Integrated Management of Strawberry Diseases.
Leaf Diseases
Angular leaf spot
Common leaf spot (Mycosphaerella)
Phomopsis leaf blight
Gnomonia leaf blotch
Powdery mildew
Leaf scorch
Phytoplasmas
Viruses

Fruit
Gray Mold
Anthracnose Ripe fruit rot
Gnomonia fruit rot
Leather fruit rot
Tan brown spot
Miscellaneous fruit rots

Crown and Root Diseases
Anthracnose crown rot
Phytophthora crown rot
Black root rot
Red Stele
Southern stem blight
Armillaria root rot
Fusarium wilt
Botrytis crown rot
Nematodes (root knot, Pratylenchus, Sting)
Cylindrocarpon
Risk Management Resources for Strawberry Growers

The risk management materials on this portal cover topics ranging from marketing and human resources to legal and food safety issues. Crop insurance products are presented in addition to disaster assistance programs and agricultural contracts. You will

READ THE REST »

At the moment, there are no upcoming events listed.
Strawberry Diagnostic Key
Integrated Pest Management

Alternaria black spot details
Scientific Name(s): Alternaria alternata
Characteristics:
- Disease: Deformed, Lesion, Harvest
- Type: Fruit Condition, Season

Anthracnose Fruit Rot details
Scientific Name(s): Colletotrichum acutatum
Characteristics:
- Disease: Young, Lesion
- Type: Leaf Condition, Fruit Texture, Root
- Soft, Necrotic, Lesion, Death, Colony
- Stunted, Necrotic
- Random, Localized
- Rain, Thunderstorms, High temperature, Temp. between 20° and 32°
- Posttransplant, Pre-harvest, Harvest
- Annual plasticulture, Perennial matted row

Anthracoce Fruit Rot of Strawberry

Introduction
Anthracnose is an important disease of strawberry with all parts of the plant (fruit, crown, leaves, petals and runners) being susceptible to the pathogen. Three related species of the fungus: Colletotrichum acutatum, C. gloeosporioides, and C. fragariae can be associated with anthracnose. However, C. acutatum is the main pathogen associated with the antracnose fruit rot (AFR) phenomenon and the main target of this checklist. Disease control is difficult when environmental conditions are favorable for disease development (low prevailing conditions) but if inoculum is present. The disease can be especially destructive to susceptible California strawberry cultivars (e.g., Chandler, Camarosa, Albion) when grown on black plastic.

Symptoms and Signs
Anthracnose fruit rot appears as brown to black, water-soaked spots on green leaves. Lesions may appear on stems and petioles. Fruit lesions are sunken and black, especially when they are mature. Flowers or leaves may wilt and die rapidly. Anthracnose fruit rot is caused by Colletotrichum acutatum, which can be present on many strawberry cultivars. It thrives in wet conditions and spreads through air-borne spores. The disease can be controlled by managing moisture levels and minimizing the use of overhead irrigation. Crop rotation and the use of disease-resistant cultivars are also effective strategies.
Gray mold on different parts of strawberry; a) Sporulation on dead petiole and leaf; b) fruit infection from colonized dead tissue; c) lesion appearance from internal infection that has occurred through the flower parts such as the stigma.
Infection Cycle of *B. cinerea*

- **Transplant lvs**
- **Nov / Dec lvs**
- **New lvs**
- **Flower development**
- **Fruit set**
- **Critical time for management**

**Source of inoculum**

**Oct | Nov | Dec | Jan | Feb | Mar | Apr | May**
IPM-based Management for Gray Mold:

• manage optimum fertility
• optimum plant spacing
• remove dead and dying leaves before first bloom (not economical if fungicides will be used; never conduct if anthracnose is present)
• initiate fungicide sprays at first bloom
• Implement a fungicide program to reduce risk of disease and that seeks to prevent selection of Botrytis populations that are resistant to the new fungicides.

