Crop Profile: Red Raspberries in New York

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I. Profile Prepared by:

Eric Harrington/George Good
PMEP
Cornell University
Ithaca, NY 14853
607-255-1866

II. Basic Commodity Information

State Rank: ..... NA
% U.S. Production: ..... NA
Acres of Bearing Age: 450
Acres Harvested:..... 450 (1.1 million pounds)
Cash Value:..... $2,250,000
Yearly Production Costs:..... $4,500
Production Regions: Statewide
Production Methods: In New York, both summer-bearing and fall-fruiting red raspberries are grown. For summer-bearing berries, the root system is perennial and plants are capable of living for several years. Their growth habit is to produce vegetative primocanes the first year, that then become flowering and fruiting floricanes the second year, which then die. Each established field will contain both primocanes and floricanes at the same time. Under ideal soil conditions and good cultural maintenance, a planting may remain productive for 10 or more years.

Fall-fruiting or "everbearing" red raspberries produce fruits on the growing tips of primocanes. When the primocanes reach a certain number of nodes of growth, the apical meristem (growing tissue at the tip of the cane) changes from a vegetative to a reproductive state. Flower bud initiation continues from the top to the bottom of the cane.

A raspberry field is established by planting certified, nursery grown rootstock. Plants are set 30 inches apart within rows, 9 to 10 feet between rows, and 1 inch deeper than they were grown in the nursery. The first year planting produces vegetative canes only (primocanes). In the fall, these primocanes are trained to a single trellis wire about 5 ft. from the ground. In mid-summer of the following season, these overwintering canes (now called floricanes) will flower and produce fruit. A new flush of primocanes begins to emerge from the root crown area every spring beginning in late March. Floricanes are cut out each fall after harvest, and the remaining primocanes are tied to the trellis wire.

In New York, the majority of raspberries go for fresh market. A small percentage goes to wineries or for juice. Growers receive between 3 and 4 dollars per pound for fresh market berries. Raspberries do not keep well on the plant and must be harvested every two or three days.

Raspberries require irrigation during the bloom, harvest, and post-harvest periods in most years depending on rainfall amounts and timing. Most fields are irrigated with trickle irrigation. Drip tubes, tricklers, or emitters drip water continuously or intermittently into the root zone around the plant so that the plant receives as much water as it can use, but no more. Interrow spaces remain firm and dry, and the root zone remains moist at all times.

Weed control between the rows is accomplished largely by routine cultivation during the growing season. Weed control within the rows is accomplished using pre-emergent herbicides usually applied in the spring and contact herbicides as needed.
Cultural Practices: Floricanes, cut from the trellis after harvest, are chopped and disced back into the soil. This practice adds organic matter and helps reduce cane disease inoculum, by subjecting the overwintering stages of cane diseases to microbial breakdown in the soil. Planting into elevated ridges is becoming quite widely practiced as a cultural method to reduce infection from Phytophthora and other root rotting organisms. Insect control prior to harvest is critical in order to avoid contamination of fruit by a myriad of pest and non-pest arthropods which inhabit the raspberry canopy. Fungicides are applied during the bloom period to control cane and foliar diseases and help prevent Botrytis fruit infection and subsequent fruit rot during harvest.
Cultivars: Bramble canes are usually vegetative during the first growing season, when they are called primocanes. However, flower buds are formed along the primocane and its branches during the first season. Some cultivars may flower lightly on the tops of primocanes, and then complete flowering the following spring. These cultivars are called primocane-fruiting or fall-fruiting. In their second year, flowering canes are called floricanes. Cultivars which flower and fruit only on the second year canes are called floricane-fruiting or summer-fruiting. Fall-bearing cultivar varieties of raspberries are very important to New York's production.
Commodity Destination(s):

Fresh Market..... 90%
Processing..... 10%

III. Pest Information: Insects

1. Cane Borers

Biology: Raspberry Cane Borer: This beetle is slender, about 1/2 inch long, and black, except for a bright orange thorax that has two or three black spots. The long, black antennae are easily noticed.

These insects require two years to complete their life cycle. The adults appear in raspberry plantings in early June and may be present until late August. They feed on the tender, green epidermis of cane tips and leave brownish patches or scars. Before laying an egg, the female punctures the stem with hermouthparts in a girdling fashion. She creates two puncture rings around the cane, about 1/2 inch apart and about 6 inches from the cane tip or lateral shoot. After puncturing, the female deposits an egg into the cane pitch in between the rings.

Upon hatching, larvae burrow down through the cane, reaching its base by the fall and down to the crown by the next summer. The larvae spend the next season underground, then pupation occurs the second spring, generally in an old stub from which adults emerge.

Biology: Flat-headed Cane Borers: These two species of borers burrow through the canes of raspberries, blackberries, and dewberries. Agrilus ruficollis, the red-necked cane borer, has a reddish-colored thorax that contrasts sharply with its black head and wing covers. A. rubicola, the bronze cane-borer, is similar except for its iridescent bronze or copper color. Adults of A.ruficollis are about 1/4-inch long, while A. rubicola may be much smaller.

The life cycles of the two species are nearly identical. Adults are present from late May to early August. They feed along leaf edges and can be most easily found on sunny days. Females deposit whitish, scale-like eggs along the bark of new growth in May and June. After hatching, the larvae construct long, winding tunnels which spiral around the cane several times in the sapwood, turn into the hardwood, and then end in the pith. A swelling usually develops where the tunneling occurs and is apparent by July or August. Once the tunnel reaches the pith, it straightens into a path through the pith. The larva is full-grown by fall, remains in the tunnel during the winter, and pupates in the spring. Adults emerge in the summer.

Symptoms: A number of borers burrow through the canes of brambles; their presence may be indicated by a generally symmetrical swelling in the cane, from 11/4 to 3 inches long and usually a few inches, but as much as 4 feet, above the ground. 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. Adults are active from June through August.

