

# Crop Profile for Strawberries in New York

Prepared: March 9, 2000

## General Production Information



- **State Rank:** 7
- **% U.S. Production:** NA
- **Acres of Bearing Age:** 1,700
- **Acres Harvested:** 1,600 (7.8 million pounds)
- **Cash Value:** \$8.27 million
- **Yearly Production Costs:** \$5,230
- **Production Regions:** Statewide

## Production Methods

Strawberries can grow in a wide variety of soils. They prefer a soil pH between 5.8-6.5 and produce the best yields on deep, fertile soil with a high organic matter content. Site selection for strawberry production is important because the site should be well drained year-round. June bearing cultivars, with fruit ripening from late May until early June, are the most popular in New York. Most growers use the matted row system where the strawberry plants are placed 12-18 inches apart on raised beds with 36-40 inches between rows. With strawberries, spring frosts are a problem. Overhead irrigation and row covers are used to address the problem.

Weed control is a major concern in strawberry production. New strawberry fields are planted between April 15 and May 15. Immediately after planting, residual herbicides are applied to cultivated soil as pre-emergent weed control. Additional residual and systemic herbicides are used to reduce emerging weeds, mainly perennial weeds in late summer and early fall. After planting, flowers are removed to increase plant growth and runner formation. If the soil contains adequate minor and major elements, applications of 25 to 40 lb./A of actual nitrogen are applied 10 to 14 days after planting and the same amount in August to promote flower bud formation. Irrigation may be used several times during the low rainfall period of July and August. Insecticides, miticides and fungicides may be used for potato leafhopper, mites and/or on cultivars susceptible to leaf diseases, respectively.

In established plantings, a foliar application of nitrogen can be made in the early spring, preceded by an herbicide application in April. Strawberries ripen within 28-30 days after the first bloom and are harvested normally every other day for about 6 to 7 pickings. Strawberry plants will produce more than one season with proper care. Immediately after a harvest ends, the established strawberry field should be

renovated to restore vigor and growth. During renovation it is important to 1) mow off leaves close to the ground so that diseased leaves can be replaced, 2) improve access to sunlight, 3) fertilize [25-40 lbs. of nitrogen/A] for improved berry size, 4) place soil over crown to improve root development, 5) apply herbicides to control weeds. In late summer or early fall, after runners have set, herbicides can be applied and once again before mulching. Mulch is applied to strawberry plants to minimize damage from freezing temperatures usually from November 15-30. The mulch is then removed in early spring followed by a herbicide application.

**Commodity Destination(s):**

Fresh Market - 95%

Processing - 5%

## **Insect Pests**

### **Aphids**

**Biology:** These soft-bodied insects usually occur on new shoots and buds in the crown of the plant and also along the veins on the undersides of the leaves. When present in large numbers, they weaken the plant. Their honeydew promotes the growth of a black sooty mold, which makes the fruit and leaves sticky, hindering harvest and reducing marketability. More important, aphids are vectors for several serious virus diseases.

**Resistant Cultivars:** None known

**Cultural Control Practices:** None

**Chemical Controls:** endosulfan. A spray against aphids can be used just before bloom; however, many pesticides that are effective against aphids are also toxic to predators of cyclamen mites and spider mites.

### **Cyclamen Mite**

**Biology:** This tiny (1/100 inch) mite is pinkish orange and shiny when mature. Its translucent eggs are often so abundant that they appear as a white mass along the midveins of folded, newly emerging leaves. The mites feed on the young leaves in the plant crown; when the leaves emerge, they are stunted, crinkled, and malformed. Blossom feeding later results in misshapen fruit. The mites are most troublesome in strawberry beds that are kept for long periods. They increase in number during bloom and reach a peak during fruit development.

**Resistant Cultivars:** None

**Cultural Control Practices:** Avoidance of infested planting stock.

**Chemical Controls:** endosulfan. Used just before bloom or during bed renovation.

### Leafhoppers

**Biology:** The most common leafhopper on strawberries is the potato leafhopper. 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. They feed mostly on the undersides of strawberry leaves. This feeding causes the leaves to yellow between the veins and become curled and distorted. Most serious damage is done in the late spring and early summer.

**Resistant Cultivars:** None

**Cultural Control Practices:** None

**Chemical Controls:** carbaryl. A broad spectrum insecticide applied when the leafhoppers first appear provides control.

### Leafrollers

**Biology:** Strawberry leafrollers overwinter as fully grown larvae or pupae in folded leaves or leaf litter. Adult moths which are reddish brown and have a distinctive yellow marking on their forewings, emerge in April and May and deposit translucent eggs, usually on the lower surface of strawberry leaves. The eggs hatch in 1-2 weeks into pale green and then grayish brown larvae. As the larvae feed they release silken threads to fold and tie leaves around them. The larvae pupate inside the folded leaves for about one week. The leafrollers undergo 2-3 generations each year. Infestations may develop in spring and early summer, but they may also build up after harvest.

