

# Crop Profile for Strawberries in Arkansas

Prepared: February, 2003

Revised: June, 2003

## General Production Information

- **State Rank:** NA
- **Percentage of U.S. Production:** NA
- **Total acres grown:** 250 acres (Industry estimate)
- **Cash Value:** \$NA
- **Production Regions:** Strawberry production is distributed throughout Arkansas

### Production Methods:

Most growers in Arkansas now produce strawberries using the plasticulture production system. Consequently, this system will be referred to in the remainder of this profile. Strawberry plasticulture is the annual hill training system in which 'green' strawberry transplants (freshly dug or plug plants) are planted in early fall in double rows at densities of approximately 15,000 to 17,400 plants per acre on methyl bromide fumigated, raised beds that are covered with black plastic mulch.

Methyl bromide (67%) + chloropicrin (33%) is currently applied prior to planting (minimum of two weeks between application and planting) transplants for management of soil borne diseases, nematodes, insects, and weeds. A single application of approximately 200 lb. of product per acre is injected into the soil during construction of the raised beds. Row middles are not treated. The bed is then immediately covered with black plastic mulch. Transplants are set in late September to mid October. In the strawberry plasticulture system berries can be harvested in just 7 to 8 months after planting. Drip and overhead sprinkler irrigation are used to reduce stress on plants during establishment, irrigate plants, and protect plants from frost. Following a period of vegetative growth in the fall, cool temperatures and short day length stimulate the plant to produce flowers that begin to bloom in March. The harvest period is mid April through May. Fruit are harvested by hand every 2-3 days during the harvest season. Due to the frequency of harvest, preharvest intervals (PHI) and restricted entry intervals (REI) are important considerations for growers. Following harvest (early to mid June), the strawberry plants are destroyed due to the high risk of infection with anthracnose fruit rot in second year beds.

### Commodity Destination(s):

- Fresh Market 100%

## Cultural Practices

### Worker Activities

Strawberry plants are normally planted in the fall (September – October) into plastic covered beds (usually fumigated before planting). Approximately 70% of the planting is by mechanical means. Thirty percent of acres have follow-up planting by hand after mechanical planting.

Row covers are applied to approximately 75% of the strawberry acres for freeze protection and removed up to six times from November through March.

Preemergent herbicide applications are applied to the strawberry beds of traditionally planted (no plastic mulch) strawberries. These applications are made in early spring, primarily with tractor mounted spray equipment. Postemergence herbicide applications are made to the beds of traditionally grown strawberries and the row middles of plastic covered beds in early summer and occasionally after harvest primarily with tractor mounted sprayers although backpack sprayers are occasionally used. Virtually all of the strawberry acres are hand weeded and hand labor is used to position the plants above the plastic (January – February).

Insecticides and fungicides are applied from early spring up to harvest primarily with orchard blast sprayers or boom sprayers.

Virtually the entire strawberry crop is hand-harvested (April – May). The strawberry plants are normally removed after harvest as well as the plastic mulch. This is all done by hand. The beds are renovated in preparation for fumigation before replanting in the fall.

## Insect Pests

### Strawberry Weevil (Clipper)

*Anthonomus signatus* Say

Adult clippers are dark, reddish-brown weevils about 1/10-inch long and with a head prolonged into a thin curved snout about half the length of the body. One generation of clippers appears each year. The adult beetles overwinter in debris, straw, and mulch. Once temperatures reach 60 °F, usually in March, these insects move to nearby early budding plants such as Redbud tree and strawberry. The adults feed on the immature pollen of the blossom buds. Then the females deposit one egg inside the bud, girdles the bud and clips the stem. This causes the bud to hang down or fall to the ground. In about a week, the egg hatches into a white, legless larva. The larva completely develops inside the bud and reaches maturity in three to five weeks.

**Chemical control:** The following compounds are registered for control of Strawberry bud weevil in strawberry: Brigade, Danitol, Lorsban, and Sevin.