Control: As a preventive 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 and the damaged tissue destroyed.Methoxychlor is registered for control of red-necked cane borer. An insecticidal spray against the adult beetles is generally applied late preboom for summer-bearing types or when primocanes are 18 inches tall.

2. Japanese Beetles

Biology: Adults are about 1/2 inch long and shiny metallic green. They emerge frompupal chambers in the soil from June to September and feed on ripe bramble fruit, in addition to hundreds of other kinds of plants. Eggs are laid on the ground, particularly in acidic soil. After hatching, the larvae feed on roots of grasses and other plants. The winter is spent as partially grown larvae. Growth and feeding continues in the spring. Pupation begins in June, with adult emergence following later in the month.

Symptoms: 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 can cause significant leaf damage which appears as skeletonization.

Control: A chemical spray may be needed at late prebloom, just before the blossoms open or when primocanes of fall-bearing varieties are 18 inches long. Japanese beetles prefer Festival, Ruby, Heritage, Reveille, Liberty, Latham, Newburgh, Southland, Durham, Fallgold, and Skeena over other cultivars.

3. Potato Leafhopper

Biology: Leafhoppers are approximately 1/8 inch long, green and bullet-shaped insects that take flight quickly if disturbed. Their nymphs are light green, do not fly and move sideways when disturbed.

Symptoms: They feed mostly on the undersides of leaves. This feeding causes the upper leaves to curl upwards and growth is reduced.

Control: Apply carbaryl as insects appear.

4. Raspberry Aphid

Biology: The two aphid pest species of brambles are (1) the large raspberry aphid, Amphorophora agathonica, and (2) the small raspberry aphid, Aphis rubicola. They are both light green to yellow in color. Aphidsoverwinter as eggs and hatch in May. Females, which may be winged or wingless, give birth to live young throughout the summer. A number of generations may be produced. Males are produced in the fall and mate with females to produce theoverwintering eggs.

Symptoms: Aphids are most important to bramble growers as transmitters of viral diseases, particularly in nurseries. Raspberry mosaic virus is transmitted by the large raspberry aphid, and raspberry leaf curl virus is transmitted by the small raspberry aphid.

Control: All infected plantings must be removed and destroyed. New planting stock should be aphid-resistant cultivars that are certified virus-free. Also, a distance of at least 500-1000 feet should be kept between new plantings and virus-infected plantings. Windbreaks between new plantings and wild brambles may hinder aphid movement. Special sprays can be applied to nursery stock

to control aphids.

5. Raspberry Crown Borer

Biology: The adult is an attractive, clear-winged moth resembling a yellow jacket, with a wingspan of 1-1 1/4 inches, and with bright yellow bands across the abdomen. As with the raspberry cane borer, this insect requires two years to complete its life cycle.

Adults appear in early August and are present through most of September. Females can be seen during the day resting on the foliage where they lay their reddish-brown eggs individually on the undersides of leaves near the edges. After hatching, the larva moves to the cane base where it either excavates a cavity in which to overwinter or finds a protected place in the bark. The next spring, the larva enters the crown and also the roots, but it usually tunnels into a new cane and girdles it before returning to the root tissue. The second winter is spent in the roots. By the second summer, the crown can be extensively damaged. The larva transforms into a pupa by August of the second summer, and the adult emerges shortly thereafter.

Symptoms: The first indication of injury is wilting and dying 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 insects appear in early August and are present during most of September.

Control: During the growing season, destroy dying canes and those showing evidence of infestation. Eradicate wild brambles in the area, because they may harbor the pest. No pesticides are labeled for control of crown borer in New York.

6. Raspberry Fruitworm, Raspberry Sawfly

Biology: Raspberry Fruitworm: The fruitworm adult is a small, somewhat hairy, light brown beetle, about 1/8 inch long. Adults emerge in late April to early May from overwintered pupae in the soil, about the same time as raspberry leaves are unfolding. These beetles can be found along the midribs of leaves on which they feed. They also feed on flower buds and reduce fruit set.

The adult females lay eggs on or near the blossom buds or, later, on the flowers and green berries. After hatching, the larvae enter the blossoms or young fruit where they feed on the fleshy receptacles. The full-grown larva is yellowish-white, 1/4 inch long, and has two transverse (crosswise) rows of stiff hairs. Larvae are full-grown by mid-July, when they fall to the ground and change to pupae, which overwinter in the soil. The adults emerge the following year.

Symptoms: The fruitworm adult is a small, light brown beetle; the full-grown larva is yellowish white and 1/4 inch long. In early May the 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. Fruitworms are most usually a problem in weedy fields.

Biology: Raspberry Sawfly: The adult is a small, black, thick-bodied insect about 1/4 inch long, and appears about the time the leaves begin to unfold in early May. The female has a yellowish-white band across her abdomen. She deposits eggs singly between the upper and lower epidermis of the leaves. Eggs hatch into spiny, many-legged, pale green "worms". When fully grown, the sawfly larva is 1/2 inch long.

Symptoms: Younger larvae usually feed on the outer edges of leaves but they chew irregular holes throughout the leaf as they become older. In heavy infestations, all of the leaf surface is eaten, with the exception of the larger veins. Sawfly larvae may occasionally feed on the new bark, blossom buds, or young fruit.

Control: An insecticide should be applied when the insects or their damage is first noticed in the spring.

7. Sap Beetle

Biology: Adults are about 1/4 inch long and colored black, with four orange-red spots on their wing covers. Overwintered beetles emerge in May from organic matter in sheltered sites, generally after temperatures exceed 60-65F for several days. They feed, mate, and lay eggs in the organic matter. After larval and pupal development is completed, new adult beetles appear from July to September when they feed on the ripening fruits.

Symptoms: The sap beetle is attracted to fruit and any fermenting material. At any time from the start of fruit coloring through harvest, these small beetles may be found feeding on ripe or injured berries. They either feed near the surface or they bore into the fruit where they can be found next to the receptacle.

Control: Although an insecticide can help reduce the incidence of this pest, controlling other damaging insects and promptly harvesting ripe berries are recommended to minimize its occurrence.