**Resistant Cultivars:** None known

**Cultural Control Practices:** None

**Chemical Controls:** diazinon

### Root Weevils

**Biology:** Different species (but most commonly the strawberry root weevil, the black vine weevil, and the rough strawberry root weevil) attack the roots or crowns of plants while in the grub stage. All have a one-year life cycle, although some are known to live two seasons. Adults emerge about late June. Beds with heavy infestations show distinct patches or spots that appear stunted and have substantially reduced yields. The roots of injured plants are badly eaten away, and continued infestation may completely destroy the plants.

**Resistant Cultivars:** None

**Cultural Control Practices:** None

**Biological Controls:** A biological larvicide (Exhibit) containing parasitic nematodes (*Steinernema carpocapsae*) spot applied to problem areas in late September or early October, and again in late April to early May, when larvae are close to the surface.

**Chemical Controls:** bifenthrin. Spray is targeted against adult weevils. Bifenthrin is a broad spectrum pyrethroid and will kill pest and beneficial arthropods. Frequent use may disrupt biological control of spider mites resulting in mite outbreaks.

### Sap Beetles

**Biology:** Sap beetles make cavities in ripe fruit, spread spores of decay organisms, and deposit eggs in berries. Until a few years ago sap beetles were uncommon in strawberries. Now sap beetles are occasionally found in later ripening strawberry plantings throughout the state. Two species feed on strawberry fruits -- the common picnic beetle, 1/4 inch long with four yellow spots on the back -- and the smaller, brown strawberry sap beetle without distinctive markings.

**Resistant Cultivars:** None known

**Cultural Control Practices:** Keeping the field free of ripe or over-ripe fruit. Early renovation reduces populations for the following year.

**Chemical Controls:** bifenthrin. Bifenthrin is a broad spectrum pyrethroid and will kill pest and beneficial arthropods. Frequent use may disrupt biological control of spider mites resulting in mite outbreaks.

## Slugs

**Biology:** Slugs are soft bodied, slimy, worm-like molluscs. In the spring, slugs emerge from eggs that were laid in the soil in strawberry plantings during the previous fall, preferring fields covered in continuous mulch. They feed on ripening berries leaving deep ragged holes on the surface of the strawberry, especially under the cap. Most of the feeding takes place at night or on dark, overcast days. A tell-tale sign of slug injury is the slime trail left on the surface of the fruit.

**Resistant Cultivars:** None

**Cultural Control Practices:** Eliminating mulch will reduce slug populations, but will cause other problems, so this is not recommended.

**Chemical Controls:** metaldehyde bait. An application in mid-September will reduce egg-laying, while an application prior to fruit ripening will reduce the new generation.

## Spittlebugs

**Biology:** They overwinter as egg masses in strawberry stubble and other hosts such as forage crops. Nymphs will emerge in April and May and complete their development in 5 to 8 weeks. Spittlebugs first feed at the base of plants but later move up to the more tender foliage and blossom clusters during bloom. They pierce the plant and suck on its sap. The soft-bodied nymphs colored from yellow to green will produce a frothy material and remain in this protective substance until developing into adults. The feeding activity causes the plants to become stunted and berries will not attain full size. The spittle mass can also be troublesome to strawberry pickers. Adults spittlebugs will lay their eggs in September and October. The eggs are inserted into the lower parts of the strawberry plant. Only one generation of spittlebugs are produced each year.

**Resistant Cultivars:** None

**Cultural Control Practices:** Populations are usually largest in weedy fields. Only one generation is

produced per year. The leaves recover after the insects leave.

**Chemical Controls:** azinphos-methyl, endosulfan, methoxychlor.

### **Strawberry Bud Weevil (Clipper)**

**Biology:** The beetles overwinter in fence rows and woodlots. Once temperatures reach 60F the clippers move to nearby early budding plants such as strawberries. The adults feed on the immature pollen of the blossom buds and then the females deposit one egg inside the bud. The clipper girdles the bud and clips the stem, causing the bud to hang down or fall to the ground. In about a week, the egg hatches into a white, legless grub. The larva develops inside the bud and reaches maturity in three to four weeks. Adult clippers which are dark, reddish-brown weevils about 1/10-inch long and with a head prolonged into a thin curved snout about half as long as the body, emerge from the buds in late June through July. After feeding on the pollen from various flowers for a short time, the new adults seek hibernating sites and remain until the next spring. Only one generation of clippers appears each year.