### Lygus Bug/Tarnished Plant Bug

*Lygus lineolaris* Palisot de Beauvois

Adult tarnished plant bugs are ¼-inch long, brownish in color with yellow "Y" shape marking in front of the wings. Adults overwinter in vegetation and stubble that provides protection from the extreme cold. In the spring the adults are attracted to and feed on flower buds and shoot tips of many plants, including strawberries. This feeding can result in blossom losses. 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 on the receptacle of developing fruit. At the same time, their feeding kills surrounding tissue which leads to small seedy strawberries with a woody texture that fails to mature properly. 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 until a heavy frost in the fall.

**Chemical control:** Chemical control should be targeted against the susceptible first and second instar nymph stages. The following compounds are registered for control of Lygus bugs in strawberry: Brigade, Danitol, Endosulfan, Malathion and Thiodan.

## Strawberry Sap Beetle

*Stelidota geminata* Say

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 when the berries begin to ripen. Sap beetles feed in groups on the berries creating cavities on the underside of the fruit. This injury can also lead to rot infection of the strawberry. 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 larval stage usually goes unnoticed.

**Cultural control:** Sap beetle can be controlled during harvest by using bait buckets containing overripe fruit placed in the field between the berry patch and wooded areas.

**Chemical control:** The following compounds are registered for Sap beetle control in strawberry: Brigade or Danitol.

## Slugs

*Limax spp.*

Slugs are soft bodied, slimy, worm-like mollusks. 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 telltale sign of slug injury is the slime trail left on the surface of the fruit. They are especially troublesome in wet weather or where heavy mulches are used.

**Chemical control:** The following compounds are registered for slug control in strawberry: Deadline M-P and Prozap.

## Two Spotted Spider Mite

*Tetranychus urticae* Koch

The adult mite is about 1/50-inch in length and its color varies from pale greenish yellow to dark crimson, usually with dark spots. The two-spotted spider mite lives on broadleaf groundcover plants. They are found worldwide and feed on a wide range of plants. 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 chlorophyll from the leaves, which can cause them to lose their healthy green color and turn coppery-bronze and can reduce the plant vigor and yield. 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. The complete cycle may only take 10-30 days, depending upon temperature.

**Cultural controls:** Predator mites, *Neoseiulus fallacis* or *Typhlodromus pyri*, populations can be augmented by releasing commercially available predator mites into the planting to possibly achieve biological control. Road dust control can potentially reduce the rate at which spider mite populations build up.

**Chemical Control:** Use a 10x hand lens to examine 10 leaves each from 10 plants for mites. Treat if you find an average of 2.5 mites/leaf and less than one predator mite/leaf. Spider mites have a history of developing resistance to miticides. The following compounds are registered for Two spotted spider mite control in strawberry: Acramite, Agri-Mek, Brigade, Danitol, Diazinon, Kelthane, Malathion, Savey, and Vendex.

### **Cyclamen Mite**

*Stenotarsonemus pallidus* Banks

This pest is sometimes called the strawberry crown mite because it overwinters in the crown of its host plants. Cyclamen mite feeding damage results in small, distorted leaves and a rosetted plant. This tiny mite, too small to see without magnification, is football-shaped and honey-amber colored as an adult and white in the immature stages. It will feed extensively on young, unfolded leaves in the crown area. This causes stunted fruit with seeds that stand out from the flesh. Dwarfing of the leaves results in a compact leaf mass in the plant center. Its entire life cycle is spent on the plant. It has other flowering ornament hosts also.

**Chemical control:** The following compounds are registered for Cyclamen mite control in strawberry: Diazinon, Endosulfan, Kelthane, and Thiodan. Applying Thiodan 1 to 2 days before bloom and again 10 to 14 days later will give good control but isn't effective if delayed until mid-summer. A high spray volume per acre (300-500 gal) is necessary to soak unfolded leaves and immature flower buds in the crown area.

### **Strawberry Leafroller**

*Ancylis comptana* Froh

Strawberry leafrollers overwinter as fully-grown larvae or pupae in folded leaves or leaf litter. The larvae are pale-green to grayish-brown color. As the larvae feed they release silken threads to fold and tie leaves around them. Adult moths 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. These eggs will hatch within 1-2 weeks. Severely attacked buds appear burned. These leafrollers undergo 2-3 generations each year.