8. Tarnished Plant Bug

Biology: Tarnished plant bug adults are about 1/4 inch long, oval, somewhat flattened, and greenish-brown with reddish-brown markings on the wings. A distinguishing characteristic is a small, yellow-tipped triangle on the back, behind the head. Nymphs are pale green when they first hatch and are very small, less than 1/16 inch long. Later nymphal instars (a stage between molts) are successively larger, often brown in color, and have wing pads. Older nymphs have a characteristic pattern of five spots on their back.

Tarnished plant bugs overwinter as adults and become active from late April to mid-May when they lay eggs in crop and weed hosts. After hatching, nymphs feed on flowers and developing fruit. These nymphs molt to the adult stage by early summer, and the cycle is repeated; two to four generations occur annually.

Symptoms: These insects appear when fruit buds form and plants begin to bloom. Their feeding on buds, blossoms, and developing

berries results in deformed fruit.
Control: Tarnished plant bug pressure is often highest in weedy fields or in fields bordered by woody shrubs.

9. Tree Cricket

Biology: The tree cricket is a delicate-looking, greenish-white, slender-bodied insect. It has dark antennae which are usually longer than its body. During the summer, both nymphs and adults can be found on bramble canes. In late summer, females lay eggs in the canes, leaving several small punctures very close together and arranged in rows lengthwise on the cane. There may be only a few punctures or up to 50 in a row. These rows are usually 2-3 inches long and may be anywhere on the cane, but are most common within 2 feet of the tip.
Symptoms: In late summer, adults often lay eggs in the canes, leaving long rows of punctures and greatly weakening the cane above.
Control: Remove and burn infested canes, and eliminate wild brambles from the immediate area. An application of an insecticide in late August to mid-September also may be elected.

10. Twospotted Spider Mite

Biology: These mites vary in color from pale greenish-yellow to dark crimson red. As adults, they usually have two dark spots, one on each side of their bodies. The mites are barely visible to the unaided eye. Adults or late instar nymphs overwinter at the base of brambles or weeds. After moving onto the foliage, the adults lay eggs on the undersides of the leaves, which are the prime feeding areas of young and adult mites. As many as ten generations per year can occur.
Symptoms: Mites feed on the undersides of leaves, which may result in white speckling on the upper leaf surfaces. Later, discolored blotches develop. 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.
Control: No miticides are currently labeled for use; however, sulfur (80% WP) applied according to label directions for powdery mildew will provide some suppression. Predatory mites such as *Amblyseius fallacis* may promote some control of spider mites, especially when released well before spider mite densities reach damaging levels. Predatory mites can be purchased from commercial suppliers.

11. Yellow Jackets

Biology: Yellow jackets are heavy-bodied wasps, black with yellow or white markings, about 1/2 inch long. They live in grey, papery nests located either below ground, or suspended above ground in vegetation. The nests have only a single opening. Nests are dominated by an egg laying queen. The adult female overwinters in isolation and starts a colony in the spring.. A few workers are reared that then provision, build and defend the nest. The queen may not leave the nest again, as her role is to lay eggs. By the end of summer nests may contain hundreds or thousands of workers and this is when they are most troublesome and dangerous.
Symptoms: When local weather conditions are droughty, the adults are attracted to ripe or injured fruit as a source of moisture and sugar. Yellow jackets will feed on the fruit and can be an extreme annoyance to pickers.
Control: Prompt harvesting of ripe berries and "clean" picking practices will help decrease the fruit's attractiveness to the wasps.

Insecticides on Raspberries:

azinphos-methyl (Guthion)

* *Formulations*: Guthion 50WP
* *Target pests*: raspberry aphid
* *Percent crop treated*: 5%
* *Average rate of most common formulation and frequency of application*:
  o Guthion 50WP ‹ 0.5-1.0lb/A, once
* *Preharvest interval*: 14 days
* *Restricted entry interval*: 96 hours
* *Efficacy issues*: NA
* *Rationale for use*: NA

carbaryl (Sevin)

* *Formulations*: Sevin 50WP, 80WSP
* *Target pests*: raspberry fruitworm, raspberry sawfly, tarnished plant bug, Japanese beetle, potato leafhopper, tree cricket
* *Percent crop treated*: 80%
* *Average rate of most common formulations and frequency of application*:
  o Sevin 50WP ‹ 2-4 lbs/A, once
  o Sevin 80WSP ‹ 2-2.25 lbs/A, once
* *Preharvest interval*: 7 days
* *Restricted entry interval*: 12 hours

* *Efficacy issues*: NA
* *Rationale for use*: Cost effective and IPM program component

disulfoton (Di-Syston)

* *Formulations*: Di-Syston 15G
* *Target pests*: raspberry aphid
* *Percent crop treated*: <5%
* *Average rate of most common formulations and frequency of application*:
  o Di-Syston 15G ‹ 53.3 lbs/A, once
* *Preharvest interval*: nursery stock only
* *Restricted entry interval*: 48 hours
* *Efficacy issues*: NA
* *Rationale for use*: NA

malathion (Malathion)

* *Formulations*: Malathion 57 EC, 5EC
* *Target pests*: raspberry fruitworm, raspberry sawfly, Japanese beetle, sap beetle
* *Percent crop treated*: 80%
* *Average rate of most common formulations and frequency of application*:
  o Malathion EC ‹ 1.5-3.0 pts/A, late prebloom through beginning of harvest
* *Preharvest interval*: 1 day
* *Restricted entry interval*: 12 hours
* *Efficacy issues*: NA
* *Rationale for use*: NA

methoxychlor (Methoxychlor)

* *Formulations*: Methoxychlor 50WP
* *Target pests*: tree cricket, cane borer
* *Percent crop treated*: <5%
* *Average rate of most common formulations and frequency of application*:
  o Methoxychlor 50WP ‹ 2-3 lbs/A, late prebloom for cane borer; late August to mid September for tree crickets
* *Preharvest interval*: 14 day
* *Restricted entry interval*: 12 hours
* *Efficacy issues*: growers feel it is poor.
* *Rationale for use*: NA

pyrethrin (various)