**Resistant Cultivars:** None, although Seneca and Jewel strongly compensate for injury.

**Cultural Control Practices:** Mulches and full-canopy beds may encourage newly emerged adults to remain in the planting so that damage increases in succeeding years. Using cropping systems shorter than three years, plowing under all old beds immediately after the final harvest, and removing foliage and mulch to reduce the suitability of overwintering sites help to lessen the chances of clipper injury.

**Chemical Controls:** chlorpyrifos, methoxychlor. Treatment must take place when blossom buds first become visible in the crown and temperatures approach 65° F.

### **Tarnished Plant Bugs**

**Biology:** Adult tarnished plant bugs are 1/4 inch long, brownish in color and marked with yellow and black dashes. They overwinter in vegetation and stubble that provide protection from the extreme cold. In the spring the adults are attracted to flower buds and shoot tips of many plants, including strawberries. The females lay eggs in April and early May in the plant tissue. The nymphs emerge in one week and feed on developing seed during and after bloom or from the receptacle of developing fruit. At the same time, their feeding kills surrounding tissue and leads to small seedy strawberries with a woody texture that fail to mature. This injury is called "button berry" and these fruits are unmarketable. There are several generations of tarnished plant bugs each year, so adults and nymphs can be found from April or May until a heavy frost in the fall.

**Resistant Cultivars:** Honeoye is less susceptible to feeding injury than other cultivars.

**Cultural Control Practices:** Row covers accelerate development and help avoid injury.

**Chemical Controls:** malathion, pyrethrin, naled.

### Two Spotted Spider Mite

**Biology:** This pest is usually not a problem in New York but can cause significant problems when severe infestations occur. The adult mite is only about 1/50 inch in length and its color varies from pale greenish yellow to dark crimson, usually with dark spots. Adults feed and deposit eggs on the underside of the leaf and in a heavy infestation, a tangle of fine, silken threads can be found there. The mites suck sap from the leaves which can cause them to lose their healthy green color and turn coppery-bronze. The life cycle of the mite varies but usually is completed in two weeks. New broods can be produced continuously from early spring to late fall. Mite population increases are more severe in hot, dry weather. The mites overwinter as mature fertile females in protected areas in the fields.

**Resistant Cultivars:** None

**Cultural Control Practices:** Regular leaf monitoring is necessary for assessing population growth.

**Chemical Controls:** dicofol, hexakis. Chemical control of spider mites is often not completely effective because of their high mobility, reproductive rate, and resistance to some pesticides.

### **Chemical Insect Controls:**

#### **azinphos-methyl (Guthion)**

*Percent acres treated:* 5-10%

*Target pests and timing:* Sap beetles and Leafrollers from post-bloom to harvest

*Average rate of most common formulation and frequency of application:*

o Guthion 50WP < 0.80lb/A, once

*Preharvest interval:* 5 days

*Restricted entry interval:* 96 hours

*Efficacy rating:* Good to Very Good

*Rationale for Use:* Important component in IPM program & only acceptable alternative

## **bifenthrin (Brigade)**

*Percent acres treated:* NA; new material

*Target pests and timing:* Sap beetles and rootweevils, fruit set through harvest

*Average rate of most common formulation and frequency of application:*

o Brigade WSB < 6.4-32 oz/A

*Preharvest interval:* 0 days

*Restricted entry interval:* 24 hours

*Efficacy rating:* NA

*Rationale for Use:* NA

## **carbaryl (Sevin)**

*Percent acres treated:* <5%

*Target pests and timing:* Spittlebug in early Spring

*Average rate of most common formulations and frequency of application:*

o Sevin 50WP < 1.6 qt/A, once

o Sevin 80WSP < 1.5 lbs/A, once

*Preharvest interval:* 1 day

*Restricted entry interval:* 12 hours

*Efficacy rating:* NA

*Rational for Use:* Cost effective and IPM program component

## **chlorpyrifos (Lorsban)**

*Percent of acres treated:* 80%

*Target pests and timing:* Clippers and other root weevils in early Spring

*Average rate of most common formulation and frequency of application:*

o Lorsban 4EC < 1.5 pts/A, once

*Preharvest interval:* 21 days

*Restricted entry interval:* 24 hours

*Efficacy rating:* Good to Very Good

*Rational for Use:* NA

## **diazinon (Diazinon)**

*Percent of acres treated:* <5%

*Target pests and timing:* Leafrollers

*Average rate of most common formulation and frequency of application:*

o Diazinon 50WP < 1.5 pts/A, once

*Preharvest interval:* 5 days

*Restricted entry interval:* 24 hours

*Efficacy rating: Good to Very Good*

*Rational for Use: NA*

### **dicofol (Kelthane)**

*Percent of acres treated: 80%*

*Target pests and timing: Twospotted spider mite*

*Average rate of most common formulation and frequency of application:*

o Kelthane 35WP < 1-3 lb/A

o Kelthane 50WP < 0.5-1 lb/A

o Kelthane MF < 1.6-2 pts/A

*Preharvest interval: 2 days*

*Restricted entry interval: 12 hours*

*Efficacy rating: NA*

*Rational for Use: NA*

### **endosulfan (Thiodan)**

*Percent acres treated: 85%*

*Target pests and timing: Spittlebug and Tarnished Plant Bug in early Spring and post-bloom to harvest*