**Chemical control:** The following compound is registered for control of Strawberry leafroller in strawberry: Brigade.

### **Aphids Complex**

*Aphis spp.*

There are several aphids that will attack strawberries. They feed on the young foliage, stems and crown of the plant. Occasionally numbers will become heavy enough for serious damage. Strawberry aphids can transmit a virus that causes the disease known as "yellows". Cast skins will adhere to the fruit and the aphid honeydew will cause sooty molds to develop.

**Biological Control:** All life stages of the ladybug will feed on aphids. They can be commercially purchased to enhance biological control.

**Chemical control:** The following compounds are registered for control of aphids in strawberry: Brigade, Diazinon, Endosulfan, Lannate, Malathion and Thiodan

### **Meadow Spittle Bug**

*Philaenus spumarius* L.

The adult is about 7 cm long with brown/grey colors arranged variously over the body. The spittlebug overwinters as an egg mass in forage legumes. 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. The nymphs feed

head downward inside a mass of spittle. They pierce the plant and suck on its sap. The soft-bodied nymphs vary in color from yellow to green. The nymph 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. Adult spittlebugs will lay their eggs in September and October. The eggs are laid close to the ground on stems of many types of plants in the fall. There is only one generation of spittlebugs produced each year.

**Chemical control:** The following compounds are registered for spittlebug control in strawberry: Brigade, Danitol, Endosulfan, Methoxychlor, Malathion, Sevin and Thiodan.

### **Leafhoppers** *Cicadellidae spp*

The most common leafhopper on strawberries is the potato leafhopper. The potato leafhopper is approximately 1/8-inch long, green and bullet-shaped. 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.

**Chemical control:** The following compounds will give control for leafhoppers in strawberry: Brigade, Danitol, Malathion and Thiodan.

### **Eastern Flower Thrips** *Frankliniella tritici*

Adult Thrips are very slender, tiny insects, 1/16-inch long, yellow brown in color with feathery wings. When at rest the wings are folded lengthwise over the back. The nymphs are wingless and white-amber in color with a similar shape to the adult. They like to feed in flower buds. These insects are not known to overwinter outdoors. The populations develop each year due to long-distance migrations from the South on high-level winds associated with weather fronts. There are two active nymph stages and two inactive pupal-like nymph stages. The life cycle can be completed in several weeks and they have many generations per year.

Since 1994 some strawberry growers have had unusual problems on some cultivars with small, seedy fruit with a rubbery texture and poor color. There is considerable debate regarding the cause of this problem, but the two most likely culprits are fluctuations in temperature and the early arrival of the eastern flower thrips.

**Cultural Controls:** Growers should inspect the early blossoms on early varieties for the presence of thrips. Shake the plant with a heavy white paper under it to show whatever comes off the plant will usually allow you visually observe if thrips are present. Although an exact threshold is unknown at this time, it is suggested that control is warranted if counts of thrips exceed 10 per blossom.

**Chemical control:** Thiodan or Lannate are probably the best choices among conventional insecticides for thrips control on strawberry.

## **Insecticides Labeled for Strawberry**

### **Abamectin**

- Formulations: Agri-Mek 0.15EC
- Target pests: Spider mites

- Average rate of most common formulations:
  - Agri-Mek 0.15 EC (16.0 fl oz/A)
- Preharvest interval: 3 days
- Restricted entry interval: 12 hours

### **Bifenazate**

- Formulations: Acramite 50WS
- Target pests: Spider mites
- Average rate of most common formulations:
  - Acramite 50WS (0.75-1.0 lb/A)
- Preharvest interval: 1 day
- Restricted entry interval: 12 hours

### **Bifenthrin**

- Formulations: Brigade WSB
- Target pests: Aphids, Strawberry clipper, Leafhoppers, Leafrollers, Mites, Sap
- Beetles, Spittlebug and Tarnished plant bugs
- Average rate of most common formulation and frequency of application:
  - Brigade WSB (6.4-32 oz/A)
- Preharvest interval: none
- Restricted entry interval: 24 hours

