Integrated Management of Strawberry Diseases.

Fruit

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

Leaf Diseases

Angular leaf spot
Common leaf spot (Mycosphaerella)
Phomopsis leaf blight
Gnomonia leaf blotch
Powdery mildew
Leaf scorch
Phytoplasmas
Viruses

Minor Diseases
Major Diseases
Emerging Diseases

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

https://strawberries.ces.ncsu.edu

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New Growers

NC Plant Disease & Insect Clinic

Strawberry Fruit Infection Risk Tool

— Fruit Infection Risk Tool Instructions

NC Strawberry Diagnostic Key

SRSFC IPM Guide *(PDF)*

Small Fruit & Specialty Crop IPM Blog

key

FEATURED CONTENT

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

READ THE REST »


Views from the Field


Using a Digital Thermometer to Guide...


New Publication "Sustainable Practices...


Cold Injury To Strawberry Crowns (V...


Risk Management Resources for Strawb...

*At the moment, there are **no upcoming events listed**.*

https://diagnosis.ces.ncsu.edu/strawberry/disorders/?attribute_ids=41

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Strawberry Diagnostic Key

Integrated Pest Management

Home | How to use this tool | Help and definitions | Log In | Search for a disorder

11 Filter by:

- Disorder Type
- Leaf Condition
- Leaf Location
- Fruit Condition
  - Deformed (2)
  - Lesion (11)
  - Bruised (1)
- Fruit Texture
- Fruit Color
- Roots
- Petioles Condition
- Petioles Color
- Plant Size
- Flower Condition
- Field Distribution
- Prior Environmental
- Season
- Cropping System

Alternaria black spot details

Scientific Name(s) *Alternaria alternata*

Characteristics:

Type	Disease
Fruit Condition	Deformed, Lesion
Season	Harvest

Anthracnose Fruit Rot details

Scientific Name(s) *Colletotrichum acutatum*

Characteristics:

Type	Disease
Leaf Location	Young
Fruit Condition	Lesion
Fruit Texture	Soft
Roots	Necrotic
Petioles Condition	Lesion, Death, Colla
Plant Size	Stunted
Flower Condition	Necrotic
Field Distribution	Random, Localized
Prior Environmental	Rain, Thunderstorm, High temperature, Temp. between 20° and 32°
Season	Post transplant, Pre harvest, Harvest
Cropping System	Annual plasticulture, Perennial matted row

Gnomonia Stem-End Rot details

Anthracnose Fruit Rot of Strawberry

Introduction

Anthracnose is an important disease of strawberry with all parts of the plant (fruit, crowns, leaves, petioles and runners) being susceptible to the pathogen. Three related species of the fungus *Colletotrichum*, including *C. acutatum, C. gloeosporioides*, and *C. fragariae* can be associated with anthracnose. However, *C. acutatum* is the main pathogen associated with the anthracnose fruit rot (AFR) phase and the main topic of this factsheet. Disease control is difficult when environmental conditions are favorable for disease development (see predisposing conditions below) and 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 and ripe fruit (Figure SS-1, Figure SS-2). Firm, sunken brown to black lesions can develop over time depending on the prevalent relative humidity at the time of disease development. Pink, salmon, or orange-colored masses of spores may form in the lesion under humid conditions (Figure SS-3, Figure SS-6) where lesion may appear less sunken and brownish. Under dry conditions, lesions appear more sunken and black and the entire fruit may dry up to be mummified (Figure SS-2). Buds, pedicels, peduncles, and flowers of most cultivars are susceptible to *C. acutatum* (Figure SS-4). Flowers may also die and dry out. If infection occurs shortly after pollination, the developing fruit remains small, hard, and is mis-shapened. The pathogen can also wash down into the root zone and cause black lesions on roots (Figure SS-4). Infected tips can lead to widespread infections on young tissue of the plug plants (Figure SS-4) and plant loss (Figure SS-5). Infected tissue placed in an incubation chamber will sporulate within 24 hours. Symptoms can also be confused with Alternaria fruit rot, Phomopsis frit rot, Rhizoctonia dry rot, or hail damage but the combination of signs (spores) and symptoms is diagnostic for this disease.