* *Formulations*: Pyrethrin 0.5EC
* *Target pests*: raspberry fruitworm, raspberry sawfly, tarnished plant bug, Japanese beetle, sap beetle
* *Percent crop treated*: <5%
* *Average rate of most common formulations and frequency of application*:
  o Pyrethrin 0.5EC ‹ 2-12 oz/A, late prebloom through beginning of harvest
* *Preharvest interval*: 0 days
* *Restricted entry interval*: 12 hours
* *Efficacy issues*: NA
* *Rationale for use*: NA

IV. Pest Information: Diseases

1. Anthracnose

Disease Cycle: The anthracnose fungus overwinters within infection sites that developed during the preceding spring and summer. Spores produced from overwintered infections are spread by splashing rain. The spores germinate and infect young canes when they emerge in the spring. The severity of an infection period is proportional to both the temperature and the number of hours canes remain wet after rain starts.

New spores are produced from new infections. The disease will spread throughout a planting following rainy periods, as long as succulent, susceptible tissue is available. Disease risk is greatest between bud break and the preharvest period since infection appears to attack mainly young, actively growing parts of the plant.

Symptoms: Anthracnose first appears on young canes as small, slightly sunken purple spots. As these spots enlarge, they become oval in shape and turn gray in the center, and develop dark raised borders. The sites continue to sink into the woody portion of the cane, sometimes causing it to crack. Many individual infection sites (about 1/8 inch in diameter) may grow together to form large,

irregularly-shaped diseased regions. On red raspberry canes, individual infection sites are usually much smaller than on black or purple raspberries, and are often only on the surface, not sunken. Many small surface infections may fuse together on primocanes during the late summer or early fall. This produces a graying of the bark, especially on the side most exposed to the sun. Such infections do not directly harm canes, but may provide spores for more serious infections of susceptible bramble types planted close by.

Control: Prune and burn or remove diseased canes before new canes emerge in the spring. Maintain good air circulation by controlling weeds and narrowing fruiting rows. Apply a delayed dormant spray of lime sulfur or copper hydroxide.

2. Botrytis Fruit Rot (Gray Mold)

Disease Cycle: The fungus overwinters in decaying leaves and fruit on the ground and in infected tissue on the cane. Masses of spores are produced during wet or humid periods the following spring and are spread throughout the planting by air currents. Flowers may become infected if they remain wet during bloom, either blighting completely during long rainy periods or having limited, "dormant" infections during more moderate wet periods. These dormant infections may not resume activity until humid weather when they cause ripening fruit to rot. Ripening fruit may also become infected by (1) spores which blow onto them from overwintering infections, (2) spores produced upon recently infected fruit and flowers, or (3) direct contact with rotting berries in the same cluster.

Ultimate disease severity will depend on a combination of factors, including (1) the number of spores present, (2) the number and duration of individual wetting periods, including mists and dews, and (3) the temperature -- upper 60s and 70s are most damaging if accompanied by wetness. The tremendous number of spores produced upon each infected fruit can cause an epidemic "explosion" of this disease if prolonged wet conditions occur during harvest.

Symptoms: Ripening fruit becomes moldy, and some or all of the individual fruitlets are covered with a gray mass of fungus spores.

Control: Maintain good air circulation and apply fungicide sprays when needed. Gray mold can cause extensive crop losses in years when wet weather prevails during the harvest period. Because initial infections often occur during the blossom period, it is recommended that growers apply protective sprays during bloom if the weather is wet. Follow-up sprays before harvest may or may not be necessary to control secondary spread, depending on the weather. Harvesting all ripe fruit promptly and using training practices that promote air circulation around the berries also minimize disease spread. Red raspberries are generally more susceptible than blacks.

3. Cane Blight

Disease Cycle: Spores from fruiting bodies in old infected or dead canes are released during rainy periods, beginning in the spring. The spores are dispersed by wind currents or splashing rain, and they germinate and infect new canes if wound sites are available. New fruiting bodies are produced from these infection sites as the season progresses, providing many more spores for further disease spread.

Additional infections may occur any time during the growing season if wounds are present, and are particularly favored by extended periods of warm, wet weather. The fungus eventually overwinters within the infected canes, then produces new fruiting bodies the following spring, completing the disease cycle. The fruiting bodies produced from overwintering infections can continue to release infective spores for up to four years if the cane debris is not destroyed.

Symptoms: The disease is indicated by weak growth of some or all of the fruiting laterals, followed by wilting of the leaves. Dark brown or purple cankers appear on the main cane or the branches below the wilted branches, often extending several inches along the cane. Cane tissue in the infected region is weak and bends easily. Infection sites are usually associated with pruning wounds or other injuries, although these are not always obvious. Cane blight is more likely than spur blight to involve whole stems and is not as definitely confined to the areas surrounding buds. It is most common on black and purple raspberries because of tipping practices, although red raspberries appear equally susceptible..

Control: Follow the recommendations for anthracnose. Time pruning and tipping operations to allow 4 or 5 days of healing before a rain. If the disease appears on red varieties, determine and try to eliminate the source of injury.

4. Crumbly Berry (Tomato Ringspot Virus)

Disease Cycle: Tomato ringspot virus is spread by the dagger nematode *Xihinema americanum*, a microscopic roundworm that feeds on plant roots. Initial infections result from either setting out infected planting stock or planting clean material in an already infested field. Dagger nematodes in the soil may have picked up the virus from infected weeds or crop plants. The virus has a wide host range including dandelion, chickweed, fruit trees, grapes, etc.

Once plants are infected, the disease spreads from plant to plant at a rate of about 6 feet per year, producing the circular or oblong patches associated with the disease. New pockets of infection may be formed if soil infested with virus-carrying nematodes is distributed to uninfested parts of the field by cultivation.