### **Carbaryl**

- Formulations: Sevin 10, Sevin 4F, Sevin 80S, Sevin XLR
- Target pests: Spittlebug, Strawberry clipper
- Average rate of most common formulations and frequency of application:
  - Sevin 10 (20 lb/A)
  - Sevin 4F (1-2 qt/A)
  - Sevin 80S ( 1.25-2.5 lb/A)
  - Sevin XLR Plus (1-2 qt/A)
- Preharvest interval: 7 days
- Restricted entry interval: 12 hours

### **Chlorpyrifos**

- Formulation: Lorsban 4E
- Target pests: Strawberry Clipper
- Average rate of most common formulation and frequency of application:
  - Lorsban 4EC (1 qt/A), prebloom only
- Preharvest interval: 21 days
- Restricted entry interval: 24 hours

### **Diazinon**

- Formulations: Diazinon 50W, Diazinon AG500
- Target pests: Aphids, Spider mites and Cyclamen mite
- Average rate of most common formulations:
  - Diazinon 50W ( 1-2 lb/100 gal water/A)
  - Diazinon AG500 (1pt-1qt/100 gal water/A)
- Preharvest interval: 5 days
- Restricted entry interval: 24 hours

### **Dicofol**

- Formulations: Kelthane 35WP, Kelthane 50 WSP

- Target pests: Spider mites and Cyclamen mite
- Average rate of most common formulations:
  - Kelthane 35WP ( 3-6.75 lb/A)
  - Kelthane 50 WSP (1-4 lb/A)
- Preharvest interval: 3 days
- Restricted entry interval: 12 hours for Kelthane 35, 24 Hours for Kelthane 50WSP

### **Endosulfan**

- Formulations: Thiodan 3EC or 50WP, Phaser 3EC or 50WBS, Endosulfan 3EC
- Target pests: Spittlebug, Thrips, Tarnished Plant Bug, Leafhopper, Cyclomen mite, and Aphids
- Average rate of most common formulations:
  - Thiodan 50WP or Phaser 50WSB (2-4 lb/A)
  - Thiodan 3EC or Phaser 3EC (1.33 –2.66 qt/A)
  - Endosulfan 3EC (1.33-2.66 qt/A)
- Preharvest interval: 4 days
- Restricted entry interval: 24 hours

### **Fenpropathrin**

- Formulations: Danitol 2.4 EC
- Target pests: Lygus bugs, Spittle bug, Strawberry Clipper, Strawberry Sap beetle, Spider mites
- Average rate of most common formulations:
  - Danitol 2.4 EC (10.66-21.33 fl oz/A)
- Preharvest interval: 2 days
- Restricted entry interval: 24 hours

### **Fenbutatin-oxide**

- Formulations: Vendex 50 WP
- Target pests: Spider mites
- Average rate of most common formulation:
  - Vendex 50 WP (1.5-2 lbs./A)
- Preharvest interval: 1 day
- Restricted entry interval: 48 hour

### **Hexythiazox**

- Formulations: Savey 50DF, Savey 50WP
- Target pests: Spider mites
- Average rate of most common formulations:
  - Savey 50DF (6 oz/A)
  - Savey 50WP (6 oz/A)
- Preharvest interval: 3 days
- Restricted entry interval: 12 hours

### **Malathion**

- Formulations: Malathion 5E, Malathion 55, Malathion 57EC, and Malathion 8EC
- Target pests: Aphids, Mites, Spittlebugs, Thrips, and Tarnished plant bugs
- Average rate of most common formulations:
  - Malathion 5E ( 1.5-3 pts/A)
  - Malathion 55 (1.5-3 pts/A)
  - Malathion 57EC (1.5-3 pts/A)
  - Malathion 8EC (1.5-3 pts/A)
- Preharvest interval: 3 days