Figure SS-1: Anthracnose ripe fruit rot showing multiple lesions on a mature fruit. Most lesions are sunken and in this case have an orange coloration due to the presence of millions of spores.
Frank J. Louws

Figure SS-2: Anthracnose Fruit Rot showing a range of symptoms on green fruit: newly formed lesions, fruit heavily covered by lesions and spores, and a mummified fruit that has dried down.
Frank J. Louws

Figure SS-3: Anthracnose fruit rot showing a large sunken lesion with extensive amounts of sticky orange spores within the lesion. This picture was taken from fruit within a field.
Frank J. Louws

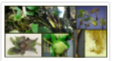


Figure SS-4: Range of symptoms associated with Colletotrichum acutatum on various tissues.
Frank J. Louws

Figure SS-5: Severe plant damage in a plug operation due to Colletotrichum acutatum. More than 60,000 plugs were lost. Symptoms often show up first as "sunken" areas of growth within a tray or across several trays due to plant stunting, then plant death.
Frank J. Louws

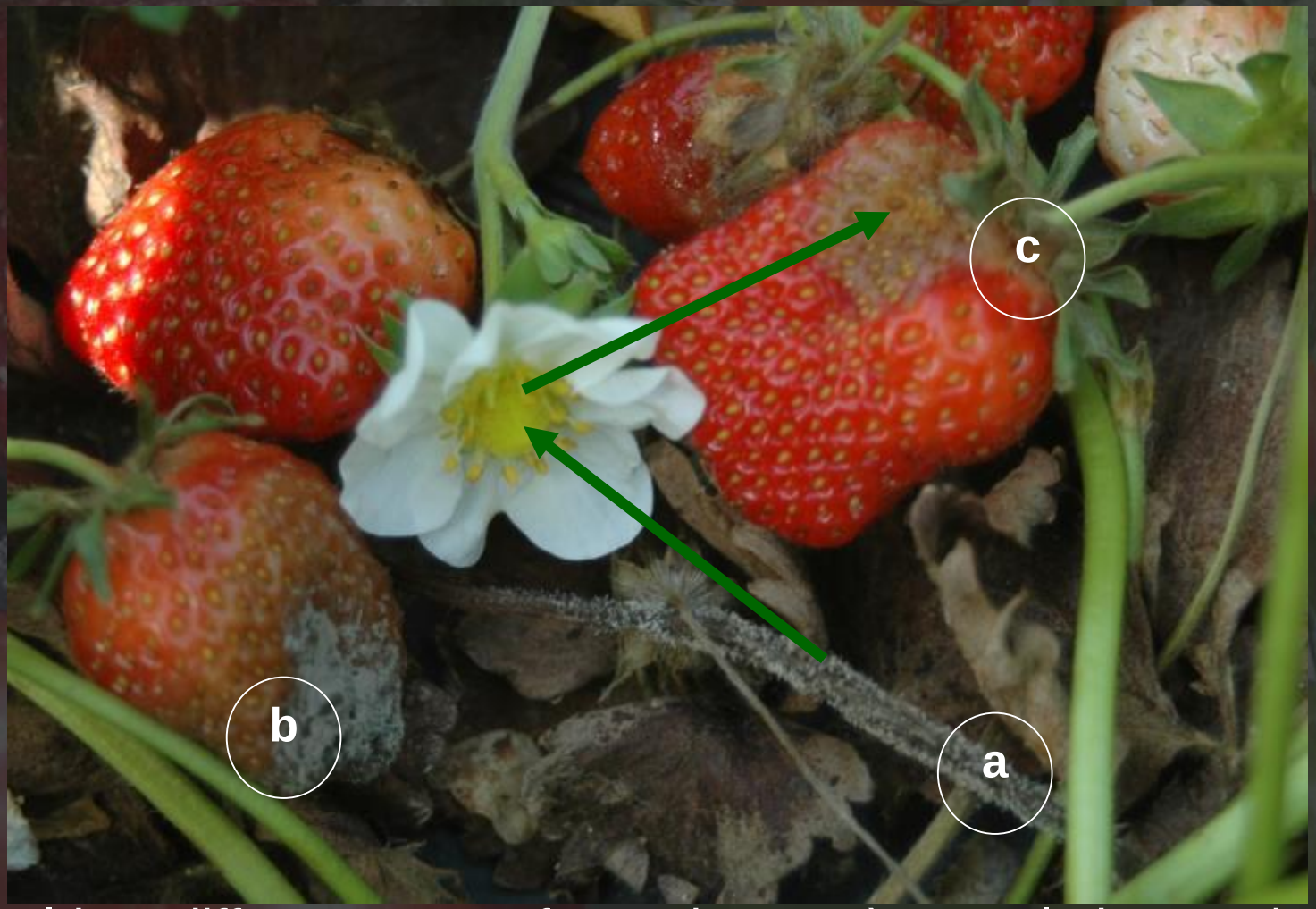
Figure SS-6: Gelatinous mass of orange C. acutatum conidia produced within a sunken lesion on an infected strawberry.
Garrett Ridge