*Average rate of most common formulations and frequency of application:*

o Thiodan 50WP - 1.5lbs/A, once

o Thiodan 3EC < 1.85 pts/A, once

*Preharvest interval: 4 days*

*Restricted entry interval: 24 hours*

*Efficacy rating: Good to Very Good*

*Rational for Use: Important component in IPM program & only acceptable alternative*

### **hexakis (Vendex)**

*Percent acres treated: 15-20%; occasional use, more so on Long Island*

*Target pests and timing: Twospotted Spider Mite*

*Average rate of most common formulations and frequency of application:*

o Vendex 4L < 1.5-2 pts/A, after planting (first growing season)

*Preharvest interval: 1 day*

*Restricted entry interval: 48 hours*

*Efficacy rating: NA*

*Rational for Use: NA*

### **malathion (Malathion)**

*Percent acres treated: 90%*

*Target pests and timing: Tarnished Plant bug*

*Average rate of most common formulations and frequency of application:*

o Malathion 57EC <1.5-2 pts/A, prebloom and fruit set through harvest

o Malathion 5EC <1.5-2 pts/A, prebloom and fruit set through harvest

*Preharvest interval: 3 days*

*Restricted entry interval: 12 hours*

*Efficacy rating: NA*

*Rational for Use: NA*

## **metaldehyde (Deadline)**

*Percent acres treated: 10-20%*

*Target pests and timing: Slugs from post-bloom to harvest*

*Average rate of most common formulation and frequency of application:*

o Deadline 40 < 14 lbs/A, once

o Deadline Bullet < 14 lbs/A, once

*Preharvest interval: NA*

*Restricted entry interval: 12 hours*

*Efficacy rating: Good*

*Rational for Use: NA*

## **methoxychlor (Marlate)**

*Percent acres treated: <5%*

*Target pests and timing: Twospotted Spider Mite, Spittle Bug, and Bud Weevil*

*Average rate of most common formulation and frequency of application:*

o Methoxychlor 50WP < 2-3 lbs/A

*Preharvest interval: 14 days*

*Restricted entry interval: 12 hours*

*Efficacy rating: growers feel it is poor.*

*Rational for Use: NA*

## **mineral oil (various)**

*Percent acres treated: <5%*

*Target pests and timing: Powdery mildew*

*Average rate of most common formulation and frequency of application:*

o JMS Stylet Oil < 3 qts/100 gal. water

*Preharvest interval: 0 days*

*Restricted entry interval: 0 hours*

*Efficacy rating: NA*

*Rational for Use: NA*

## **naled (Dibrom)**

*Percent acres treated:* <25% for sap beetles because of the DTH; 60% for tarnished plant bugs; 95% for growers with Day Neutral varieties

*Target pests and timing:* Sap beetles; Tarnished Plant Bug, apply prebloom and fruit set through harvest

*Average rate of most common formulation and frequency of application:*

o Dibrom 8EC < 1 pt/A

*Preharvest interval:* 1 day

*Restricted entry interval:* 24 hours

*Efficacy rating:* Fair, Good for tarnished plant bugs

*Rational for Use: NA*

## **oxythioquinox (Morestan)**

*Percent acres treated:* <5%

*Target pests and timing:* Greenhouse whitefly

*Average rate of most common formulation and frequency of application:*

o Morestan 25WP < 0.5-1 lb/100 gal. water

*Preharvest interval:* do not apply past early bloom

*Restricted entry interval:* 24 hours

*Efficacy rating:* NA

*Rational for Use: NA*

## **parasitic nematodes (Exhibit)**

*Percent acres treated:* <5%

*Target pests and timing:* Root weevils, spot-treat postharvest and again in late April to early May

*Average rate of most common formulation and frequency of application:*

o Exhibit < 100-200 gal/A

*Preharvest interval:* 0 days

*Restricted entry interval:* 0 hours

*Efficacy rating:* NA

*Rational for Use: NA*

## **Cultural Controls:**

Damaged, diseased and overripe fruits should be removed from the fields at regular intervals. Locate

fields away from woodlots or other suitable insect overwintering sites.

