

Crop Profile for Strawberries in Ohio

Prepared: May, 1999

General Production Information

(Rosaceae *Fragaria* spp.)



- Acres in Ohio: 801 (harvested) (1)
- 275 (non-bearing estimate) (6)
- Percent of US Acreage/Rank: 1.5%/10th(1)
- Number of Growers: 375(1)
- Average Per Acre Value: \$3900 to \$6500 (6)
- Value of Production in Ohio: \$3.1 to \$5.2 million(6)

Location Of Production

Counties with the most acres in strawberries are located in the Northeast and Central regions of the state. The following counties are the top strawberry producers in the state: Portage (79A), Lorain (61A), Columbiana (48A), Mahoning (37A), Franklin (30A), Wayne (27A), Lake (27A) and Fulton (26A).(1)

Production Methods(3)

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 Ohio. 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.

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 leaf hopper, 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 a 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.

Insect Pests

1. Spittlebugs

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 in to the lower parts of the strawberry plant. Only one generation of spittlebugs are produced each year.

2. Clippers (Strawberry Weevil)

The beetles overwinter in fence rows and woodlots. Once temperatures reach 60 °F 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. Adults clippers which are dark, reddish-brown weevils about 1/10-inch long and with a head prolonged in to 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 from a short time, the new adults seek hibernating sites and remain until the next spring. Only one generation of clippers appears each year.

3. Tarnished Plant Bugs

Adult tarnished plant bugs are ¼ inch long, brownish in color and marked with yellow and black dashes. They overwinter in vegetation and stubble that provides 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.

4. Slugs

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.

5. Leafhoppers

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.

6. Sap Beetles

The strawberry sap beetle is a small brown insect less than 1/8 inch long. Adult sap beetles enter strawberry plantings from the surrounding wooded areas at the time the berries begin to ripen.

Sap beetles, usually in groups, feed on the berries creating cavities on the underside of the fruit. This injury can also lead to infection of the strawberry by rot organisms. Adult sap beetles are rarely seen because they fall to the ground when fruit is disturbed. Females lay their eggs on the damaged fruit. The eggs will hatch in 2-3 days. Larvae will remain in the fruit for about one week, but since the berry has already begun to decompose, damage done by the larvae usually goes unnoticed.

7. **Two Spotted Spider Mite**

This pest is usually not a problem in Ohio 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.

8. **Leafrollers**

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, usually uncommon in Ohio, may develop in spring and early summer, but they may also build up after harvest.

Chemical Insect Controls

Endosulfan (Thiodan)

Percent acres treated: 61%(5)

Target pests and timing: Spittlebug and Tarnished Plant Bug in early Spring and post-bloom to harvest (2)

Average rate of most common formulations and frequency of application: (5)

- Thiodan 50WP - 1.5lbs/A, once; OR
- Thiodan 3EC – 1.85 pts/A, once

PHI: 30 days (5)

Efficacy rating: Good to Very Good (5)

Rational for Use: Important component in IPM program & only acceptable alternative (5)

Azinphos-methyl (Guthion)

Percent acres treated: 41% (5)

Target pests and timing: Sap beetles and Leafrollers from post-bloom to harvest (2)

Average rate of most common formulation and frequency of application: (5)

- Guthion 50WP – 0.80lb/A, once

PHI:

Efficacy rating: Good to Very Good (5)

Rationale for Use: Important component in IPM program & only acceptable alternative (5)

Chlorpyrifos (Lorsban)

Percent of acres treated: 35% (5)

Target pests and timing: Clippers and other root weevils in early Spring (2)

Average rate of most common formulation and frequency of application: (5)

- Lorsban 4EC – 1.5 pts/A, once

PHI: 30-45 days (5)

Efficacy rating: Good to Very Good (5)

Rational for Use:

Carbaryl (Sevin)

Percent acres treated: 26% (5)

Target pests and timing: Spittlebug in early Spring (2)

Average rate of most common formulations and frequency of application: (5)

- Sevin 50WP – 1.6 qt/A, once; OR
- Sevin 80S – 1.5 lbs/A, once; OR
- Sevin XLR Plus – 1 qt/A, once post harvest

PHI:

Efficacy rating:

Rational for Use: Cost effective and IPM program component (5)

Metaldehyde (Deadline)

Percent acres treated: 18% (5)

Target pests and timing: Slugs from post-bloom to harvest (2)

Average rate of most common formulation and frequency of application: (5)

- Deadline M-P's – 14 lbs/A, once

PHI: 1 month (5)
Efficacy rating: Good (5)
Rational for Use:

Bifenthrin (Brigade)

Percent acres treated: 9% (5)

Target pests and timing: Sap Beetles, Clippers, Mites and Spittlebug in early spring and from post-bloom to harvest (2)

Average rate of most common formulation and frequency of application: (5)

- o Brigade 10WP – 6.4 oz/A, once

PHI: 10 days (5)

Efficacy rating: Good (5)

Rational for Use: Resistance management (5)

Cultural Controls(3)

of the strawberry growers reported using no chemical insecticides on their crop. Damaged, diseased and overripe fruits should be removed from the fields at regular intervals. Locate fields away from woodlots or other suitable overwintering sites.

