aphis rubicola*) and large raspberry aphid (*Amphorophora agathonica*). Direct feeding damage causes curling of leaves and reduction of plant growth. Both can transmit some of the more detrimental raspberry viruses such as raspberry leaf spot and mottle viruses.

Raspberry Aphid Management Options	
Scouting/thresholds	None established.
Variety susceptibility	Susceptible varieties include 'Redwing' and 'Summit' Less susceptible varieties include 'Algonquin', 'Festival', 'Titan', 'Tulameen', and 'Royalty'
Cultural management	None established.
Chemical Treatment	If infestation is noticed, insecticide treatment may be warranted.

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USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.6.10 Pesticides Labeled for Management of Aphids

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	?	
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	?	See container label for specific rates used.
BioCeres WP (Beauveria bassiana strain ANT-03)	1-2 lb/acre	0	4	?	
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
BioRepel (garlic oil)	1 part BioRepel to 100 parts water	-	-	?	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.
Damoil (mineral oil)	0.75-1.5 gal/100 gal water	-	4	?	
DEsect CROP (silicon dioxide)	1 lb/1000 sq ft	-	12	?	
DES-X (insecticidal soap)	2% formulation sprayed at 75-200 gallons/acre	1/2	12	?	
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	?	25(b) pesticide.
Ecotrol Plus (rosemary oil, peppermint oil, geraniol)	1-3 pts/acre	0	-	?	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.
GC-Mite (garlic oil, clove oil, cottonseed oil)	1 gal / 100 gal spray water	-	-	?	25(b) pesticide. Conduct compatibility test prior to application.
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	?	
KOPA Insecticidal Soap (potassium salts of fatty acids)	2 gal/100 gal water	1/2	12	?	
Mantis EC (rosemary oil, soybean oil, peppermint oil)	1-8 pt/100 gal water	0	-	?	25(b) pesticide.
Molt-X (azadirachtin)	10 oz/acre	0	4	?	
M-Pede (insecticidal soap)	1-2% vol/vol solution	0	12	?	Works by contact. Good coverage is important
Nuke Em (citric acid)	Normal: 1 fl oz/32 fl oz water	0	-	?	25(b) pesticide.
Oleotrol-I Bio-Insecticide Concentrate (soybean oil)	43-45 fl oz/100 gal water	-	-	?	25(b) pesticide.
PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97)	1-2 lb/acre	-	4	?	

Table 7.6.10 Pesticides Labeled for Management of Aphids

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Preferal (Isaria fumosorosea Apopka str. 97)	14-28 oz/100 gal water	-	4	?	For high tunnel use only.
PureSpray Green (white mineral oil)	Dilute: 0.75-1.5 gal/100 gal water. Concentrate: 1.5-3 gals/A	UDH	4	?	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	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	?	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.
Safer Brand #567 II (potassium laurate, pyrethrins)	6.4 oz/gal water applied at 1 gal mix/ 700 sq ft	Until Dry	12	?	Apply one gallon of mixed spray per 700 sq. ft. of plant surface area.
Sil-Matrix (potassium silicate)	0.5-1% 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	?	Mix 1-4 qts in 100 gallons of water and apply at 50-250 gallons finished spray/acre.
SuffOil-X (mineral oil)	1-2 gal/100 gal water	UDH	4	?	Do not use in combination with or immediately before or after spraying with fungicides containing sulfur.
TerraNeem EC (cold pressed neem oil)	0.5-1.5% solution	0	4	?	See label for specific volumes of water to use. Do not apply sulfur or sulfur-containing products within 14 days of treatment.
Trilogy (neem oil)	1% solution	UDH	4	?	Maximum labeled use of 2 gal/acre/application. Do not apply while bees are actively visiting.
TriTek (mineral oil)	1-2 gal/100 gal water	UDH	4	?	Do not use in combination with or immediately before or after spraying with fungicides containing sulfur.
Venerate XC (Burkholderia spp. str A396)	1-4 qt/acre	0	4	?	Suppression only.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 Other Insects of Concern

Many insects found in raspberry and blackberry plantings of New York, while having the capacity to cause economic damage, may 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 POTATO LEAFHOPPER *(Empoasca fabae)*

Damage from the potato leafhopper occurs throughout eastern North America and may reduce plant growth. Adults and nymphs feed along the veins on the undersides of leaves. Upper leaves curl upwards and margins of affected leaves develop a light yellow color. Adults are bright green and about $^1/_8$ inch long while nymphs are smaller and light green. Adults migrate into New York State in early to mid-June. Avoid proximity to alfalfa plantings, which provide a major source of potato leafhopper population build-up.