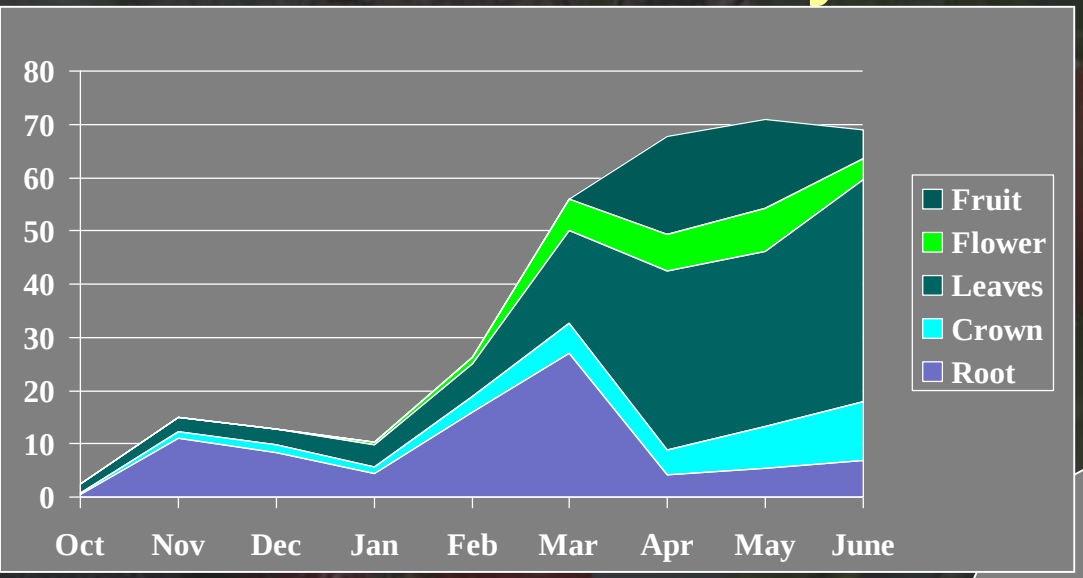



Botrytis Biology: Gray mold of strawberry



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*



Fruit set

Flower development

New lvs

Nov / Dec lvs

Critical time for management

Transplant lvs

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May

Source of inoculum

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

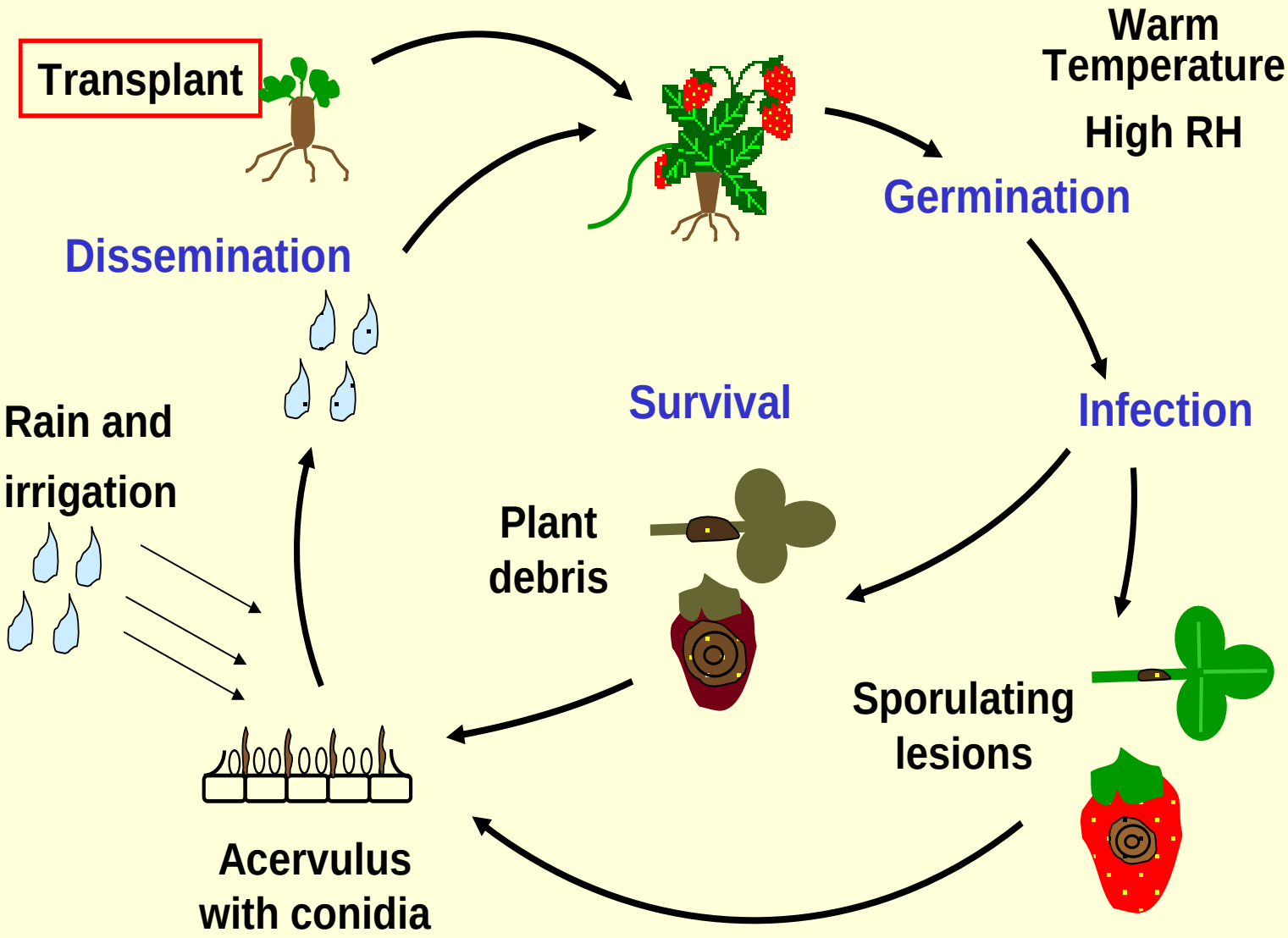
Strawberry Anthracnose: Biology

Colletotrichum acutatum