FACTSHEET
https://content.ces.ncsu.edu/botrytis-cinerea-botrytis-fruit-rot-and-blight-on-strawberry
Strawberry Anthracnose: Biology

*Colletotrichum acutatum*
## IPM of Anthracnose

<table>
<thead>
<tr>
<th>Species</th>
<th>Associated Disease Phase</th>
<th>Economic Importance in NC</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Colletotrichum acutatum</em></td>
<td>Fruit rot</td>
<td>High</td>
</tr>
<tr>
<td><em>Colletotrichum gloeosporioides</em></td>
<td>Crown rot</td>
<td>Low to moderate</td>
</tr>
<tr>
<td><em>Colletotrichum fragariae</em></td>
<td>Crown rot</td>
<td>Not found since 1986</td>
</tr>
</tbody>
</table>
Disease cycle of *C. acutatum* on strawberry

- Transplant
- Dissemination
- Rain and irrigation
- Acervulus with conidia
- Sporulating lesions
- Survival
- Infection
- Germination
- Warm Temperature
- High RH
All parts of strawberry are susceptible to *C. acutatum* Anthracnose petiole rot, flower blight & green fruit rot.
Problems in plug production and transplants (plant source)
Poor grow-out of infected plants
Anthracnose

Ripe fruit rot/black spot: *Colletotrichum acutatum*

Symptoms appear as whitish, water soaked lesions (3mm) eventually become sunken and black

Crown rot: *C. gloeosporioides*

Symptoms: Above ground-Plant collapse/wilting and death; Crown-firm, reddish brown/marbled appearance
Symptoms on foliage

- Quiescently infected tips normally express symptoms during plug production under mist.
- Plants are not establishing in the field uniformly
- Black irregular lesions on leaf
- Black lesion on runner and petiole
(Gramoxone) Paraquat-killed leaves allow the pathogen to grow out.

The pathogen reproduces on green leaves without showing symptoms (Hemibiotrophic).
Biology: Anthracnose of strawberry

• Infested plants are the main source of disease.
• NC observations suggest over-summering of the disease does not occur if all infected plants are destroyed after final harvest.
• Infested tips leads to widespread problems in plug houses
• Quiescent infections may be present and spring epidemics occur under favorable conditions
• *C. gloeosporioides* can originate from wild hosts
IPM-based Management for Anthracnose ripe fruit rot:
• buy disease-free plants (Tissue cultured, certified or grown under similar stringent conditions)
• immediately rogue out infected plants if small number
• destroy or bury all infected plants/fruit

• initiate QoI fungicides [Cabrio/Pristine] combined with or rotated with Captan sprays (NOTE: Failure using Quadris has occurred in recent years)

• specific recommendation programs with available fungicides for proactive management and re-active management of anthracnose ripe fruit rot.
Fungicide Efficacy
Product Evaluations

• Screen products for efficacy

• Integrate products into program for anthracnose, Botrytis, and resistance management

• Make IPM recommendations to growers
Fungicides: New chemistry, Efficacy and Scheduling

captan
topsin-M
thiram
Copper
Rovral
Elevate
Switch
Quadris
Cabrio
Pristine
Scala
Quadris
Top
Ridomil
Aliette
ProPhyt
Phostrol
Rally (NOVA)
Procur
Sulfur
Quintec
Tilt (Jade)
Inspire
Super
Fungicide Evaluations
Gray mold (Botrytis cinerea) cumulative incidence 1998