Potato Leafhopper Management Options	
Scouting/thresholds	None established.

Potato Leafhopper Management Options	
Variety susceptibility	No resistant varieties known. 'Polka' and 'Jaclyn' appear to be particularly sensitive.
Cultural management	None established.
Chemical Treatment	See below.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the 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 Potato Leafhopper

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.
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	1	
AzaGuard (azadirachtin)	10-16 fl oz/acre	0	4	?	
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	1	See container label for specific rates used.
BioLink Insect & Bird Repellant (garlic juice)	0.5-4 qt/acre	1/2	-	?	25(b) pesticide.
BioRepel (garlic oil)	1 part BioRepel to 100 parts water	-	-	?	25(b) pesticide.
Captiva Prime (garlic oil, capsicum oleoresin extract, canola oil)	1-2 pt/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.
DES-X (insecticidal soap)	2% formulation sprayed at 75-200 gallons/acre	1/2	12	?	
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	?	25(b) pesticide.
Ecotrol Plus (rosemary oil, peppermint oil, geraniol)	1-3 pts/acre	0	-	?	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.
KOPA Insecticidal Soap (potassium salts of fatty acids)	2 gal/100 gal water	1/2	12	?	
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	2	Works by contact. Good coverage is important.
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.
Neemix 4.5 (azadirachtin)	7-16 fl oz/acre	0	4	?	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	1	Short residual activity may require multiple applications. Caution: do not

Table 7.7.1 Pesticides Labeled for Management of Potato Leafhopper

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
					use when bees are active in the planting.
PyGanic EC 5.0 II (pyrethrins)	4.5-15.6 fl oz/acre	0	12	1	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.
Safer Brand #567 II (potassium laurate, pyrethrins)	6.4 oz/gal water applied at 1 gal mix/ 700 sq ft	Until Dry	12	?	Apply one gallon of mixed spray per 700 sq. ft. of plant surface area.
Surround WP (kaolin clay)	20-50 lb/acre	UDH	4	?	Suppression only. Only use before 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. Do not apply sulfur or sulfur-containing products within 14 days of treatment.

*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 TREE CRICKET *(Oecanthus sp.)*

The tree cricket is a greenish-white, slender-bodied insect with dark antennae that are usually longer than its body. During the summer, both nymphs and adults can be found on bramble canes. In late summer, adults lay eggs in the canes, leaving long rows of punctures and greatly weakening the cane above.

Tree Cricket Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known.
Cultural management	Remove and burn infested canes. Eliminate old fruiting canes and wild brambles from the immediate area.
Chemical Treatment	Insecticides may be applied from late August to mid-September.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the NYSDEC Bureau of Pesticides Management – Information Portal. ALWAYS CHECK WITH YOUR CERTIFIER before using a new product.

Table 7.7.2 Pesticides Labeled for Management of Tree Cricket

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.
DEsect CROP (silicon dioxide)	1 lb/1000 sq ft	-	12	?	
Garlic Barrier AG+ (garlic juice)	1 gal/99 gal water	-	-	?	25(b) pesticide. Repellent.
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	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	?	Short residual activity may require multiple applications. 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.

7.7.3 BROWN MARMORATED STINK BUG *(Halymorpha halys)*

Raspberries and blackberries may be particularly vulnerable compared to other crops. Adult stink bugs are about 1.5 cm in length and brown in color, resembling other species of native stink bugs. Antennae have characteristic light-colored bands and the rear edge of the abdomen has light and dark banding. Immatures (nymphs) vary in color depending on stage, but have white bands on legs and red eyes. Adult and immature bugs feed on developing and ripe fruit, causing tissue scaring and off flavors. They can be very numerous and although they do not bite, they can release an unpleasant odor.

Brown Marmorated Stink Bug Management Options	
Scouting/thresholds	Visual scouting for adult and immature bugs on fruit is currently the best approach. Thresholds not established.
Variety susceptibility	No resistant varieties known.
Cultural management	None known.
Chemical Treatment	See below.