## Diseases

### Anthracnose

**Biology:** One or more circular spots occur on the fruit; spots originally are tan or light brown but soon become darker brown and sunken. Sunken spots are usually about 1/8 to 1/2 inch in diameter and may be covered with a pink slime during wet or very humid periods. The disease may occur on both green and ripe fruit, but is most common following periods of warm wet weather. In New York, anthracnose occurs only sporadically and is a more common problem on day-neutral varieties in the summer than it is on June-bearers; however, it may affect these varieties as well if weather conditions are suitable.

**Resistant Cultivars:** None

**Cultural Control Practices:** Providing good air circulation by controlling weeds and plant densities. Straw mulch can significantly reduce the rate of disease spread relative to bare ground (less splash).

**Chemical Controls:** benomyl, captan. Spray will provide some control of this disease, but will not stop an epidemic once it has begun.

### Black Root Rot

**Biology:** Over time, plant vigor and productivity decline. Feeder rootlets die, and fleshy structural roots deteriorate and become blackened. Blackening frequently starts as patches along the length of the root, rather than from the tip back. This disease is often associated with fields having a long history of strawberry production.

**Resistant Cultivars:** Honeoye appears to be particularly susceptible to black root rot, and should be avoided in fields without adequate rotation.

**Cultural Control Practices:** Practices that reduce soil compaction, improve aeration, and promote good drainage are frequently beneficial. Rotating a field out of strawberries for at least 2-3 years before replanting is strongly recommended to minimize black root rot damage. Measures to control phytophthora frequently help alleviate black root rot.

**Chemical Controls:** chloropicrin, methyl bromide, vapam. Preplant fumigation sometimes controls the microorganisms associated with black root rot. Other times, such treatments provide no control or even increase black root rot severity in the next planting.

### **Botrytis Fruit Rot (Gray Mold)**

**Biology:** Gray Mold is one of the most common and serious fruit rot diseases in strawberries. The causal fungus *Botrytis cinerea* can affect petals, flower stalks, fruit caps and the fruit. The disease is most severe during prolonged rainy and cloudy periods just before or during harvest. Young blossoms are very susceptible to infection. Fruit are more susceptible as they mature. Fruit infections appear as soft, light brown, quickly expanding areas on the berry. If the fruit remains on the plant, the berry dries up (mummifies) and becomes covered with a gray dusty powder. Infection is most severe in well-protected areas of the plant where the humidity is high and air movement limited. Strawberries resting on the soil or touching another decaying berry or dead leaf are most commonly affected. After harvest, the mature fruits are also very susceptible to gray mold, especially if damaged.

**Resistant Cultivars:** Earliglow and jewel are less susceptible. Allstar is very susceptible.

**Cultural Control Practices:** Disease control is greatly aided by controlling weeds and regulating plant density and by using other practices that promote good air circulation and rapid drying of the fruit. Spring applications of nitrogen increase disease potential dramatically.

**Chemical Controls:** fenhexamid, captan, thiram, benomyl, thiophanate-methyl, iprodione.

### **Leaf Scorch**

**Biology:** The fungus *Diplocarpon earliana* is the causal organism for leaf scorch. The fungus can infect leaves, petioles, runner, fruit stalks and berry caps. The symptoms of leaf scorch are similar to the early stages of leaf spot. Infection causes round to angular or irregular dark-purple spots between 1/8 to 1/4 inch in diameter to appear on the upper leaf surface. The center of the spots remain dark purple and this distinguishes the disease from leaf spot. When many infections occur on the same leaf, it will become reddish or light purple. Severely infected leaves dry up and appear scorched. The lesions can girdle the fruit stalk causing flowers and young fruit to die. The leaf scorch fungus can infect strawberry leaves at all stages of development.

**Resistant Cultivars:** Fungicide sprays are likely to be necessary only on susceptible varieties including Raritan and Sparkle.

**Cultural Control Practices:** Destruction of infected leaves at renovation (e.g., mowing and burying) will reduce the amount of disease carry-over. Promotion of good air circulation (plant spacing, weed control) to speed drying time and limit infection periods.

**Chemical Controls:** thiram, captan. Early spray is recommended primarily when disease carry over from the previous year is high and the weather is wet.

### Leaf Spot

**Biology:** Leaf Spot is caused by the fungus, *Mycosphaerella fragariae*. It can infect leaves, petioles, runners, fruit stalks and berry caps. The main symptom of the disease is the appearance of small round spots on the upper surface of the leaf. At first the spots are dark purple to reddish-purple and are 1/8 inch in size. With time, the centers of the spots become tan or gray and eventually almost white. Later in the season, tan or bluish areas form on the underside of the leaf. Temperatures between 65 and 75F are optimal for infection and disease development. Infection can occur any time throughout the season, except during dry, hot weather.