- Control
- Captan
- Quadris
- Cygnus
- Switch
- Elevate

Days since harvest start

Gray mold incidence (# fruit/plot)
<table>
<thead>
<tr>
<th>TRT #</th>
<th>Treatment</th>
<th>Fruit with Botrytis (g/plot)</th>
<th>Total Wt (g/plot)</th>
<th>MKTBLE Wt (g/plot)</th>
<th>%MKTBLE (g/plot)</th>
<th>% Gray Mold Wt (g/plot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Captan/P/Sw1-9</td>
<td>221.6</td>
<td>A 13198</td>
<td>12224</td>
<td>92.7</td>
<td>B 1.69</td>
</tr>
<tr>
<td>12</td>
<td>Capt/TM Fall and 1-9</td>
<td>237.8</td>
<td>A 13438</td>
<td>12280</td>
<td>91.5</td>
<td>B 1.73</td>
</tr>
<tr>
<td>3</td>
<td>Captan/P/Sw1-4</td>
<td><strong>226.9</strong></td>
<td>A <strong>12855</strong></td>
<td><strong>11312</strong></td>
<td><strong>88.1</strong></td>
<td><strong>B 1.75</strong></td>
</tr>
<tr>
<td>5</td>
<td>Captan/P/Capt1-9</td>
<td>242.3</td>
<td>A 12390</td>
<td>11370</td>
<td>91.8</td>
<td>B 1.95</td>
</tr>
<tr>
<td>1</td>
<td>Control</td>
<td>524.8</td>
<td>B 12495</td>
<td>11084</td>
<td>88.7</td>
<td>B 4.22</td>
</tr>
<tr>
<td>7</td>
<td>Experimental</td>
<td>773.1</td>
<td>C 12875</td>
<td>10528</td>
<td>82.0</td>
<td>A 5.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>0.05</strong></td>
<td><strong>NS</strong></td>
<td><strong>0.05</strong></td>
<td><strong>0.05</strong></td>
</tr>
</tbody>
</table>
Importance of Post-harvest decay
1. No spray
2. Thiram 65WS 3.0 lb
3. Switch 62.5 WG 11 oz /
   Elevate 50 WG 1.5 lb
4. Elevate 50 WG 1.0 lb +
   Captan 50 WP 3.75
5. Elevate 50 WG 1.5 lb
6. Sanitation
7. Captan 50 WP 4.0 lb +
   Topsin M 70W 1.1 lb /
   Elevate 50 WG 1.5 lb /
   Switch 62.5 WG 11 oz
8. Switch 62.5 WG 11 oz
9. Captan 50 WP 4.0 lb +
   Topsin M 70W 1.1 lb /
   Pristine 1.45 lb /
   Switch 62.5 WG 11 oz
10. Pristine 1.45 lb
Anthracnose Incidence Castle Hayne Trial 2002
### Anthracnose Incidence 2002

<table>
<thead>
<tr>
<th>Treatment and rate/A</th>
<th>Timing*</th>
<th>Anthracnose (%)**</th>
<th>Total yield (lb/plot)</th>
<th>Marketable fruit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitation</td>
<td>-</td>
<td>19.3 f</td>
<td>12.4</td>
<td>50.7 a</td>
</tr>
<tr>
<td>No spray</td>
<td>-</td>
<td>17.5 ef</td>
<td>13.1</td>
<td>54.6 ab</td>
</tr>
<tr>
<td>Captan 50WP 4.0 lb + Quadris 2.08SC 9.0 fl oz</td>
<td>6-9</td>
<td>11.9 de</td>
<td>14.1</td>
<td>70.8 cd</td>
</tr>
<tr>
<td>Captan 50WP 4.0 lb + Quadris 2.08SC 9.0 fl oz</td>
<td>1,2</td>
<td>9.9 cd</td>
<td>14.2</td>
<td>64.0 bc</td>
</tr>
<tr>
<td>Switch 62.5 WG 0.88 lb</td>
<td>3,4</td>
<td>9.0 bcd</td>
<td>15.9</td>
<td>68.9 cd</td>
</tr>
<tr>
<td>Thiram 65 WSB, 3.0 lb</td>
<td>1-10</td>
<td>5.4 abc</td>
<td>13.6</td>
<td>75.8 de</td>
</tr>
<tr>
<td>Switch 62.5WG 0.88 lb</td>
<td>1,3</td>
<td>4.6 abc</td>
<td>15.8</td>
<td>74.8 de</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.0 fl oz</td>
<td>2,4</td>
<td>4.2 ab</td>
<td>18.2</td>
<td>81.3 e</td>
</tr>
<tr>
<td>Elevate 50 WG 1.5 lb + Captan 50WP 5.63 lb</td>
<td>1-10</td>
<td>3.0 a</td>
<td>15.4</td>
<td>83.0 e</td>
</tr>
<tr>
<td>BAS 516 UDF 38% 1.45 lb</td>
<td>1-10</td>
<td>5.5</td>
<td>NS</td>
<td>9.6</td>
</tr>
</tbody>
</table>