IPM of Anthracnose

Species	Associated Disease Phase	Economic Importance in NC
Colletotrichum acutatum	Fruit rot	High
Colletotrichum gloeosporioides	Crown rot	Low to moderate
Colletotrichum fragariae	Crown rot	Not found since 1986

Disease cycle of *C. acutatum* on strawberry



L. Leandro

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

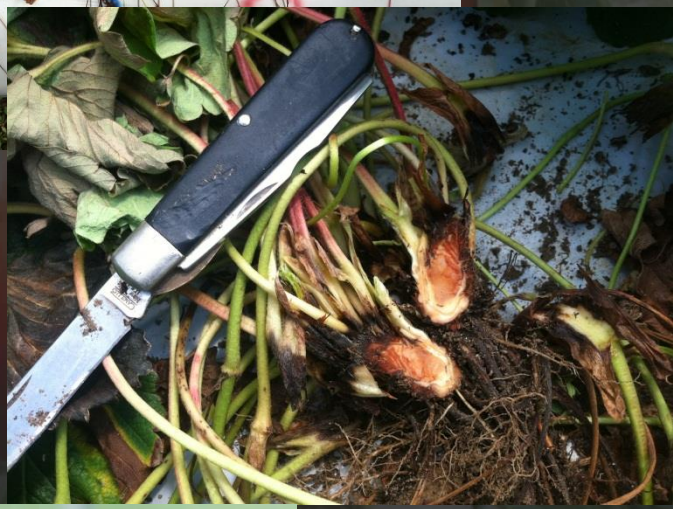
Crown rot: *C. gloeosporioides*

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:

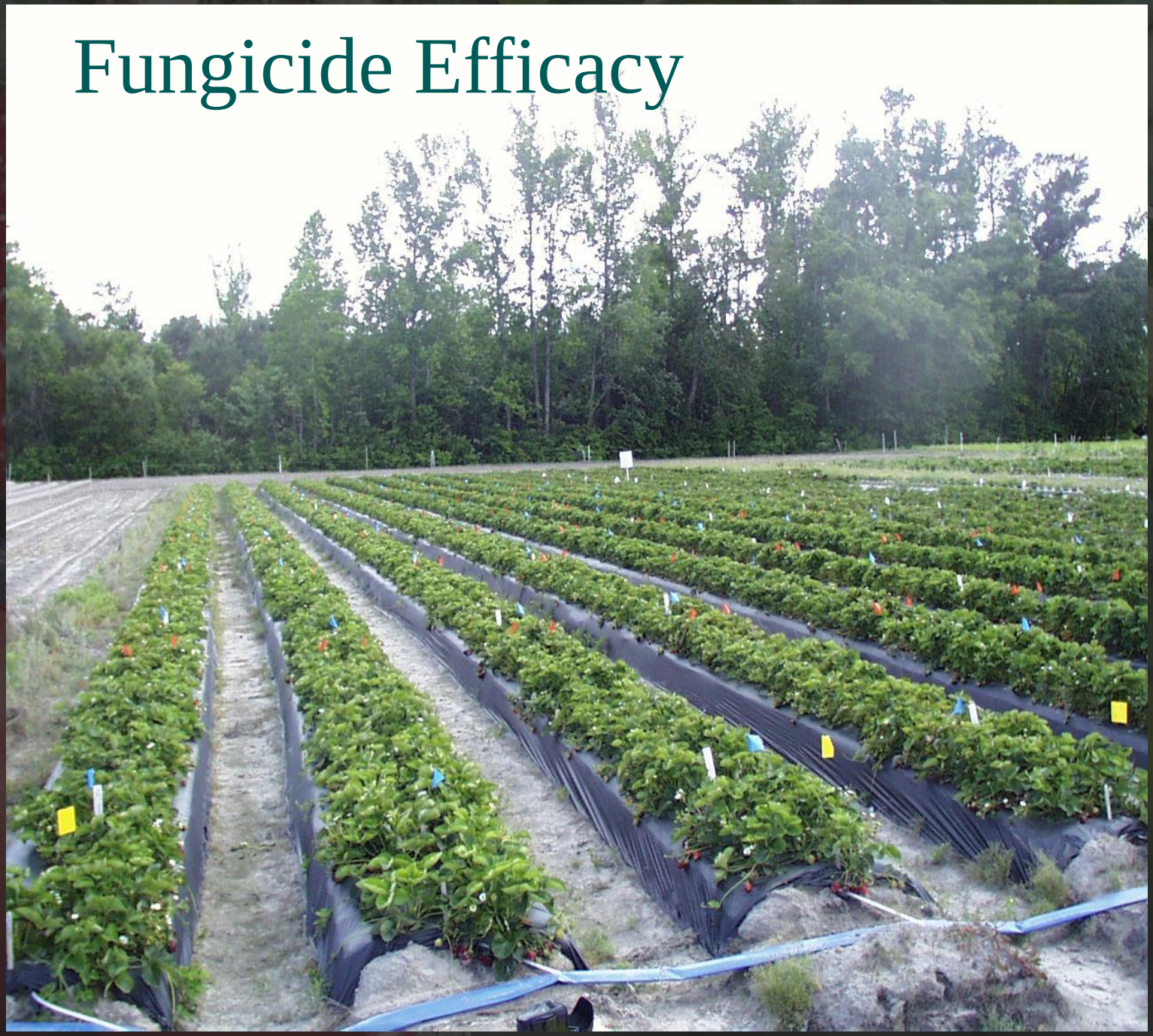
- buy disease-free plants (Tissue cultured, certified or grown under similar stringent conditions)
- immediately rogue out infected plants if small number