- Restricted entry interval: 12 hours

### Metaldehyde

- Formulations: Deadline M-Ps, Prozap Snail & Slug AG Pelleted Bait
- Target pests: Slugs from post-bloom to harvest
- Average rate of most common formulation and frequency of application: water in
  - Deadline M-P's ( 10-40 lb/A)
  - Prozap (12-39 lb/A)
- Preharvest interval: not listed on label
- Restricted entry interval: 12 hours

### Methomyl

- Formulations: Lannate LV, Lannate SP
- Target pests: Thrips, Aphids and Lygus bugs
- Average rate of most common formulations:
  - Lannate LV (1.5-3 pts/A)
  - Lannate SP (0.5-1 lb/A)
- Preharvest interval: 3 days
- Restricted entry interval: 48 hours

### Insecticides Used on Strawberries

Crop	Class	Insecticide	Trade Name	% Acres Treated as Reported by Growers in 1991	% Acres Treated In 2002	Average # Applications
Strawberry	Insecticide	Carbaryl	Sevin 10 or 4F or 80S or XLR	78	45	1
Strawberry	Insecticide	Diazinon	Diazinon 50W or AG500	Not reported	25	1
Strawberry	Insecticide	Malathion	Malathion 5E or 55 or 57EC or 8EC	10	5	1
Strawberry	Insecticide	Azinphos-methyl*	Guthion	15	15	1

\* The registration for the use of azinphos-methyl on strawberries has been cancelled as of September 1, 2002.

## Weeds

Weed control is essential in strawberry production because strawberries are shallow-rooted and often cannot effectively compete with weeds for sunlight, moisture, and nutrients. Furthermore, a proliferation of weeds may increase disease pressure and reduce harvest efficiency. Weeds growing on raised beds have been managed by methyl bromide treatment and use of black plastic mulch.

However, the external border area of the mulch and transplant holes allow some weed germination and emergence. Hand weeding is used in these areas but it is labor intensive and costly. In addition, nutsedge is a troublesome weed on raised beds when fumigation was inadequate. Nutsedge will penetrate the plastic mulch as it emerges and is very competitive with strawberry plants. Weeds can also be a season-long problem in row middles. Row middles are mulched with organic materials to suppress weed growth or are treated with herbicides. Commonly used herbicides are clethodim, paraquat, or sethoxydim. Care is taken to prevent herbicide drift from contacting any portion of the strawberry plant or its fruit. Even with its high cost of application and regulatory restrictions, methyl bromide was used exclusively by growers in Arkansas in fall 2002. The lack of suitable, cost-effective alternatives will severely impact strawberry growers as the methyl bromide phase-out concludes.

### **Herbicides Labeled for Strawberry**

Postemergence herbicides are primarily used on strawberries in Arkansas with the plasticulture system. Applications are to row middles

#### **2,4-D Amine**

- Formulations: Orchard Master, Formula 40, others
- Target weeds: broadleaf weeds
- Application: Apply as multiple applications (1-2) in established plantings as a directed spray to actively growing weeds. Apply 2-3 pt. per acre.
- Restricted entry interval: 12 hours
- Comments: Do not use on newly planted trees. Do not contact foliage, limbs or stems. Research indicates best results are achieved in winter, before bud break. Do not apply within 2 weeks before or after bloom, apple blossoms are very sensitive to 2,4-D.

#### **Clethodim**

- Formulations: Select 2EC
- Target weeds: grasses
- Application: Apply as multiple applications (2-4) in established plantings as a directed spray to actively growing weeds. Apply 6 to 16 fl. oz./ acre plus crop oil concentrate containing at least 17% emulsifier at 1% v/v.
- Restricted entry interval: 12 hours
- Comments: Grasses need to be actively growing and need to be 4 to 6 inches or taller for maximum absorption. Do not apply within 4 days of harvest.

#### **Napropamide**

- Formulations: Devrinol 50 DF
- Target weeds: grasses and broadleaf weeds
- Application: Single application of 8 lb. in at least 20 gallons of water/acre. Apply to the base of plants in late fall to spring on weed free soil.
- Restricted entry interval: 12 hours
- Comments: May be applied to newly planted (non-bearing) or established (bearing) plants. Requires sufficient irrigation or rainfall to wet the soil to a depth of 4 inches within 24 hours of application for incorporation. Do not allow spray to contact fruit or foliage.