* Applications 1-10 correspond to weekly applications between 14 Mar and 16 May. Alternatively, fungicides were limited to 4 appl applied early season only (appl 1-4) or beginning at first appearance of anthracnose fruit rot (appl 6-9; no application in week 5).

** Values followed by the same letter within a column are not significantly different.
# Efficacy of fungicides and biologicals against AFR, 2009

<table>
<thead>
<tr>
<th>Treatments and rates (units product/A)</th>
<th>Schedule</th>
<th>Anthracnose Incidence (%)(^w)</th>
<th>Marketable Yield (g/plant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not-treated ...........................................</td>
<td>---</td>
<td>67.85 ab</td>
<td>142.91</td>
</tr>
<tr>
<td>Captan 50 WP 4.0 lb + Topsin M 70 W 1.0 lb</td>
<td>spray #1,4,7,8</td>
<td>25.66 d</td>
<td>333.23</td>
</tr>
<tr>
<td>Pristine WG 1.45 lb ..............................</td>
<td>spray #2,3,5,6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captan 50 WP 4.0 lb + Topsin M 70 W 1.0 lb</td>
<td>spray #1,4,7,8</td>
<td>62.35 bc</td>
<td>250.69</td>
</tr>
<tr>
<td>Abound 12 fl oz .................................</td>
<td>spray #2,3,5,6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KPP-105WP 2.0Kg ....................................</td>
<td>spray #1-8</td>
<td>68.73 a</td>
<td>188.43</td>
</tr>
<tr>
<td>KPP105WP 4.0Kg .....................................</td>
<td>spray #1-8</td>
<td>61.92 bc</td>
<td>197.10</td>
</tr>
<tr>
<td>Captan 50 WP 4.0 lb + Topsin M 70W 1.1 lb</td>
<td>Spray#1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BU EXP 1216S4 3 lb ......................</td>
<td>Spray#2,4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CaptEvate 68WDG 4.5 lb</td>
<td>Spray#3,5,7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BU EXP 1216S4 3 lb ...............................</td>
<td>Spray#6,8</td>
<td>60.72 c</td>
<td>280.21</td>
</tr>
</tbody>
</table>

\(^w\)Means within a column followed by the same letter are not significantly different according to Fisher’s protected LSD test \((P \leq 0.05)\). Average from all harvests.

Abound did not work either in 2007-2008 or 2008-2009 while Captan, pristine based schedule was effective.
Only from 6th harvest, fungicides were applied 24 h prior to inoculation
Strawberry Growers Information

Strawberry Fruit Infection Risk Predictions (Oct 20 2015 to Nov 06 2015)

'Mclick' marker to view risk information.
Kinston, NC (Lenoir County) - Cunningham Research Station (KINS)

**Pest**
- Anthracnose (Colletotrichum acutatum)
- Grey Mold-Rot (Botrytis cinerea)

**Model**
- FLSAS

**Risk**
- High

**Anthracnose (Colletotrichum acutatum)**
**Florida Strawberry Advisory System Model (FLSAS)**

If flowers and/or fruit are present and the last fungicide application was more than 7 days ago, a fungicide application is recommended. For more information read Southeast Regional Strawberry IPM Guide.