- 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

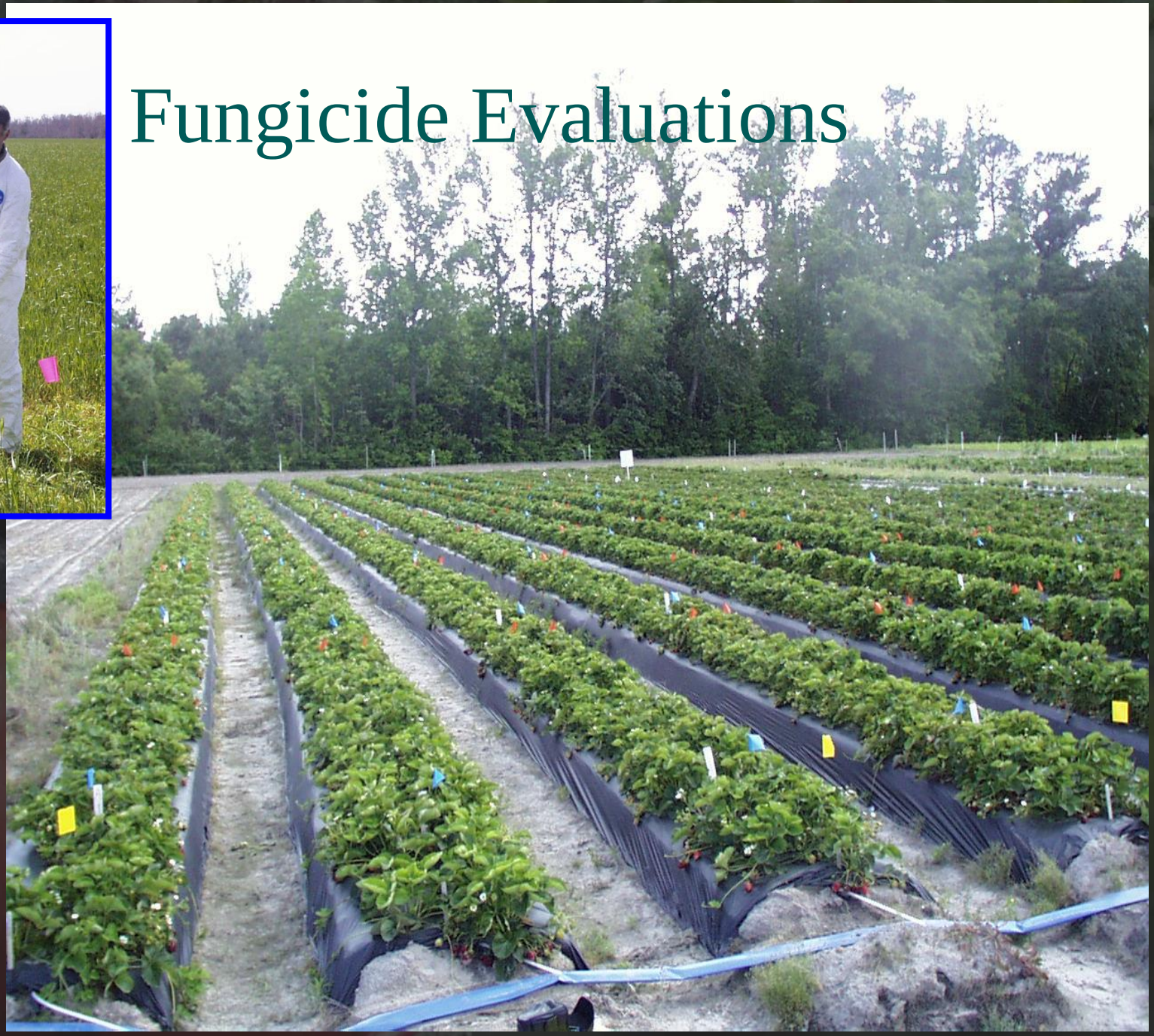
Elevate
Switch
Quadris
Cabrio
Pristine
Scala
Quadris
Top