**Resistant Cultivars:** Fungicide sprays are likely to be necessary only on susceptible varieties including Raritan, Honeoye, Sparkle, Veestar, Micmac, and Tribute; Kent is particularly susceptible.

**Cultural Control Practices:** Destruction of infected leaves at renovation (e.g., mowing and burying) will reduce the amount of disease carry-over. Promotion of good air circulation (plant spacing, weed control) to speed drying time and limit infection periods.

**Chemical Controls:** thiram, captan. Early spray is recommended primarily when disease carry over from the previous year is high and the weather is wet.

### Leather Rot

**Biology:** Leather rot is caused by the fungus, *Phytophthora cactorum*. Whereas the fungus can infect strawberries at any time during their development, it causes the most serious problem when it infects the green berries. The infected areas appear dark brown or green outlined by a brown margin. As the disease spreads, the entire strawberry becomes brown, rough in texture and leathery in appearance. On ripe fruit the disease is more difficult to distinguish because the infection causes little color change. These fruits are initially soft to touch but eventually also become tough and leathery. Strawberries that have been infected with leather rot also have a distinctive unpleasant odor and bitter taste. Leather rot is most common in poorly-drained areas where there is or has been free standing water, or the fruit come in

direct contact with the soil.

**Resistant Cultivars:** None

**Cultural Control Practices:** Minimizing soil puddling through site selection, avoiding ruts and soil compaction; and providing a supplemental layer of straw mulch between rows throughout the fruiting season (the mulch provides a physical barrier between the soil-borne leather rot fungus and the susceptible fruit).

**Chemical Controls:** mefanoxam, fosetyl-Al. Most effective when used in combination with straw mulch.

### Powdery Mildew

**Biology:** Under extended cool weather conditions the disease may appear. The leaves of infected plants will roll upwards at the edges and a thick white covering of fungal growth appears on the lower surface of the leaves, stem and fruit. Severe infections cause purple blotches on leaves and in some cases can kill leaves.

**Resistant Cultivars:** Guardian and Earliglow (and to a lesser extent, Raritan) are the only varieties commonly affected in New York.

**Cultural Control Practices:** None

**Chemical Controls:** Control with currently registered fungicides has not been effective. JMS Stylet Oil is registered and effective on other powdery mildew diseases, but has not been tested on strawberries in New York State.

### Red Stele

**Biology:** The fungus which causes red stele, *Phytophthora fragariae*, infects the roots of the strawberry plant. The disease is most destructive in heavy clay soils that are saturated with water during cool weather when the fungus is most active. Infected plants have very few new roots and existing roots appear gray. The plant starts to wilt and die. Positive identification of the disease can be made by looking for a pink to brick red color to the central portion of the root (the stele). The red color is best seen in the spring up to the time of fruiting. Diseased plants are stunted, lose their shiny, green luster and produce few runners. Younger leaves often have a metallic bluish-green cast, while the older leaves turn prematurely yellow or red. With the first hot, dry weather the diseased plants will wilt rapidly and die.

**Resistant Cultivars:** Earliglow, Lateglow, Sunrise, Redchief, Midway, Scott, Guardian, Allstar, Tribute, Tristar, Surecrop, and Sparkle. These varieties are not resistant to all races of the red stele fungus, so the disease can still occur if a race to which they are not resistant is present.

**Cultural Control Practices:** Plant only on a well-drained site or provide supplemental drainage if possible. Growing strawberries on a raised bed also reduces disease severity.

**Chemical Controls:** mefanoxam, fosetyl-Al. The fungus persists for many years even when strawberries are no longer grown.

### Verticillium Wilt

**Biology:** Plants are affected most severely during their first year of growth. Outer leaves turn brown and eventually collapse, but inner leaves remain green until the plant dies. This symptom distinguishes Verticillium wilt from other root and crown disorders. Affected plants may occur uniformly, or appear scattered throughout a field.

**Resistant Cultivars:** Earliglow, Guardian, Allstar, Scott, Delite, Tribute, and Tristar.

**Cultural Control Practices:** Many weeds are hosts of the Verticillium fungus. Nightshade, groundcherry, redroot pigweed, lambsquarters, and horsenettle should be strictly controlled in current and future planting sites to keep Verticillium population low. If soil fumigation is not practical or desired, susceptible strawberry cultivars should not be planted for at least three years after the last crop of tomatoes, potatoes, or eggplant.

**Chemical Controls:** vapam, methyl bromide + chloropicrin. Fall application is necessary to avoid delay in planting if susceptible varieties are to be planted where disease is likely.