Diseases

1. Botrytis Fruit Rot (Gray Mold)

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.

2. Leaf Spot

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 range in size from 1/8 to 1/4 inch across. 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. Temperature between 65 and 75 °F are optimal for infection and disease development. Infection can occur any time throughout the season, except during dry, hot weather.

3. Leaf Scorch

The fungus *Dicplocarpon 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 up 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 infection 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.

4. Red Stele

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.

5. Leather Rot

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.

6. Angular Leaf Spot (Bacterial Blight)

Angular leaf spot is the only bacterial disease of strawberries in Ohio. It is caused by the bacterium, *Xanthomonas fragariae*. Symptoms of infection first appear as small, water-soaked lesions on the lower leaf surface. The lesions enlarge and become angular spots, usually delimited by small veins. Under moist conditions, lesions often have a viscous exudate on the lower leaf surface that will dry to a whitish scaly film. The lesions may grow together and cover large portions of the leaf. At this point the lesions become visible on the upper leaf surface as irregular, reddish brown spots which become necrotic. Heavily infected leaves may die, especially if major veins are infected.

7. Powdery Mildew

Powdery mildew is normally not a problem in Ohio. However, under extended cool weather condition 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.

Chemical Disease Controls

Benomyl (Benlate)

Percent acres treated: 52% (5)

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 (2)

Average rate of most common formulation and frequency of application: (5)

- o Benlate 50WP – 0.83lb/A, twice

PHI: 7-10 days (5)

Efficacy rating: Good (5)

Rational for use: Important for resistance management (5)

Captan

Percent acres treated: 51% (5)

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 (2)

Average rate of most common formulation and frequency of application: (5)

- Captan 50WP – 3.8 lbs/A, 2-3 times

PHI: 7-10 days (5)

Efficacy rating: Good (5)

Rational for use: Important for resistance management (5)

Mefenoxam (Ridomil Gold)

Percent acres treated: 28% (5)

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 (2)

Average rate of most common formulation and frequency of application: (5)

- Ridomil Gold – 1.4 pts/A, once

PHI: 30 days (5)

Efficacy rating: Very Good (5)

Rational for use: Best alternative, especially for Red Stele (5)

Vinclozolin (Ronilan) (This chemical is no longer available for use by strawberry growers)

Percent acres treated: 21% (5)

Target diseases and timing: Botrytis blossom blight and Fruit Rot, Leaf Spot, Leaf Scorch, and Leaf Blight from early bloom to harvest. (2)

Average rate of most common formulation and frequency of application: (5)

- Ronilan 50WP – 1.5lbs/A, twice

PHI: 7 days (5)

Efficacy rating: Good (5)

Rational for use: Best activity against Botrytis & important for resistance management (5)

Fosetyl-aluminum (Aliete)

Percent acres treated: 9% (5)

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 (2)

Average rate of most common formulation and frequency of application: (5)

- Aliete 80 WDG – 2.75 lbs/A, 1-2 times

PHI: 7 days (5)

Efficacy rating: Good (5)

Rational for use: Important for resistance management (5)

Thiophanate-methyl (Topsin-M)

Percent acres treated: 9% (5)

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. (2)

Average rate of most common formulation and frequency of application: (5)

- Topsin-M 70WSB – 0.85 lb/A, twice

PHI: 10 days (5)

Efficacy rating: Good to Very Good (5)

Rational for use: Important for resistance management (5)

Iprodione (Rovral) (This chemical is no longer available for use by strawberry growers)

Percent acres treated: 3% (5)

Target diseases and timing: Botrytis blossom blight and Fruit Rot, Leaf Spot, Leaf Scorch, and Leaf Blight from early bloom to harvest (2)

Average rate of most common formulation and frequency of application: (5)

- Rovral 50WP – 1.8 lbs/A, once

PHI: 24 hours (5)

Efficacy rating: Good to Very Good (5)

Rational for use:

Cultural Controls(3)

Of the strawberry growers, 3% reported using no chemical fungicides on their crop. 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

Napropamide (Devrinol)

Percent acres treated: 75% (5)

Average rate of most common formulation and frequency of application: (5)

- Devrinol 50DF – 6.5 lbs/A, once in early spring prior to weed emergence or immediately after harvest.