**Infection Events**

### Past 10 Days

<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
<th>Start</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>3</td>
<td>Aug 10 10:37PM</td>
<td>9.92</td>
</tr>
<tr>
<td>High</td>
<td>2</td>
<td>Aug 11 10:42PM</td>
<td>16.58</td>
</tr>
</tbody>
</table>

### Forecast

<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
<th>Start</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>3</td>
<td>Aug 16 08:30PM</td>
<td>11.00</td>
</tr>
<tr>
<td>High</td>
<td>1</td>
<td>Aug 17 09:30PM</td>
<td>59.00</td>
</tr>
</tbody>
</table>

NC Climate Office: Aug 06 12:00AM - Aug 16 01:40AM
NOAA's NWS Forecast: Aug 16 02:00AM - Aug 23 01:00AM
All times Eastern Standard (EST)
# Prediction based spray schedule

<table>
<thead>
<tr>
<th>Treatments</th>
<th># of sprays applied</th>
<th>AFR incidence (%)&lt;sup&gt;ab&lt;/sup&gt;</th>
<th>Marketable yield (lb/plant)&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non treated control</td>
<td>-</td>
<td>8.5 a</td>
<td>0.73 b</td>
</tr>
<tr>
<td>Regular Schedule</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captan 50WP 4.0 lb + Topsin M 70W 1.0 lb</td>
<td>1</td>
<td>3.2 b</td>
<td>0.87 a</td>
</tr>
<tr>
<td>Pristine WG 1.45 lb</td>
<td>2, 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CaptEvate 68WDG 4.5 lb</td>
<td>3, 5, 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pristine WG 1.45 lb</td>
<td>6, 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prediction based schedule</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captan 50WP 4.0 lb</td>
<td>1</td>
<td>4.4 b</td>
<td>0.75 ab</td>
</tr>
<tr>
<td>Captan 50WP 4.0 lb</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pristine WG 1.45 lb</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Disease incidence was calculated from all harvested fruits over 8 weeks

<sup>b</sup>Means in a column followed by the same letter are not significantly different by Fisher’s protected LSD test (\( \alpha \leq 0.05 \)).
Anthracnose fruit rot incidence as impacted by no fungicides compared to 7 weekly sprays (Std Full) and 3 forecast-based sprays (Std reduced).
Anthracnose Fruit Rot Incidence (%)

Harvest Week (Week 1=4/15/2016)

- Water Control
- Standard Weekly (C/P;S;P;C;S;P;S;P)
- STD 4 apps
- Forecast
- Forecast 4apps
- Resistance Mgmnt
*In vitro* resistance to 0, 1.0, 100.0 \( \mu g/ml^{-1} \) benomyl-amended PDA
Growth after 4 days

<table>
<thead>
<tr>
<th>Sensitive</th>
<th>Resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Untreated)</td>
<td>Rovral</td>
</tr>
<tr>
<td>Pristine, boscalid</td>
<td>Topsin M</td>
</tr>
<tr>
<td>Scala</td>
<td>Switch, fludioxonil</td>
</tr>
<tr>
<td>Elevate</td>
<td>Cabrio</td>
</tr>
</tbody>
</table>
## Botrytis Resistance Profile of Fungicides