### **Chemical Disease Controls:**

#### **benomyl (Benlate)**

*Percent acres treated: 50%*

*Target diseases and timing: Botrytis blossom blight, Fruit rot, Leaf spot, Leaf Scorch, and Leaf Blight during the entire season (except during harvest), post harvest and during new plantings*

*Average rate of most common formulation and frequency of application:*

o Benlate 50WP < 0.83lb/A, twice  
*Preharvest interval:* 1 day  
*Restricted entry interval:* 24 hours  
*Efficacy rating:* Good  
*Rational for use:* Important for resistance management

### **captan (Captan)**

*Percent acres treated:* 85% (very important for Anthracnose control)  
*Target disease and timing:* Leaf Spot, Leaf Scorch and Leaf Blight during entire season except during harvest, post harvest and during new plantings and Botrytis Fruit Rot from post-bloom to harvest  
*Average rate of most common formulation and frequency of application:*  
o Captan 50WP < 3.8 lbs/A, 2-3 times  
o Captan 80WP  
o Orthocide 7.5D  
o Captec 4L  
*Preharvest interval:* 0 days  
*Restricted entry interval:* 96 hours  
*Efficacy rating:* Good  
*Rational for use:* Important for resistance management

### **fenhexamid (Elevate)**

*Percent acres treated:* NA; NYS registration is pending  
*Target disease and timing:* Botrytis fruit rot (gray mold), applied during bloom  
*Average rate of most common formulation and frequency of application:*

o Elevate 50 WDG < 1.5 lb/A  
*Preharvest interval:* 0 days  
*Restricted entry interval:* 4 hours  
*Efficacy rating:* NA  
*Rational for use:* Recently approved for use by USEPA; NYS registration is pending.

### **fosetyl-Al (Aliete)**

*Percent acres treated:* 50%  
*Target diseases and timing:* Leather Rot from post-bloom through harvest, post harvest and with new plantings, Red Stele in early Spring and in new plantings  
*Average rate of most common formulation and frequency of application:*  
o Aliete 80 WDG < 2.75 lbs/A, 1-2 times  
o Aliete 80 WP

*Preharvest interval:* 0 days  
*Restricted entry interval:* 24 hours  
*Efficacy rating:* Good  
*Rational for use:* Important for resistance management

## **iprodione (Rovral)**

*Percent acres treated:* 50%  
*Target diseases and timing:* Botrytis blossom blight and Fruit Rot, Leaf Spot, Leaf Scorch, and Leaf Blight from early bloom to harvest  
*Average rate of most common formulation and frequency of application:*  
o Rovral 50WP < 1.5-2 lbs/A, once  
o Rovral 4F < 1.5-2 pts/A, once  
*Preharvest interval:* 0 days  
*Restricted entry interval:* 12 hours  
*Efficacy rating:* Good to Very Good  
*Rational for use:* Strawberries has recently been removed from the label

## **mefanoxam (Ridomil)**

*Percent acres treated:* 40%; growers also using resistant varieties  
*Target disease and timing:* Red stele  
*Average rate of most common formulation and frequency of application:*  
o Ridomil Gold 4EC < 1-2 applications  
*Preharvest interval:* before fruit set  
*Restricted entry interval:* 12 hours  
*Efficacy rating:* NA  
*Rational for use:* NA

## **thiophanate-methyl (Topsin-M)**

*Percent acres treated:* 50%  
*Target diseases and timing:* Botrytis blossom blight and fruit rot, leaf spot, Leaf Scorch, and Leaf Blight during the entire season, after harvest and during new plantings.  
*Average rate of most common formulation and frequency of application:*  
o Topsin-M 70WP < 0.85 lb/A, twice  
o Topsin-M 4.5F  
*Preharvest interval:* 1 day  
*Restricted entry interval:* 12 hours  
*Efficacy rating:* Good to Very Good  
*Rational for use:* Important for resistance management; rotate in place of Benlate.

## thiram (Thiram)

*Percent acres treated:* 10-20%

*Target diseases and timing:* Fruit Rots, Leaf Spot, and Leaf Scorch during early spring, fruit set through harvest, and postharvest

*Average rate of most common formulation and frequency of application:*

o Thiram 65WP < 3-5 lb/A

o Thiram 4F

*Preharvest interval:* 3 days

*Restricted entry interval:* 24 hours

*Efficacy rating:* NA

*Rational for use:* can use early

### Cultural Controls:

The use of resistant cultivars is an important cultural method to reduce the incidence of disease. Additionally, use of certified, disease-free plants is highly recommended and make sure that all machinery and equipment used are thoroughly cleaned. Always plant in light, well-drained soil in a location with lots of sun and good air circulation. For leaf diseases, remove older and infected leaves from the runner plants before setting. Effective weed management will also help reduce the spread of disease. To avoid verticillium wilt, do not plant susceptible cultivars in soil where tomato, peppers, potato, eggplant, melons, okra, mint, brambles, stone fruits, chrysanthemums, rose or related susceptible crops have been grown for the past 5 years. To help control fruit rots it is also recommended to use a mulch to limit fruit contact with the soil and remove all diseased berries from the field. Handle strawberries with care to avoid bruising and refrigerate promptly to limit spread of gray mold.