PHI: 2-3 months (5)

Efficacy rating: Good (5)

Rational for use: This is a broad spectrum herbicide which does not injure the strawberry plants and is highly effective in controlling annual grasses and certain broadleaf weeds from seed.

Terbacil (Sinbar)

Percent acres treated: 72% (5)

Target weeds: grasses and broadleaf (2)

Average rate of most common formulation and frequency of application: (5)

- Sinbar - 5.5 oz/A, up to two times per year - after harvest during renovation and/or on dormant plants in late fall.

PHI: 10 months (5)

Efficacy rating: Good to Very Good (5)

Rational for use: Controls annual broadleaf weeds and grasses from seed and also controls seedlings of certain annual and perennial weeds.

Sethoxydim (Poast)

Percent acres treated: 62% (5)

Target weeds: grasses (2)

Average rate of most common formulation and frequency of application: (5)

- Poast 1.5 EC – 1.67 pt/A, once when grass is actively growing, usually used as a spot spray.

PHI: 42-60 days (5)

Efficacy rating: Good to Very Good (5)

Rational for use: Poast is occasionally required by most growers to control emerged annual grasses or perennial broadleaf weeds.

2,4 – D plus 2,4 amine (Formula 40)

Percent acres treated: 59% (5)

Target weeds: broadleaf (2)

Average rate of most common formulation and frequency of application: (5)

- Formula 40 – 1.25 qt/A, once usually immediately after last harvest.

PHI: 10 months (5)

Efficacy rating: Good (5)

Rational for use: 2,4-D is the only herbicide available to strawberry growers that is effective in controlling established perennial broadleaf weeds.

DCPA (Dacthal)

Percent acres treated: 18% (5)

Target weeds: grasses and broadleaf (2)

Average rate of most common formulation and frequency of application: (5)

- Dacthal 75WP – 9 lb./A, once on new plantings immediately after transplanting, on established plantings immediately after removing mulch in the spring; may be repeated following harvest and renovation.

PHI: 2-3 months (5)

Efficacy rating: Good (5)

Rational for use: Dacthal is important because it can be used for weed control immediately after planting strawberries and because it controls certain grasses and broadleaf weeds from seed.

Oxyfluofen (Goal)

Percent acres treated: 5% (5)

Target weeds: annual weeds

Average rate of most common formulation and frequency of application: (5)

- Goal 1.6E – 1.6 pt./A, once

PHI: 6 months (5)

Efficacy rating: Good (5)

Rational for use: Provides effective control at renovation or after onset of dormancy of difficult weed species which other herbicides cannot control. Use on strawberries currently through section 18C label (5)

Glyphosate (Roundup)

Percent acres treated: 3% (5)

Target weeds: most annual and perennial grass and broadleaf weeds (2)

Average rate of most common formulation and frequency of application: (5)

Roundup – 1 qt/A, once as spot treatment

PHI:

Efficacy rating: Average (5)

Rational for use: Used to eradicate perennial weeds prior to planting and as a spot spray to control established weeds.

Gramoxone Extra (Paraquat)

Percent acres treated: 2% (5)

Target weeds: most annual weeds and top kill of perennial weeds (2)

Average rate and frequency of application: (5)

- Paraquat – 1 pt/A, once

PHI:

Efficacy rating: Very Good (5)

Rational for use: Mainly used as a spot spray to control emerged annual weeds.

Cultural Controls(3)

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.

CRITICAL PEST CONTROLS ISSUES

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

- Chlorpyrifos (OP)
- Azinphos-methyl (OP)
- Carbaryl (C)
- Captan (B2)
- Benomyl (C)
- Vinclozolin (B2)
- Thiophanate-methyl (C)
- Ipridione (B2)

CHEMICAL OR NONCHEMICAL ALTERNATIVES AND NEW REGISTRATIONS

Elevate 50 WDG is a new fungicide that was just labeled for use on strawberries for control of Botrytis gray mold. It represents new chemistry and is very active against Botrytis. In 1996 Brigade 10WP was registered for use on strawberries to control spittlebugs, tarnished plant bugs, mites, leafrollers, sap beetles and clippers the same insects previously controlled by various combinations of chlorpyrifos, azinphos-methyl and carbaryl. Growers in Ohio have been slow to adopt the use of this newer chemical. Brigade was used on only 9 % of the strawberry acreage in 1998. Danitol 2.4EC is another relatively new chemical for use on strawberries for spittlebug and tarnished plant bug control. Growers in Ohio have also shown a reluctant to use this new product. No growers reported using Danitol in the 1998 Small Fruit Survey.

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