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Resistance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pristine (QoI) (use Cabrio)</td>
<td>R- High</td>
</tr>
<tr>
<td>pyraclostobin</td>
<td>R- High</td>
</tr>
<tr>
<td>boscalid</td>
<td></td>
</tr>
<tr>
<td>Fontelis</td>
<td>R- medium</td>
</tr>
<tr>
<td>Captan</td>
<td>none</td>
</tr>
<tr>
<td>Elevate</td>
<td>R- High</td>
</tr>
<tr>
<td>CaptEvaTE</td>
<td>As above</td>
</tr>
<tr>
<td>Scala</td>
<td>R- High</td>
</tr>
<tr>
<td>Switch</td>
<td></td>
</tr>
<tr>
<td>cyprodinil</td>
<td>R- medium</td>
</tr>
<tr>
<td>fludioxinil</td>
<td>R- very low</td>
</tr>
<tr>
<td>Rovral</td>
<td>R- medium</td>
</tr>
<tr>
<td>Topsin-M</td>
<td>R- Very High</td>
</tr>
<tr>
<td>Fungicide</td>
<td>Active Ingredient(s)</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>fixed copper</td>
<td>fixed copper</td>
</tr>
<tr>
<td>Thiram</td>
<td>thiram</td>
</tr>
<tr>
<td>Captan</td>
<td>captan</td>
</tr>
<tr>
<td>Captevate</td>
<td>captan + fenhexamid</td>
</tr>
<tr>
<td>Tospin M</td>
<td>thiophanate-methyl</td>
</tr>
<tr>
<td>Rovral</td>
<td>iprodione</td>
</tr>
<tr>
<td>Rally</td>
<td>myclobutanil</td>
</tr>
<tr>
<td>Procure</td>
<td>triflumizole</td>
</tr>
<tr>
<td>Ultra Flourish</td>
<td>mefenoxam</td>
</tr>
<tr>
<td>MetaStar</td>
<td>metalaxyl</td>
</tr>
</tbody>
</table>

Guido Schnabel Clemson University MyIPM app

Fungicide resistance management guidelines for strawberries grown in the Southeast - 2013; modified from mid-Atlantic Guide

Same color fungicides belong to the same chemical class or FRAC code; M = multi-site mode of action (MOA), numbered codes = chemistries with similar, single MOA; Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop; * = resistance reported on East Coast; x = resistance widespread on East Coast; High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively.

- Protectants, multi-site Mode of Action (MOA), use alone, or tank mix and rotate with high-risk fungicides
- Tank mix and rotate with other FRAC codes
- Tank mix with FRAC code M fungicides and rotate with other non-FRAC code 11 fungicides
- Can be applied as spray or through drip irrigation
- Use as preplant dip or spray application, see label
- See label for use instructions
- Tank mix and rotate with other FRAC codes
Risk Management Resources for Strawberry Growers

The risk management materials on this portal cover topics ranging from marketing and human resources to legal and food safety issues. Crop insurance products are presented in addition to disaster assistance programs and agricultural contacts. You will find detailed guidance to help you make informed decisions.

At the moment, there are no upcoming events listed.
Sponsored by:
Clemson University, NC State University, Virginia Polytechnic Institute and State University, University of Arkansas, The University

2016 Southeast Regional Strawberry Integrated Pest Management Guide

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Recommendations are based on information from the manufacturer’s label and performance data from research and Extension field tests.

Because environmental conditions and grower application methods vary widely, suggested use does not imply that performance of the pesticide will always conform to the safety and pest control standards indicated by experimental data.

This publication is intended for use only as a guide. Specific rates and application methods are on the pesticide label, and these are subject to change at any time. Always refer to and read the pesticide label before making any application! The pesticide label supersedes any information contained in this guide, and it is the legal document referenced for application standards.
HOST RESISTANCE:
Evaluation of Strawberry Selections
For Management of Ripe Fruit Rot

What are the components of field level resistance?

Incidence of quiescent infections?
Fruit rot resistance?
Nursery epidemics?

Are the components linked?

Rahman et al. 2013a;
Phytophthora crown and root rot
Oospores of *P. cactorum* can be seen in infected strawberry root tissue