Symptoms: This disease occurs only on red raspberries. Infected plants appear normal but produce small, crumbly berries that fall apart when picked. Infected plants often occur in circles or groups that expand over time.

Control: Plant only virus-indexed nursery stock. Do not replant sites from which crumbly berry plants have been removed. Analyze new planting sites or suspected problem sites for the dagger nematode, which transmits the virus that causes the disease; if detected, fumigate for its control before planting.

5. Mosaic Virus Complex

Disease Cycle: Spread is almost entirely caused by a single insect, the large raspberry aphid, *Amphorophora agathonica*. The aphid picks up the virus as it feeds on infected raspberries, wild or cultivated, then transmits it to healthy plants as it feeds on them. Spread can be very rapid, with disease incidence increasing from a small percentage to a majority of the planting in a period of just 2-3 years. The activity of the aphid occurs primarily from mid-June through mid-August in New York State.

Symptoms: 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; they are also usually smaller than normal and are frequently deformed or cupped. Leaf symptoms are most apparent in the spring, but become masked by high summer temperatures. On black and purple raspberries, the young shoot tips sometimes die, becoming black and bent. Infected plants are gradually stunted and produce dry, poor-quality fruit.

Control: Plant only nursery stock derived from virus-indexed sources; 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. Isolate new plantings from old raspberries or wild brambles. Do not plant black or susceptible purple raspberries near red raspberries, which may be symptomless virus carriers. Remove and destroy obviously infected plants as they appear. Aggressively control aphids, which spread the disease. Royalty purple raspberry is immune to the aphid that transmits the disease and is not likely to become infected.

6. Orange Rust

Disease Cycle: The orange rust fungi overwinter within infected plants which they colonize systemically (throughout the plant). Thus, new shoots arising from the roots or crowns of plants infected the previous year are already infected. The rust-colored spores produced upon the leaves of these shoots early in the growing season are spread by wind currents. The spores can infect the leaves of healthy plants under the proper environmental conditions. These conditions are not well-defined, but are presumed to be relatively stringent.

On black raspberries, new leaf infections are confined to a small area, but they eventually produce a mass of brown or black spores in late summer or early fall. This second spore type then infects buds on cane tips that are just rooting, or new buds and shoots being formed on the crowns of mature plants. The fungus grows down into the crown and root system. On blackberries, direct infection of healthy young shoots occurs by the rust-colored spores that are liberated in the spring, then the fungus spreads into the below-ground portions of the new plant. In either case, infected shoots that arise the following year produce a new crop of spores, and the cycle continues. Disease spread may also occur through natural root grafting of adjacent infected and healthy plants.

Symptoms: This disease occurs only on black and purple raspberries and blackberries. New canes arising from infected plants in the spring are weak, spindly, and thornless and have misshapen, pale leaves. They usually arise in bunches rather than singly, in contrast with new canes arising from a healthy plant. The lower surfaces of new leaves are covered first with orange pustules and, several weeks after the leaves unfold, with a powdery orange-colored mass of spores.

Control: Do not establish new plantings next to wooded areas or fence rows unless wild brambles are eradicated first. Examine new plants about one month after planting, and check them each succeeding year when new canes are 12 to 18 inches tall. It is important to identify infected plants before infectious spores are discharged from the orange pustules on the undersides of the leaves. Dig up and burn all infected plants immediately, taking care to remove the roots as well. Once infected with orange rust, a plant will never recover; it will just spread the disease to healthy neighboring plants.

7. Phytophthora Root Rot

Disease Cycle: The fungi primarily persist in infected roots or as dormant resting spores in the soil. When the soil is moist, reproductive structures are formed on infected tissue or by germinating resting spores in the soil. Within each structure are many infective spores which are discharged into the soil when it becomes completely saturated with water. These spores then "swim" through the water- filled soil pores using specialized "tails" (Magella), attach themselves to the plant's roots, and begin the infection process.

If water remains standing and oxygen is depleted from the root zone, the plant apparently becomes less capable of resisting the fungus's attempts at invasion. Infection becomes more likely and more severe. Thus, periods of excessive soil moisture effectively serve as infection periods for this disease. Each new infection site can serve as a source of additional infective spores, providing the potential for epidemic disease development in sites that are frequently wet or following a succession of several excessively wet seasons.

Symptoms: Infected plants frequently produce fewer canes, most of which are weak and stunted. Leaves on the canes may be small, turn yellow, or scorch 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 (or) most of the crown appear to be dead. Plants in low or poorly drained sections of a field are frequently infected. This disease has often been misdiagnosed as "wet feet" or winter injury. However, primocane emergence following winter injury is usually vigorous, whereas primocane emergence is poor from plants infected with root rot.

Control: The disease is caused by a group of soilborne fungi that show significant activity only during very wet conditions. Therefore, planting only on well-drained sites and providing good supplemental drainage are the primary components of a control

program. Similarly, recent experience has shown that establishing raspberries on beds raised 8-12 inches high is extremely effective for mintinizing this disease. Avoiding highly susceptible raspberry cultivars and applying specific chemical treatments are two other control measures that are often beneficial on sites where drainage is inadequate during some seasons or periods of the year.

The relative susceptibility of many raspberry cultivars is still uncertain. Black raspberry cultivars are generally least susceptible to this disease. Brandywine and Royalty purple raspberries and Newburgh red raspberry also appear less susceptible than most red raspberries; Latham, Boyne, Killarney, and Nordic red raspberries appear to be the most resistant red or purple cultivars. Among the reds, Festival, Taylor, and Reveille appear to be very susceptible, and Titan, Ruby, and Hilton are extremely susceptible; they should be planted only on very well drained sites.

Mefanoxam (Ridomil Gold), an effective chemical treatment, is recommended where the disease has been diagnosed or is suspected; it is also recommended as a preventive treatment for new Titan plantings on all but the very best soils. Growers should be aware of the limitations of this chemical, however, and realize that it will provide unacceptable results if raspberries are planted in inappropriate (very wet) sites, particularly with the more susceptible cultivars. Fosetyl-Al (Aliette) also is labeled for control of Phytophthora root rot on raspberries. Experience with this chemical in New York is limited; however, results from here and other regions suggest that Aliette is often somewhat less effective than Ridomil on raspberries.