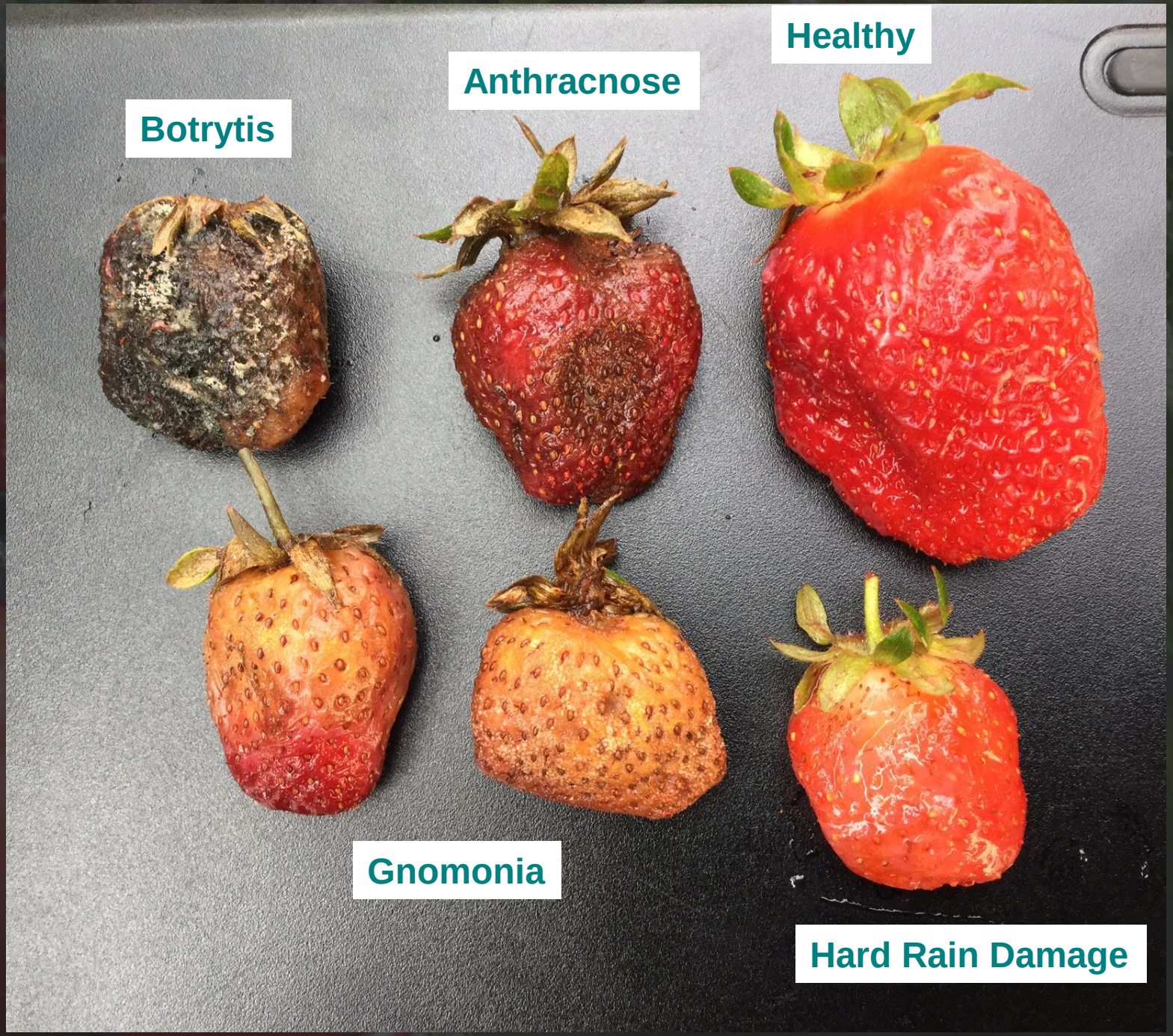
Ridomil
Aliette
ProPhyt
Phostrol

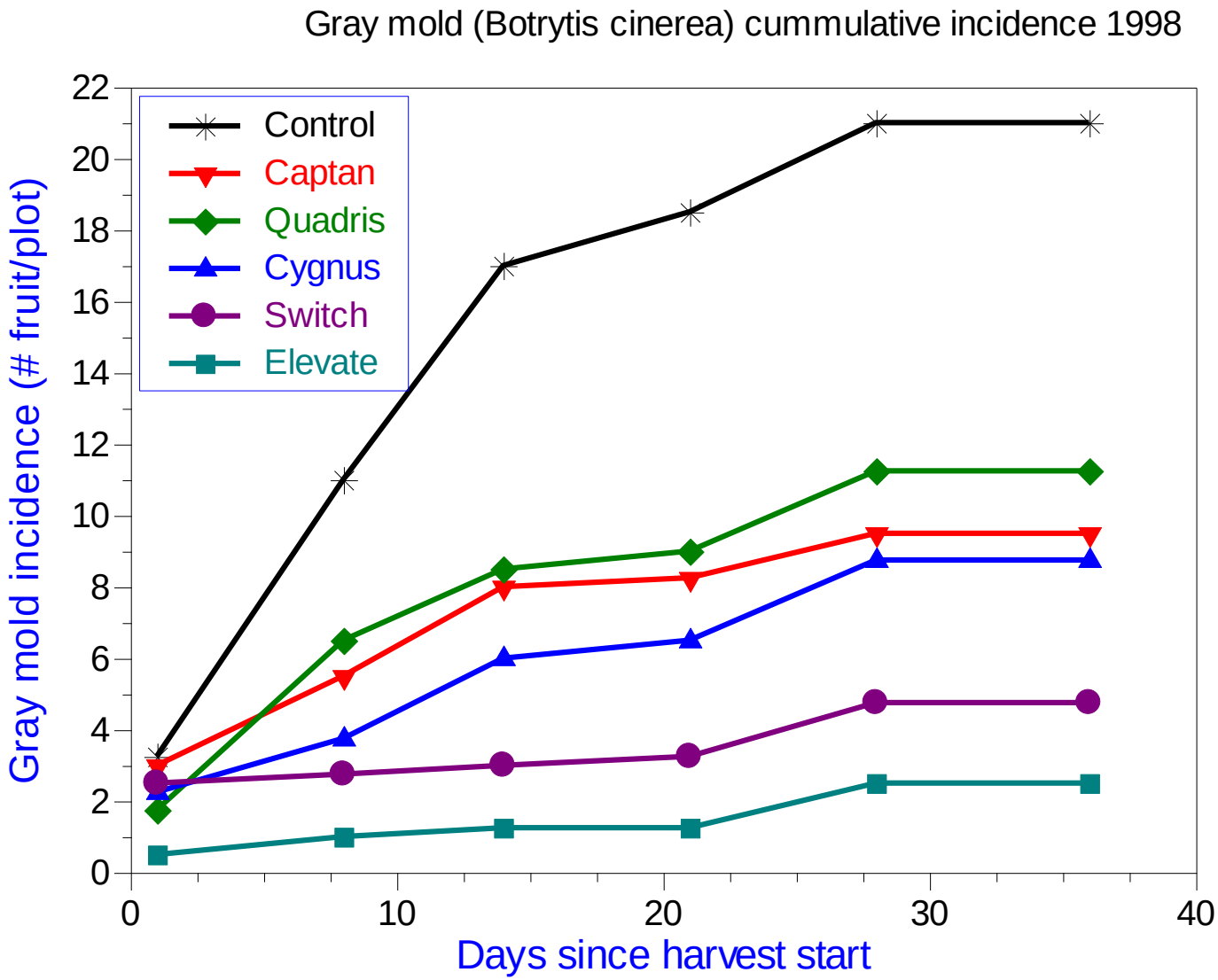
Tilt (Jade)