At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in USEPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the 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 Brown Marmorated Stink Bug

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
Aza-Direct (azadirachtin)	1-2 pts/acre	0	4	?	
AzaGuard (azadirachtin)	10-16 fl oz/acre	0	4	?	
*AzaSol (azadirachtin)	6 oz/acre	0	4	?	
Azera (azadirachtin, pyrethrins)	1-3.5 pts/acre	0	12	1	See container label for specific rates used.
BioCeres WP (Beauveria bassiana strain ANT-03)	1-2 lb/acre	0	4	?	
Captiva Prime (garlic oil, capsicum oleoresin extract, canola oil)	1-2 pt/acre	0	4	?	
DES-X (insecticidal soap)	2% formulation sprayed at 75-200 gallons/acre	1/2	12	?	
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.
KOPA Insecticidal Soap (potassium salts of fatty acids)	2 gal/100 gal water	1/2	12	?	
Molt-X (azadirachtin)	10 oz/acre	0	4	?	Plus 0.25 to 1.0% non-phytotoxic crop oil.
Mycotrol ESO (Beauvaria bassiana)	0.25-1 qt/acre	0	4	?	
Neemix 4.5 (azadirachtin)	7-16 fl oz/acre	0	4	?	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	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	?	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.

Table 7.7.3 Pesticides Labeled for Management of Brown Marmorated Stink Bug					
Trade Name (active ingredient)	**Product Rate**	**PHI (Days)**	**REI (Hours)**	**Efficacy[1]**	**Comments**
TerraNeem EC (cold pressed neem oil)	0.5-1.5% solution	0	4	?	See label for specific volumes of water to use. Do not apply sulfur or sulfur-containing products within 14 days of treatment.
Venerate XC (Burkholderia spp. str A396)	1-4 qt/acre	0	4	?	Suppression only. 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.

7.7.4 YELLOW JACKETS AND HORNETS *(Vespa sp.)*

During droughty conditions in the late summer and fall ripe and over-ripe fruit become very attractive to yellow jackets and hornets (various species) as a source of moisture and sugar. Damaged fruit is particularly attractive, although adults have chewing mouthparts and can make their own holes.

For more information on managing these pests see: see *Wasp and Bee Management, A Common Sense Approach* (2011) by Jody Gangloff-Kaufman.

Yellow Jacket and Hornet Management Options	
Scouting/thresholds	None established.
Variety susceptibility	No resistant varieties known.
Cultural management	Avoid accumulation of over-ripe or injured berries. Removal of nests in the surrounding area may be helpful. Traps with attractive baits have been partially successful in reducing numbers.
Chemical Treatment	As a general rule, insecticides to control wasps and hornets in the crop are not very effective and may interfere with harvest.

7.7.5 BLACKBERRY PSYLLID *(Trioza tripunctata)*

Early season curling and stunting of shoots and leaves of thornless and thorny blackberries: curled leaves are often darker green in color as compared to normal ones. Flower buds and fruiting spurs may also be stunted. Psyllid damage is often mistaken for a plant disease since the curling continues for some time after the adult insects are gone. Damage occurs only when blackberries are grown in close proximity to conifers, which serve as an overwintering site for adults. Adults move from conifers to blackberries in mid-May for egg-laying; leaf curling becomes visible 7-10 day later. Nymphs may cause continuing symptoms on infested plants.

Blackberry Pysllid Management Options	
Scouting/thresholds	None established; the feeding of just one adult psyllid is sufficient to initiate cane stunting and leaf curl.
Variety susceptibility	No resistant cultivars known.
Cultural management	Avoid sites within 250 yards of conifer plantings (*Pinus* spp, *Juniperus* spp, *Picea* spp).
Chemical Treatment	See below.

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Table 7.7.5 Pesticides Labeled for Management of Blackberry Psyllid					
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 7.7.5 Pesticides Labeled for Management of Blackberry Psyllid

Trade Name (active ingredient)	Product Rate	PHI (Days)	REI (Hours)	Efficacy[1]	Comments
*AzaSol (azadirachtin)	6 oz/acre	0	4	?	Spray for "new" instar nymphs appearing on new discolored foliage.
Ecotec Plus (rosemary oil, peppermint oil, geraniol)	1-4 pt/100 gal water	0	-	?	25(b) pesticide.
Oleotrol-I Bio-Insecticide Concentrate (soybean oil)	43-45 fl oz/100 gal water	-	-	?	25(b) pesticide.
PFR-97 20% WDG (Isaria fumosorosea Apopka str. 97)	1-2 lb/acre	-	4	?	
PyGanic EC 1.4 II (pyrethrins)	16 fl oz/acre	Until Dry	12	?	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	?	Short residual activity may require multiple applications. Caution: do not use when bees are active in the planting.
Safer Brand #567 II (potassium laurate, pyrethrins)	6.4 oz/gal water applied at 1 gal mix/ 700 sq ft	Until Dry	12	?	Apply one gallon of mixed spray per 700 sq. ft. of plant surface area.
Surround WP (kaolin clay)	20-50 lb/acre	UDH	4	?	Suppression only. Only use before 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.