8. Powdery Mildew

Disease Cycle: The fungus overwinters within infected buds near the tips of heavily infected canes. Shoots that emerge from these buds the following spring are infected, and spores produced upon them are distributed by air currents to spread the disease. Repeat cycles of infection can continue throughout the summer. Unlike most fungal diseases, powdery mildew infections do not require periods of wetness in which to develop. However, they are more likely to become severe during humid weather conditions.
Symptoms: Infected leaves are covered with a white powdery growth, usually on their undersides, and may curl upwards. Some cultivars simply develop light green blotches on the leaf surfaces. Infected shoots may be long and spindly and have dwarfed leaves.
Control: Maintain good air circulation around the planting and remove late developing primocanes that may be infected. Fungicidal control is generally not effective or practical. Royalty, Reveille, Latham, and Hilton are susceptible red cultivars; Dundee and Logan are susceptible black cultivars.

9. Raspberry Leaf Spot

Disease Cycle: The fungus overwinters in the inconspicuous cane lesions or infected fallen leaves. Spores produced from these sites are distributed the following spring by air currents and splashing rain, and infect young canes and leaves while they remain wet. Additional spores are produced from these new infection sites, and are distributed by splashing rains throughout the summer, spreading the disease. Only young, growing tissues are susceptible to infection.
Symptoms: Circular brown spots, often less than 1/16 inch in diameter, appear on the leaves in summer. The spots enlarge and coalesce during the season. Defoliation can occur in extreme cases.
Control: Maintain good air circulation in the planting. The delayed dormant spray recommended for control of cane diseases may also provide some benefit. Taylor and Sentry are particularly susceptible; Reveille, Madawaska, Canby, Gatineau, and Boyne are also susceptible. Cultivars exhibiting less susceptibility include Latham, Heritage, September, Fallgold, August Red, Hilton, and Redwing. Black raspberries are generally much less susceptible than reds.

10. Spur Blight

Disease Cycle: Spores produced in fruiting bodies on overwintered canes start the disease cycle the following growing season. These spores escape into the air during rainy periods from mid-spring through early summer. They are carried by air currents to newly emerging canes where they germinate and cause infection if the canes remain wet long enough. A second type of spore is produced within new infection sites during the summer. This type is spread by splashing rain, and can help cause an epidemic spread of disease during excessively wet years.
Symptoms: Chocolate brown or purple blotches centered around 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. The disease is more of a problem on red raspberries than on blacks. Royalty, Titan, Taylor, Canby, Skeena, Matsqui, Willamette, Reveille, and Sentry are particularly susceptible. Brandywine, Killarney, Latham, Madawaska, Festival, Hilton, and Newburgh are less susceptible.
Control: Prune and burn or remove diseased canes before new canes emerge in the spring. Maintain good air circulation by controlling weeds and narrowing fruiting rows. Apply a delayed dormant spray of lime sulfur or copper hydroxide.

11. Verticillium Wilt

Disease Cycle: The fungus persists in the soil in an actively growing state or as dormant resting structures. Infection occurs when roots come in contact with the active fungus or a germinating resting structure. The disease is probably favored by cool, wet spring weather. The fungus can infect through either healthy or wounded roots and root hairs. After initial penetration, the fungus grows into the water-conducting cells of the root (xylem). There, it produces spores that help spread the infection upward into the cane xylem with the normal flow of water. Infected xylem cells develop constrictions and become plugged by the growth of the fungus

within them. Eventually, the flow of water is so restricted that the canes wilt and die. Fungal structures are then returned to the soil as the dead roots decompose and spores become available to infect new plants.
Symptoms: Leaves wilt, turn yellow, and fall off, starting from the bottom of the cane and progressing toward the top. Symptoms frequently appear on only one side of a cane or on only one or two canes out of several in a hill. This disease is much more severe on black raspberries than on reds.
Control: The disease is caused by a soilborne fungus which also attacks a number of other crops, most particularly potato, tomato, eggplant, and pepper. Strawberry, cherry, squash, and cucumber are also common hosts. Before planting raspberries where these crops have been grown, nonhost crops such as wheat or corn should be grown for at least 2 years, or the soil should be treated before planting with a broad-spectrum fumigant such as Vapam or *methyl bromide plus *chloropicrin. Many weeds, particularly nightshade, horse nettle, groundcherry, redroot pigweed, and lambsquarters, are also hosts of the Verticillium fungus. These weeds should be strictly controlled in current and future planting sites to keep the Verticillium population low.

Fungicides on Raspberries:

benomyl (Benlate)
* *Formulations*: Benlate 50WP
* *Target pests*: powdery mildew
* *Percent crop treated*: <5%
* *Average rate of most common formulation and frequency of application*:
  o Benlate 50WP ‹ 12 oz/A
* *Preharvest interval*: 3 days
* *Restricted entry interval*: 24 hours
* *Efficacy issues*: Fair
* *Rationale for use*: Use in a resistance management program

copper hydroxide (various)
* *Formulations*: Blue Shield 50WP, Kocide 61DF, 2.4L, 4.5L, 77WP, Champ 4.6F
* *Target pests*: anthracnose, spur blight, cane blight
* *Percent crop treated*: occasional; potentially 80% if outbreak occurs.
* *Average rate of most common formulation and frequency of application*:
  o Blue Shield 50WP, Kocide 61DF, 77WP ‹ 4 lbs/A, delayed dormant
  o Champ 4.6F ‹ 2.66 pts/A
* *Preharvest interval*: NA
* *Restricted entry interval*: 48 hours
* *Efficacy issues*: NA
* *Rationale for use*: Only registered spray for use in brambles for anthracnose, spur blight, and cane blight control.