(Photo courtesy of F.J. Louws, NC State University)
Site Selection

❖ Good soil drainage is critical!
❖ Areas of standing water will increase the possibility of Phytophthora crown and root rot.
<table>
<thead>
<tr>
<th>Pest/Problem</th>
<th>Management Options</th>
<th>Effectiveness (+) or Importance (*)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthracnose</td>
<td></td>
<td>******</td>
<td>Use of certified plants or plants produced in a similarly stringent program is the most important method to prevent these diseases.</td>
</tr>
<tr>
<td>Angular leaf spot</td>
<td></td>
<td>++++</td>
<td></td>
</tr>
<tr>
<td>Phytophthora crown rot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viruses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nematodes</td>
<td>Sample soil</td>
<td>***</td>
<td>Sample soil for nematode analysis through local state services to determine which fumigant may be required.</td>
</tr>
<tr>
<td></td>
<td>Crop rotation and cover crop selection</td>
<td>***</td>
<td>Selected soils, cover crops and rotating fields to other crops for 2-3 years can suppress nematode populations.</td>
</tr>
<tr>
<td>Weeds</td>
<td>Pre-plant fumigation and laying down plastic mulch</td>
<td>++++</td>
<td>See fumigation recommendations. Consult with custom applicators and/or Extension agents for product and rate recommendations.</td>
</tr>
</tbody>
</table>

Pre-plant fumigation and laying down plastic mulch

Use of certified plants or plants produced in a similarly stringent program is the most important method to prevent these diseases.
There are several registered fumigants which provide good disease management, to include control of *Phytophthora* spp. in the planting bed.

**Caution:** fumigating could allow rapid recolonization by *Phytophthora* species.

---

### Relative Efficacy: Currently Registered Fumigants or Fumigant Combinations for Managing Soilborne Nematodes, Diseases, and Weeds

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate per Broadcast Acre</th>
<th>Nematodes</th>
<th>Disease</th>
<th>Nutsedge</th>
<th>Weeds: Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telone C35(^3) (1,3-D + chloropicrin)</td>
<td>39 – 50 gal</td>
<td>++++</td>
<td>++++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Telone C35 + VIF(^3)</td>
<td>See comments below</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Metam sodium(^2) (MS)(^3)</td>
<td>37.5 - 75 gal</td>
<td>++</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Chloropicrin(^3)</td>
<td>150 - 350 lb</td>
<td>+</td>
<td>++++</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Pic-Clor 60(^2) (chloropicrin + 1,3-D)</td>
<td>19.5 – 31.5 gal</td>
<td>++++</td>
<td>++++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Chloropicrin + MS(^3)</td>
<td>19.5 – 31.5 gal + 75 gal</td>
<td>++</td>
<td>++++</td>
<td>?</td>
<td>+++</td>
</tr>
<tr>
<td>Paladin (dimethyl disulphide) should be formulated with 21% chloropicrin +VIF</td>
<td>35.0 – 51.3 gal</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
<td>+++(^5)</td>
</tr>
</tbody>
</table>

\(^1\)Each of the fumigants listed in this table has performed well in regional trials. Some alternative fumigants may need to be complemented with herbicides or hand weeding, depending on weed pressure.

\(^2\)Metam sodium can be Vapam, Sectagon, or other registered formulations.

\(^3\)Refer to the Herbicide Recommendation section of this guide for directions pertaining to herbicide applications.

\(^4\)Reduced rates can be used with VIF.

\(^5\)Paladin has low efficacy on certain small seeded broadleaf weeds and grasses; Paladin is not registered in all States.
Several products are registered for plant dips to kill pathogens or to protect plants just prior to field setting, but only a limited amount of research has been done with plant dips. In general, these treatments are not recommended except under specific circumstances, for example, if a disease has been diagnosed to be on the transplants.
Phosphites—Dip plants in 2.5 lb/100 gal (Aliette), 2 pints/100 gal (ProPhyt), or 2.5 pints/100 gal (Phostrol) for 15 to 30 minutes, and then plant within 24 hours after treatment. This treatment should help to suppress *Pythium* and *Phytophthora* problems.
# Phytophthora Fungicidal IPM Tools

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Application Rate</th>
<th>REI</th>
<th>PHI</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ridomil Gold SL</strong></td>
<td>1 pt/acre</td>
<td>12 hrs</td>
<td>0 days</td>
<td>3 applications are allowed.</td>
</tr>
<tr>
<td><strong>Phosphites</strong> (phosphonates)</td>
<td>Various rates; see label</td>
<td>12 hrs</td>
<td>0 days</td>
<td>Red Stele and Leather Rot are on the label. Do not tank mix with copper compounds of foliar fertilizers.</td>
</tr>
<tr>
<td>i.e. Aliette, ProPhyt, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Management through root-development phenology-based recommendations

Strawberry plants initiate considerable root growth in the early spring. Time control applications in problem fields when new growth begins in the spring.
What about resistance development?