#### **Paraquat**

- Formulations: Gramoxone Extra
- Target weeds: grasses and broadleaf weeds
- Application: Multiple applications (2-4) of 1.5 pt. in 20 to 100 gallons of water/acre. Apply as a directed spray to row middles using shields to protect strawberry plants. Add non-ionic

surfactant at 1-2 pt. or crop oil at 1 gal per 100 gallons of water for best result.

- Restricted entry interval: 12 hours
- Comments: Do not allow spray to contact strawberry plants. Do not apply within 21 days of harvest or more than three times per season.
- Restricted use pesticide.

### Sethoxydim

- Formulations: Poast EC
- Target weeds: grasses
- Application: Multiple applications (2-3) of 1.0 to 2.5 pt. plus 2 pt. of a crop oil concentrate in 25 gallons of water/acre. Apply as a directed spray when grass is actively growing.
- Restricted entry interval: 12 hours
- Comments: Low spray volumes generally improve control. Do not apply within 7 days of harvest or apply more than 2.5 pt. per season.

### Herbicides Used on Strawberries

Crop	Class	Herbicide	Trade Name(s)	% Acres Treated as Reported by Growers in 1991	% Acres Treated inf 2002	Average # Applications
Strawberry	Herbicide	2,4-D	Many	30	60	1
Strawberry	Herbicide	Naproamide	Devrinol 50DF	57	50	1
Strawberry	Herbicide	Sethoxydim	Poast EC	30	45	1

## Diseases

### Leaf Spot

*Mycosphaerella* Sp.

The fungus, *Mycosphaerella fragariae*, causes Leaf Spot. 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. Similar spots may be present on the leaf, stems, fruit stalks, runners and caps. Later in the season, tan or bluish areas form on the underside of the leaf. Temperatures between 65°F and 75°F are optimal for infection and disease development. Infection can occur any time throughout the season, except during dry, hot weather. Splashing rain will scatter these spores about the planting.

**Cultural Control:** Control for leaf spot is achieved through the use of resistant cultivars, using disease-free nursery stock and following a fungicide application program.

**Chemical Control:** Topsin M + Captan is applied on a weekly basis to control leaf spot and

provides poor to fair control. Fixed Coppers: applied two or three times in the early seasons before the plants start blooming offers good control. Nova, Syllit and Thiram are also registered for control of this disease.

### **Gray Mold** *Botrytis cinerea*

Gray Mold is one of the most common and serious fruit rot diseases in strawberries. The fungus 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. Plasticulture methods reduce some of the factors that contribute to gray mold infection. After harvest, the mature fruits are also very susceptible to gray mold, especially if damaged.

**Cultural Control:** Plant population control of weeds and excess strawberry plants, which reduce air circulation and drying, will decrease disease risk.

**Chemical Control:** The following fungicides are used to control this disease: Elevate, Captan, Thiram and Topsin-M.

### **Fruit Anthracnose** *Elsinoe veneta*

Anthracnose can be a severe disease attacking both green and ripe strawberry fruit. The disease is favored by high temperatures accompanied by rainfall prior to and during harvest. If anthracnose was a problem in the planting during the previous growing season or is detected in the planting during the current growing season, growers may want to consider an intensified fungicide spray program. In areas where the disease is a constant problem, the use of fungicides is becoming less effective in controlling this disease.

**Chemical Control:** Captan is used to control this disease and results in fair control. Azoxystrobin (Quadris) at 7-10 day intervals provides very good control.

### **Leaf Scorch** *Dicplocarpon earliana*

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 ¼-inch in diameter to appear on the upper leaf surface. The center of the spots remains dark purple without white spots 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.

**Cultural Control:** Plant in areas with good air drainage and use resistant plants.

**Chemical Control:** The following chemicals are registered for Leaf scorch control on strawberry:

Captan, Kocide and Topsin-M.