fosetyl-Al (Aliette)
* *Formulations*: Aliette 80WP
* *Target pests*: phytophthora root rot
* *Percent crop treated*: occasional; potentially 80% if outbreak occurs.
* *Average rate of most common formulation and frequency of application*:
  o Aliette 80WP ‹ 5 lbs/A
* *Preharvest interval*: 60 days
* *Restricted entry interval*: 12 hours
* *Efficacy issues*: Fair, less effective than Ridomil on raspberries
* *Rationale for use*: Experience with product in NYS is limited

iprodione (Rovral)
* *Formulations*: Rovral 50WP, 4F
* *Target pests*: gray mold
* *Percent crop treated*: 30%
* *Average rate of most common formulation and frequency of application*:
  o Rovral 50WP ‹ 1-2 lbs/A
  o Rovral 4F ‹ 1-2 pts/A
* *Preharvest interval*: 0 days
* *Restricted entry interval*: 12 hours
* *Efficacy issues*: Good control
* *Rationale for use*: NA

lime sulfur (Orthorix)

* *Formulations*: Orthorix, Miller Lime Sulfur
* *Target pests*: anthracnose, spur blight, cane blight
* *Percent crop treated*: 80%
* *Average rate of most common formulation and frequency of application*:
  o Miller ‹ 10-12 gal/100 gal water, delayed dormant
* *Preharvest interval*: Dormant
* *Restricted entry interval*: 48 hours
* *Efficacy issues*: Good control
* *Rationale for use*: NA

mefanoxam (Ridomil Gold)

* *Formulations*: Ridomil Gold 4EC, 2.5GR
* *Target pests*: phytophthora root rot
* *Percent crop treated*: 30-40%
* *Average rate of most common formulation and frequency of application*:
  o Ridomil Gold 4EC ‹ 4 fl oz/1000 ft or row, once in early spring and early fall
  o Ridomil Gold 2.5GR ‹ 5 lbs/1000 ft of row, once in early spring and early fall
* *Preharvest interval*: 45 days
* *Restricted entry interval*: 12 hours
* *Efficacy issues*: Average to good
* *Rationale for use*: NA

sulfur (various)

* *Formulations*: Microthiol 80WP, Thiolux 80WP
* *Target pests*: powdery mildew
* *Percent crop treated*: <5%
* *Average rate of most common formulation and frequency of application*:
  o Microthiol 80WP ‹ 6-15 lbs/A, at first bloom throughout fruit set
  o Thiolux 80WP ‹ 6-15 lbs/A, at first bloom throughout fruit set
* *Preharvest interval*: NA
* *Restricted entry interval*: 24 hours
* *Efficacy issues*: NA
* *Rationale for use*: NA

vinclozolin (Ronilan)

* *Formulations*: Ronilan 50WP, 4L
* *Target pests*: gray mold
* *Percent crop treated*: 80%
* *Average rate of most common formulation and frequency of application*:
  o Ronilan 50WP ‹ 1-2 lbs/A; during bloom if wet weather, follow-up sprays before harvest may be necessary depending on weather.
  o Ronilan 4L ‹ 1-2 pts/A; during bloom if wet weather, follow-up sprays before harvest may be necessary depending on weather.
* *Preharvest interval*: 9 days
* *Restricted entry interval*: 12 hours
* *Efficacy issues*: Good control
* *Rationale for use*: NA

V. Pest Information: Weeds

Mulches (straw and plastic) can be used for weed control in the planting year on sites that are not at risk for Phytophthora, but they are not recommended for mature plantings because they interfere with primocane emergence and increase the risk of Phytophthora.

Cultivation can be used to control weeds, although grassy row middles will minimize weeds within the planting.

Herbicides should be selected on the basis of particular weed problems. Not all herbicides are appropriate for all fields. Purple raspberries are sensitive to high rates of herbicides, as are tissue-cultured plants in the first few weeks after planting.

Herbicides on Raspberries:

Herbicide	Amount of Product per Sprayed Acre Formulation	 lbs active ingredient
PREEMERGENT		
dichlobenil (Casoron)	4G (100 lb)	4
Apply in late fall when the temperature is under 45 F or late winter before basal buds open. For new plantings, apply 4 wks after transplanting and incorporate immediately. Uniform application is essential. Must use a device specifically designed for spreading Casoron, or apply by hand-held shaker. % usage: 30% PHI: NA REI: 12 hours		
napropamide (Devrinol)	50DF (8 lb), 10G (40 lb)	4
Apply in late fall or early spring before seedling weeds emerge. Incorporate within 24 hrs of application with cultivation or water. % usage: <5% PHI: 42 days REI: 12 hours		
norflurazon (Solicam)	80DF (2.5-5 lb)	2-4
Apply as a directed spray from fall to early spring before weeds emerge and when plants are dormant. Make only 1 application per yr. Do not use on plantings less than 12 months old. % usage: <5% PHI: NA REI: 12 hours		
oryzalin (Surflan)	75 WSP (2.5-5.0 lb) A.S. (2-6 qt)	2-4
Apply late fall or early spring before weed emergence. Do not apply to newly transplanted bushes. Not recommended on highly organic soils. One inch of water is required within 21 days of application. May be tank mixed with Gramoxone, Princep or Solicam. % usage: 50% PHI: NA REI: 12 hours		
simazine (Princep)	90WDG (2.2-4.4 lb), 4L (2-4 qt)	2-4
Apply in fall or spring before weed emergence. Use lower rate on plantings less than 6 months old. For quackgrass suppression, apply lower rate in fall and spring, or high rate in fall. Not recommended for use on Royalty or on first-year tissue-cultured plants. % usage: 80-90% PHI: NA REI: 12 hours		