7.8 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 raspberries and other small fruits.

Various rodents can damage a raspberry or blackberry planting, especially as they feed under mulch in the winter. Closely mowing the area around the planting 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.

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*.
Mice and voles	Removal of dropped fruit; habitat manipulations including elimination of unmowable areas surrounding plantings; monitor to determine the need for management. Mow closely in late fall around the planting and apply winter mulch only after mowing. Population control through trapping by landowner.
Raccoons	Avoid sites with woods along the edge(s) because these will support raccoon populations. Electrified exclusion fencing. Population reduction through shooting by licensed hunters or landowners in appropriate seasons; through trapping by landowner, by licensed trapper, or by licensed nuisance wildlife control agent.

Table 7.8.1 Vertebrate Damage Mitigation Practices

Animal Pest	Management Practices[1]
Red and gray foxes	Tend to chew on irrigation lines. Manipulation including elimination of protective cover around plantings. Population reduction through shooting by licensed hunters or landowners in appropriate seasons; through trapping by landowner, by licensed trapper, or by licensed nuisance wildlife control agent.
White-tailed deer	Exclusion fencing (8 ft. [250 cm] high-tensile woven wire or 5 to 6 ft. [150 to 200 cm] electric exclusion fencing; peanut-butter baited electric fences; invisible fencing with dogs); habitat manipulation including elimination of protective cover around plantings. Population reduction through shooting by licensed hunters, landowners or their agents with DMAP or Deer Damage Permits. Unlike some other vertebrate pests, landowners cannot kill nuisance deer without a permit.
Woodchucks	Exclusion fencing (electrified exclusion fencing); habitat manipulation including removal of brush piles. Population reduction through shooting by licensed hunters or landowners; through trapping by landowner or by licensed nuisance wildlife control agent.

[*] 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.

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. Deer Damage Permits (DDPs; for taking deer outside of hunting season), or Deer Management Assistance Program Permits (DMAPs; taking deer during open hunting seasons) for shooting of deer causing substantial damage may be available to reduce the population in some areas. Contact your regional Department of Environmental Conservation wildlife office for technical advice and a permit application.

When using dogs and invisible fence to manage vertebrate pests in a planting, there is food safety risk associated with the dog excrement. If the dog consistently excretes in an area away from the field, or keeps other vertebrate animals from using the field, the food safety risk is somewhat reduced. 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.

7.9 Considerations During 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. For more information see *Wasp and Bee Management, A Common Sense Approach* (2011) by Jody Gangloff-Kaufman.

During harvest much can be done to reduce disease and insect pressure by eliminating infested and infected fruit from the planting. Separate damaged fruit from healthy fruit as it is being picked. Designate pickers to cull such fruit from the field at harvest time. Then bury or burn the diseased and infested fruit. This is helpful to combat gray mold and spotted-wing drosophila (through the removal of overripe or infested fruit).

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 (be sure to sanitize this table after use, see Section 8). All culled fruit should be destroyed by burning or burying. Cleanliness or sanitation in the planting is very important, removing dropped berries during harvest will reduce risk from gray mold and spotted-wing drosophila, as described above. At this time also make note of trouble spots in the field, or the presence of unthrifty plants, foliar diseases, leaf damage, etc. and plan steps to maintain a healthy planting. After harvest do a thorough job of pruning canes, chopping mulch, and removing infected and infested plant parts.

Keep in mind your production goals and recognize that it should be possible to obtain good yields in organic raspberry and blackberry production. Maintain good records of the planting condition and pest pressure, amount harvested, and know the market demands.

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 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 food safety 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 raspberries and blackberries, 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 BSAAOs 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.

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.

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.

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 (DEC) 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	-

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]**
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 Raspberry and Blackberry 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 Raspberry and Blackberry 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's 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.