### **Red Stele**

*Phytophthora fragariae*

The fungus 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. Fruits produced on red stele plants are small, sour and few in number. 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. On a diseased plant the fibrous roots are usually rotted away and coarse (rat-tail) roots are evident. Reddening of the crown does not indicate red stele in the plant.

**Cultural Control:** Inspected and certified planting stocks should be selected. Do not plant in low, wet spots and or on land with a history of red stele infection.

**Chemical Control:** The following chemicals are registered for control of Red stele on strawberry: Aliette, Ridomil Gold, Sectagon, and Telone. When using Aliette as a dip, apply as a pre-plant dip to roots and crowns for 15-30 minutes and plant within 24 hours.

### **Leather Rot**

*Phytophthora cactorum*

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 freestanding water, or the fruit come in direct contact with the soil.

**Cultural Control:** Plant certified plants. Practices include proper site selection (no standing water), on ridges or raised beds, and use of plasticulture to keep fruits from contacting the soil.

**Chemical Control:** Begin Aliette applications between 10% bloom and early fruit set. Continue applications on a 7-14 day interval as long as disease conditions exist. Ridomil Gold and Aliette are the two chemicals registered for this problem.

### **Powdery Mildew**

*Podosphaera leucotricha* (Ell. & Ev.) E.S. Salmon

Powdery mildew is an occasional strawberry problem. However, 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.

**Cultural Control:** Plant resistant varieties if possible.

**Chemical Control:** The following chemicals are registered for Powdery mildew control in strawberry: Benlate, Nova, Quadris and Wettable sulfur.

## Fungicides Labeled for Strawberry

### 1,3-dichloropropene

- Formulations: Telone C-35
- Target diseases: Red stele
- Average rate of most common formulations:
  - Telone C-35 (39-50 Gal/A)
- Preharvest interval: preplant
- Restricted entry interval: 5 days

### Azoxystrobin

- Formulations: Quadris F
- Target diseases: Powdery mildew and Anthracnose
- Average rate of most common formulations:
  - Quadris F (6.2-15.4 fl oz/A)
- Preharvest interval: 0 days
- Restricted entry interval: 4 hours

### Captan

- Formulations: Captan 50 W
- Target diseases: Gray mold, Anthracnose, Leaf spot, Leaf scorch, and Leaf blight
- Average rate of most common formulations:
  - Captan 50W (3-6 lb/A)
- Preharvest interval: 0 days
- Restricted entry interval: 24 hours

### Copper Hydroxide

- Formulations: Kocide 101, Kocide DF, Kocide 4.5LF, Kocide 2000
- Target diseases: Leaf spot, Leaf blight, Leaf scorch
- Average rate of most common formulation:
  - Kocide 101 (2-3 lbs/A)
  - Kocide DF (2-3 lb/A)
  - Kocide 4.5 KF (1.33-2 pts/A)
  - Kocide 2000 (1.5-2.75lb/A)
- Preharvest interval: none
- Restricted entry interval: 24 hours

### Cyprodinil and Fludioxonil

- Formulations: Switch 62.5 WG
- Target disease: Gray mold
- Average rate of applications:
  - Switch 62.5 WG (11-14 oz/A)
- Preharvest interval: none
- Restricted entry interval: 12 hours

### Dodine

- Formulations: Syllit 65WP
- Target diseases: Leaf spot, and Leaf blight

- Average rate of applications:
  - Syllit 65WP (1.5-2 lb/A)
- Preharvest interval: 14 days
- Restricted entry interval: 28 hours

### **Fenhexamid**

- Formulations: Elevate 50 WDG
- Target disease: Gray mold
- Average rate of most common formulation:
  - Elevate 50 WDG (1.5 lb/A)
- Preharvest interval: 4 hours
- Restricted entry interval: 0 days

### **Fosetyl AL**

- Formulations: Aliette WDG
- Target disease: Red stele, Leather Rot
- Average rate of most common formulation:
  - Aliette WDG (2.5-5 lb/A)
- Preharvest interval: 12 hours
- Restricted entry interval: 12 hours