• Mefenoxam resistance has been reported for *P. cactorum* (crown rot) in South Carolina (Jeffers et al., 2004).

• Continued and exclusive use of mefenoxam may easily select for resistant *P. cactorum* isolates in individual field sites, resulting in control failure.
The phosphite-based chemicals (ProPhyt, Aliette, etc.) are not as effective as Ridomil Gold. Consider phosphites if the pathogen is known to be resistant to mefenoxam or if strawberry plants have poor root systems but sufficient foliage for chemical uptake.
Table 1. Effects of treatments with Aliette or Ridomil on productivity of two strawberry cultivars in non-infested soil and soil infested with *Phytophthora cactorum*.

<table>
<thead>
<tr>
<th>Strawberry cultivar</th>
<th>Soil treatment with <em>P. cactorum</em></th>
<th>Chemical treatment program</th>
<th>Marketable yield (total grams per plant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diamante</td>
<td>Infestation</td>
<td>Aliette plant dip and spray</td>
<td>1031</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water control plant dip and spray</td>
<td>572</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ridomil soil drench</td>
<td>1163</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water control soil drench</td>
<td>659</td>
</tr>
<tr>
<td></td>
<td>Non-infested control</td>
<td>Aliette plant dip and spray</td>
<td>1113</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water control plant dip and spray</td>
<td>1097</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ridomil soil drench</td>
<td>1172</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water control soil drench</td>
<td>1128</td>
</tr>
<tr>
<td>Aromas</td>
<td>Infestation</td>
<td>Aliette plant dip and spray</td>
<td>1388</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water control plant dip and spray</td>
<td>938</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ridomil soil drench</td>
<td>1400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water control soil drench</td>
<td>891</td>
</tr>
<tr>
<td></td>
<td>Non-infested control</td>
<td>Aliette plant dip and spray</td>
<td>1481</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water control plant dip and spray</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ridomil soil drench</td>
<td>1463</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water control soil drench</td>
<td>1384</td>
</tr>
</tbody>
</table>

Least significant difference: 386

Aliette = dip and five applications
Ridomil = 3 applications
Strawberry disease diagnosis

Cut the crown longitudinally

Marbled reddish brown - most likely glo crown rot

Cut the crown longitudinally

Marbled reddish brown - most likely glo crown rot

Dull brown color - most likely Phytophthora

Presumptive quick test with Agdia immunoStrip

C. gloeosporioides
C. acutatum (rare)

Salmon colored spore masses

Blunt ends

Acute ends

Oospore (P. cactorum/fragariae)

If no conclusion is drawn, proceed with DNA based method

Abiotic causes are most likely

* High salt
* Boron toxicity
* Improper planting depth

Incubate the crown in a plastic container on 3 layers of moist paper towels

No discoloration inside crown

ANGULAR LEAFSPOT

*Xanthomonas fragariae*

- has a narrow host range restricted to strawberry

- Distribution: now world-wide probably on infected plants
Angular Leaf Spot Disease Management Requires:

1. **SITE SELECTION AND PREPARATION**: NA

2. **USE DISEASE FREE PLANTS**: Use healthy plants, although symptoms may not be apparent at the time of field setting.

3. **MONITOR AND MANAGE**: Limit overhead watering and frost protection events; Use row-covers in frost protection.

4. **CHEMICAL CONTROL**: No products have shown effective control or benefits. Copper may be useful to limit the occurrence of calyx infections. Use 3 applications during cool wet weather and as fruit is forming.