Herbicide	Amount of Product per Sprayed Acre Formulation	 lbs active ingredient
PREEMERGENT (continued)		
terbacil (Sinbar)	80WP (1-2.2 lb)	0.8-1.6
Apply in fall or early spring in at least 20 gal/A. Spray under bushes established 1 year or longer. Spray will burn opened berry leaves. With fall-bearing cultivars, apply only in autumn. % usage: 50% PHI: 70 days REI: 12 hours		
POSTEMERGENT		
fluazifop-butyl (Fusilade)	2L (16-24 oz) +1% crop oil concentrate	0.25-0.375
Apply to actively growing grasses less than 8 inches tall. Do not apply to plants that will be harvested within one year. % usage: <5% PHI: 365 days REI: 12 hours		
glyphosate (Roundup)	4L (1-3 qt)	0.25 – 0.75
For site preparation, may use repeat applications but no more than 8 qts/yr. May use a wiper application in established plantings. Avoid contact with green foliage or canes. % usage: 80-90% PHI: 30 days REI: 12 hours		
*paraquat (Gramoxone)	2.5L (2-3 pt)	0.6 – 0.9
Spray on emerged weeds in 50 gal/A, with added nonionic surfactant. Apply in early spring before new canes emerge. % usage: <5% PHI: NA REI: 12 hours		
pelargonic acid (Scythe)	3-5% soln. for annuals 5-7% soln. for perennials 7 - 10% for maximum burndown	2.25 - 20 gal
To avoid damage to bramble foliage, apply before new canes emerge in spring or after they become woody. Do not contact foliage unless excessive cane growth is to be controlled, then application should be applied when new canes are 4 to 6 inches tall. Use highest rate for primocane suppression. % usage: <5% PHI: 24 hours REI: 24 hours		

Herbicide	Amount of Product per Sprayed Acre Formulation	 lbs active ingredient
POSTEMERGENT (continued)		
sethoxydim (Poast) + 2 pt. Oil concentrate	1.5EC (0.75-2.5 pt) 0.14 – 0.47	

For perennial grasses, apply higher rates in spring when grasses are 6 inches tall. Cultivation between 14 and 21 days after application will aid in control. A second application may be necessary if regrowth occurs. Do not mix with other chemicals. Do not use more than 5 pints per season.

% usage: <50%
PHI: 45 days
REI: 12 hours

* Restricted-use pesticide.

NOTE: Herbicides are usually sprayed in a 3-4 ft band under the plants.

VI. Pest Information: Vertebrates

Bird Control: Damage to fruit by birds is a serious problem in many areas of New York. Visual scare devices such as whirlers, streamers, reflectors, and plastic hawk and owl models are used in combination with sound devices such as exploders, alarms, or recorded devices. For sound devices to be effective, their location and the frequency of sounds are changed daily. They also are in place before the fruit ripens. Some towns have passed ordinances regulating the use of sound devices. The most effective sound devices are those with species-specific bird distress calls programmed into the device.

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

Methyl anthranilate formulations for bird repellency are labelled for use but have not proven to be effective.

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

Deer Control: Deer populations are at an all time high, and they can devastate berry plantings. Multiple strategies are required to discourage deer from feeding on berry plantings. Habitat modifications, reductions in animal numbers, and evaluation of fencing alternatives are some of the methods applied.

VII. State Contacts/Reviewers

Dr. Marvin Pritts
Professor - Pomology
Cornell University
Department of Fruit and Vegetable Science
119 Plant Science Bldg.
Ithaca, NY 14853
607-255-1778
mpp3@cornell.edu

Dr. Wayne Wilcox
Professor - Plant Pathology
Cornell University
New York State Ag. Experiment Station
Geneva, NY 14456
315-787-2335
wfw1@cornell.edu

Dr. Gregory English-Loeb
Assistant Professor - Entomology
Cornell University
New York State Ag. Experiment Station
Geneva, NY 14456
315-787-2345
gme1@cornell.edu

Mr. Kevin Iungerman
Regional Specialist
Saratoga County Cooperative Extension
50 West High Street
Ballston Spa, NY 12020
518-885-8995
kai3@cornell.edu

Mr. Stephen Hoying
Regional Specialist
Cornell Cooperative Extension
Box 217
Alton, NY 14413
315-331-8415
sah19@cornell.edu

New York State Berry Growers' Association
3965 Waverly Rd.
Owego, NY 13827
607-687-2874

VIII. References

1. 2000 Pest Management Guidelines for Small Fruit Crops. 1999. Cornell Cooperative Extension, Cornell University, Ithaca, NY. 71 pp.

2. 1999 Pest Management Recommendations for Small Fruit Crops. 1998. Cornell Cooperative Extension, Cornell University, Ithaca, NY. 56 pp.

3. Bramble Production Guide. Pritts, Marvin and DavidHandley, Eds. 1989. NRAES, Ithaca, NY 14853.

4. The Home Fruit Planting. Information Bulletin 156. Revised Edition. 1989Eames-Sheavly, Marcia and Marvin P.Pritts. Cornell Cooperative Extension, Cornell University, Ithaca, NY. 44 pp.

5. New York Agricultural Statistics.1998-1999. New York Agricultural Statistics Service, New York State Department of Agriculture and Markets, Albany, NY. 104 pp.

6. New York Agricultural News: 1999 Berry Production. January 21, 2000. New York Agricultural Statistics Service, New York State Department of Agriculture and Markets, Albany, NY.

7 The 1997 Census of Agriculture. U.S. Department of Commerce, Bureau of the Census. March 1999.

8. Food and Feed Crops of the United States. Second Edition, Revised. 1998. Markle, G.M., J.J. Baron, and B.A. Schneider. Rutgers University. 517 pp.

9. Crop Profile for Raspberries in Washington.

10. US EPA Worker Protection Standard Product Safety Data Pocket Guide. 1995.

11. 1991, 1993, 1995, 1997 Agricultural Chemical Usage Fruit Summary. National Agricultural Statistics Service.

12. Entomology Notes -- Yellow Jacket Wasps. 1998. DeAngelis, Jack, Extension Entomologist, Oregon State University Extension, Corvallis, OR (www.ent.orst.edu/urban/).

13. New York State Berry Growers' Association.

NA: Information not available
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