### **Metalaxyl**

- Formulations: Ridomil Gold EC
- Target diseases: Leather Rot, Red Stele
- Average rate of most common formulation: before bloom
  - Ridomil Gold EC (1/2 pt/100 gal) for drench
- Preharvest interval: 45 days
- Restricted entry interval: 48 hours

### **Myclobutanil**

- Formulations: Nova 40WP
- Target diseases: Powdery Mildew, Leaf Spot, Leaf Blight
- Average rate of applications:
  - Nova 40WP (2.5-5 oz/A)
- Preharvest interval: 0 days
- Restricted entry interval: 24 hours

### **Sodium Methyldithiocarbamate**

- Formulations: Sectagon 42
- Target disease: Red Stele
- Preharvest interval: 14-21 days before planting
- Restricted entry interval: 48 hours

### **Sulfur**

- Formulations: Wettable sulfur
- Target diseases: Powdery mildew
- Average rate of most common formulations:
  - Wettable sulfur (2 lb/100 gal water)
- Preharvest interval: none
- Restricted entry interval: 24 hours

### **Thiophanate**

- Formulations: Topsin-M WSB
- Target diseases: Botrytis rot, Leaf spot, Leaf blight, Leaf scorch, Powdery mildew
- Average rate of most common formulations: limited site fungicide  
--Topsin-M WSB (0.75-1 lb/A)
- Preharvest interval: 1 day
- Restricted entry interval: 12 hours

### Thiram

- Formulations: Thiram 65 WP
- Target diseases: Gray mold, Leaf spot, Leaf blight, Leaf scorch
- Average rate of most common formulations:  
-- Thiram 65 WP (4-5 lb/A)
- Preharvest interval: 3 days
- Restricted entry interval: 24 hours

### Fungicides Used on Strawberries

Crop	Class	Fungicide	Trade Name	% Acres Treated as Reported by Growers in 1991	% Acres Treated In 2002	Average # Applications
Strawberry	Fungicide	Captan	Captan 50W	83	77	1
Strawberry	Fungicide	Methyl bromide + chloropicrin	Various	Not reported	15	1
Strawberry	Fungicide	Benomyl	Benlate	53	70	1

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## References

1. American Phytopathological Society. 1998. Compendium of Strawberry Diseases. APS Press, St. Paul, MN. 128 pp.
2. Monks, D. 1998. Weed control options for strawberries on plastic. North Carolina Coop. Ext. Ser. Hort. Information Leaflet 205-B. 2 pp.
3. Ohio State University. 1997. Midwest Small Fruit Pest Management Handbook. Ohio State University Coop. Ext. Bull. 861. 713 pp.
4. Poling, B. 2002. Berry Agent website strawberry advisories.  
<http://intra.ces.ncsu.edu/depts/hort/berrydoc/>
5. Poling, B., D. Wechsler, F. Louws, G. Fernandez, K. Sorensen, and D. Monks. 2002. The strawberry plasticulture notebook. North Carolina Strawberry Association, Pittsboro, NC.
6. Scott, R.C., J.W. Boyd, and K.L. Smith. 2003. Recommended chemicals for weed and brush control. Univ. of Ark. Coop. Ext. Ser. Misc. Publication 44. 154 pp.
7. Southern Region Small Fruit Consortium. 2002. SRSFC website <http://www.smallfruits.org>
8. Studebaker, G., D. Johnson, P. Fenn, S.R. Vann, J. Boyd, J. Clark, C. Rom, and R.K. Striegler. 2003. Midwest Commercial Small Fruit and Grape Spray Guide 2003. Univ. of Ark. Coop. Ext. Ser., Little Rock, AR. 75 pp.
9. University of Arkansas Cooperative Extension Service. 2003. Insecticide Recommendations for Arkansas. Univ. of Ark. Coop. Ext. Ser. Misc. Publication 144. 216 pp.
10. Vann, S. and P. Fenn. 2003. Small Fruit Diseases, p. 11-14, In: R. Cartwright (ed.). Arkansas Plant Disease Control Products Guide - 2003. Univ. of Ark. Coop. Ext. Ser. Misc. Publication 154.