## Weeds

Broadleaves and grasses. Strawberry plants are shallow rooted and compete poorly against weeds for sunlight, nutrients and moisture. Uncontrolled weed infestations can reduce yields up to 40% or more. Weeds can exacerbate disease pressure by restricting air movement through the canopy. Therefore, a weed management program is important to a successful strawberry production system.

### Chemical Weed Controls for use in Strawberry Plantings:

	Amount of Product per Sprayed Acre	
Herbicide	Formulation	lbs active ingredient

**PREEMERGENT**

napropamide (Devrinol)	50DF (8 lb), 10G (40 lb), 2E (2 gal)	4
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Apply in late fall or early spring before seedling weeds emerge or after adequate numbers of runners have rooted. Rainfall is necessary for activation. Apply 2-2.5 lbs/A a.i. in newly planted strawberry beds after the soil has settled around roots.

% usage: 85%

PHI: 42 days

REI: 12 hours

terbacil (Sinbar)	80WP (2-6 oz)	0.12-0.38
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Apply soon after harvest before new growth begins or in dormant season from mid-fall to late winter. Treat only plants established for 6 months or more. Use no more than 8 oz per year. If leaves are present when material is applied, irrigate immediately after application to wash material off leaves. Do not use on soils with less than 2% organic matter. Not recommended for use on Guardian, Darrow, Micmac, Tribute, or Tristar. Some growers have reported sensitivity in Honeyoye.

% usage: 80%

PHI: 70 days

REI: 12 hours

**POSTEMERGENT**

2,4-D (various)	4 lb/gal(2-3 pt)	1.0-1.5
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For broadleaf weeds in established plantings. Apply soon after last picking or when berry plants are dormant in late fall or early spring. Use 25 to 50 GPA.

% usage: 80%

PHI: NA

REI: 48 hours

fluazifop-butyl (Fusilade)	2L (16-24 oz)	0.25-0.375 +1% crop oil concentrate
<p>Apply when grasses are about 8 inches tall and actively growing. Do not apply to plants that will be harvested within one year of the application.</p> <p>% usage: &lt;5%</p> <p>PHI: 365 days</p> <p>REI: 12 hours</p>		
glyphosate (Roundup)	Varies according to weed problem	
<p>Apply as a preplant broadcast application, or as a wiper application post-planting. Requires 30 day interval between application and planting.</p> <p>% usage: 80%</p> <p>PHI: 30 days</p> <p>REI: 12 hours</p>		
*paraquat (Gramoxone)	2.5L (1.5 pt)	0.5
<p>Use as a postemergence directed spray in 20-60 gallons of water with nonionic surfactant. Shield to prevent contact with crop. Apply before weed growth is 6 in. high. Apply no more than 3 times per season.</p> <p>% usage: 10%; used on runners</p> <p>PHI: 21 days; limited to three applications per season</p> <p>REI: 12 hours</p>		
pelargonic acid (Scythe)	3-5% soln. for annuals 5-7% soln. for perennials 7 - 10% for maximum burndown	2.25 - 20 gal

Apply between rows to suppress weeds or narrow rows. Do not contact desirable foliage.

% usage: <5%

PHI: 24 hours

REI: 24 hours

sethoxydim (Poast)

1.5EC (0.75-2.5 pt)

0.14 – 0.47 + 2 pt. oil concentrate

For perennial grasses, apply higher rates in spring when grasses are 6 in. tall. For annual grasses, apply in spring immediately after harvest, or in late summer. Do not use within 6 weeks after Sinbar application. Do not mix with other chemicals. Do not use more than 2 pts per season.

% usage: 80%; spot treatment

PHI: 7 days

REI: 12 hours

\* Restricted-use pesticide.

**NOTE:** Herbicides are usually not banded in strawberry plantings, except when using \*paraquat (\*Gramoxone Extra).

### **Cultural Controls:**

Straw or plastic mulch can be used to help manage weeds. Hand weeding and cultivation is essential to supplement chemical weed control and can also be used to control small outbreaks.

## **Vertebrate Pests**

**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.

### **Critical Pest Control Issues**

Only one preemergent herbicide is allowed during the planting year.

Important pesticides used on strawberries for which there are few or no other alternatives or the only alternatives are organophosphates, carbamates or B2 carcinogens include:

- Azinphos-methyl (OP)
- Chlorpyrifos (OP)
- Benomyl (C)
- Carbaryl (C)
- Thiophanate-methyl (C)

- Captan (B2)
- Iprodione (B2)

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