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
Badge X2	copper hydroxide, copper oxychloride	80289-12
Basic Copper 53	basic copper sulfate	45002-8
Bio-Tam 2.0	trichoderma asperellum str ICC 012, Trichoderma gamsii str ICC 080	80289-9
BotryStop	Ulocladium oudemansii (U3 Strain)	75747-2-68539
*Brandt Lime Sulfur	calcium polysulfide	61842-30-48813
Carb-o-nator	potassium bicarbonate	70051-117
Champ WG	copper hydroxide	55146-1
ChampION++	copper hydroxide	55146-115
Cinnerate	cinnamon oil	25(b) pesticide
Companion Biological Fungicide	Bacillus amyloliquefaciens	87645-4-94485
Companion Maxx Biological Fungicide	Bacillus amyloliquefaciens ENV503	94485-4
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
Glacial Spray Fluid	mineral oil	34704-849

Table 10.1 Fungicides and Bactericides

Product Name	Active Ingredient	EPA Reg. No.
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
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
Nordox 75 WG	cuprous oxide	48142-4
Nu-Cop 50 WP	copper hydroxide	45002-7
Nu-Cop 50DF	copper hydroxide	45002-4
Nu-Cop HB	copper hydroxide	42750-132
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
Oxidate 2.0	hydrogen dioxide, peroxyacetic acid	70299-12
Oxidate 5.0	hydrogen peroxide, peroxyacetic acid	70299-28
PerCarb	sodium carbonate peroxyhydrate	70299-15
PERpose Plus	hydrogen peroxide	68539-15
Promax	thyme oil	25(b) pesticide
PureSpray Green	white mineral oil	69526-9
Regalia	Reynoutria sachalinensis	84059-3
Regalia CG	Reynoutria sachalinensis	84059-3
Romeo	Saccharomyces cerevisiae	91810-2
RootShield PLUS+ Granules	Trichoderma harzianum, Trichoderma virens	68539-10
RootShield PLUS+ WP	Trichoderma harzianum Rifai T-22, Trichoderma virens str G-41	68539-9
RootShield WP	Trichoderma harzianum	68539-7
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

Table 10.1 Fungicides and Bactericides

Product Name	Active Ingredient	EPA Reg. No.
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
Tenet WP	Trichoderma asperellum str ICC 012, Trichoderma gamsii str ICC 080	80289-9
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
TriTek	mineral oil	48813-1
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 12.2 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
BioCeres WP	Beauveria bassiana strain ANT-03	89600-2
BioLink Insect & Bird Repellant	garlic juice	25(b) pesticide
BioRepel	garlic oil	25(b) pesticide
Captiva Prime	garlic oil, capsicum oleoresin extract, canola oil	10163-336
Cinnerate	cinnamon oil	25(b) pesticide
Damoil	mineral oil	19713-123
DEsect CROP	silicon dioxide	7655-1
DES-X	insecticidal soap	67702-22-70051
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
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
GC-Mite	garlic oil, clove oil, cottonseed oil	25(b) pesticide

Table 12.2 Insecticides and Miticides

Product Name	Active Ingredient	EPA Reg. No.
Grandevo CG	Chromobacterium subtsugae str. PRAA4-1	84059-27
Grandevo WDG	Chromobacterium subtsugae str. PRAA4-1	84059-27
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
Nuke Em	citric acid	25(b) pesticide
Oleotrol-I Bio-Insecticide Concentrate	soybean oil	25(b) pesticide
PFR-97 20% WDG	Isaria fumosorosea Apopka str. 97	70051-19
Preferal	Isaria fumosorosea Apopka str. 97	70051-19-67690
PureSpray Green	white mineral oil	69526-9
PyGanic EC 1.4 II	pyrethrins	1021-1771
PyGanic EC 5.0 II	pyrethrins	1021-1772
Safer Brand #567 II	potassium laurate, pyrethrins	59913-9
Sil-Matrix	potassium silicate	82100-1
Sil-Matrix LC	potassium silicate	70051-127
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
TriTek	mineral oil	48813-1
Venerate XC	Burkholderia spp. str A396	84059-14

*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 Raspberry and Blackberry 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.

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12. GLOSSARY

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

Adjuvant – any substance added to the spray tank or combined in a pesticide formulation that helps improve the performance of a pesticide.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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