Inspire
Super

Rally (NOVA)
Procur
Sulfur
Quintec

Fungicide Evaluations

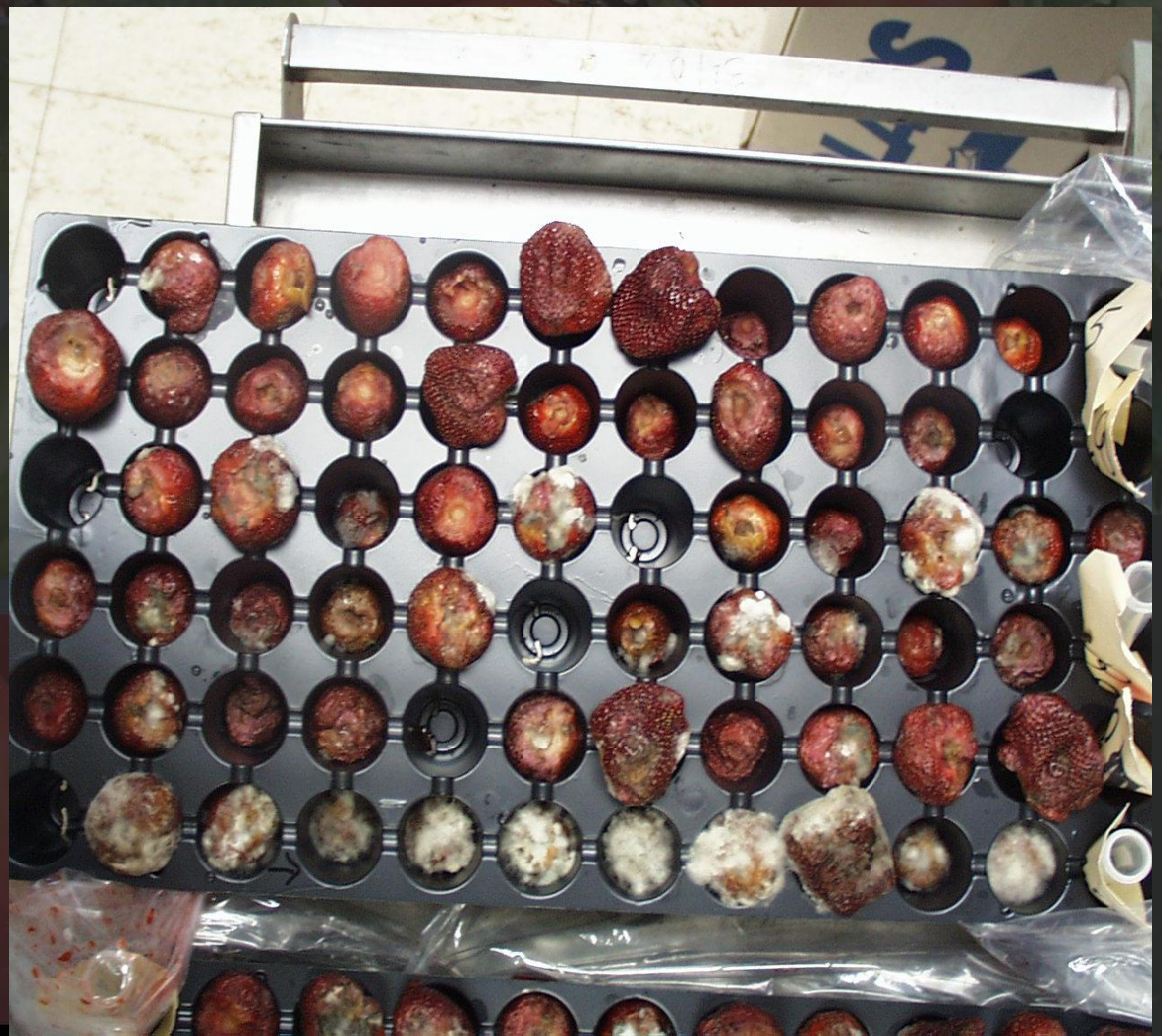


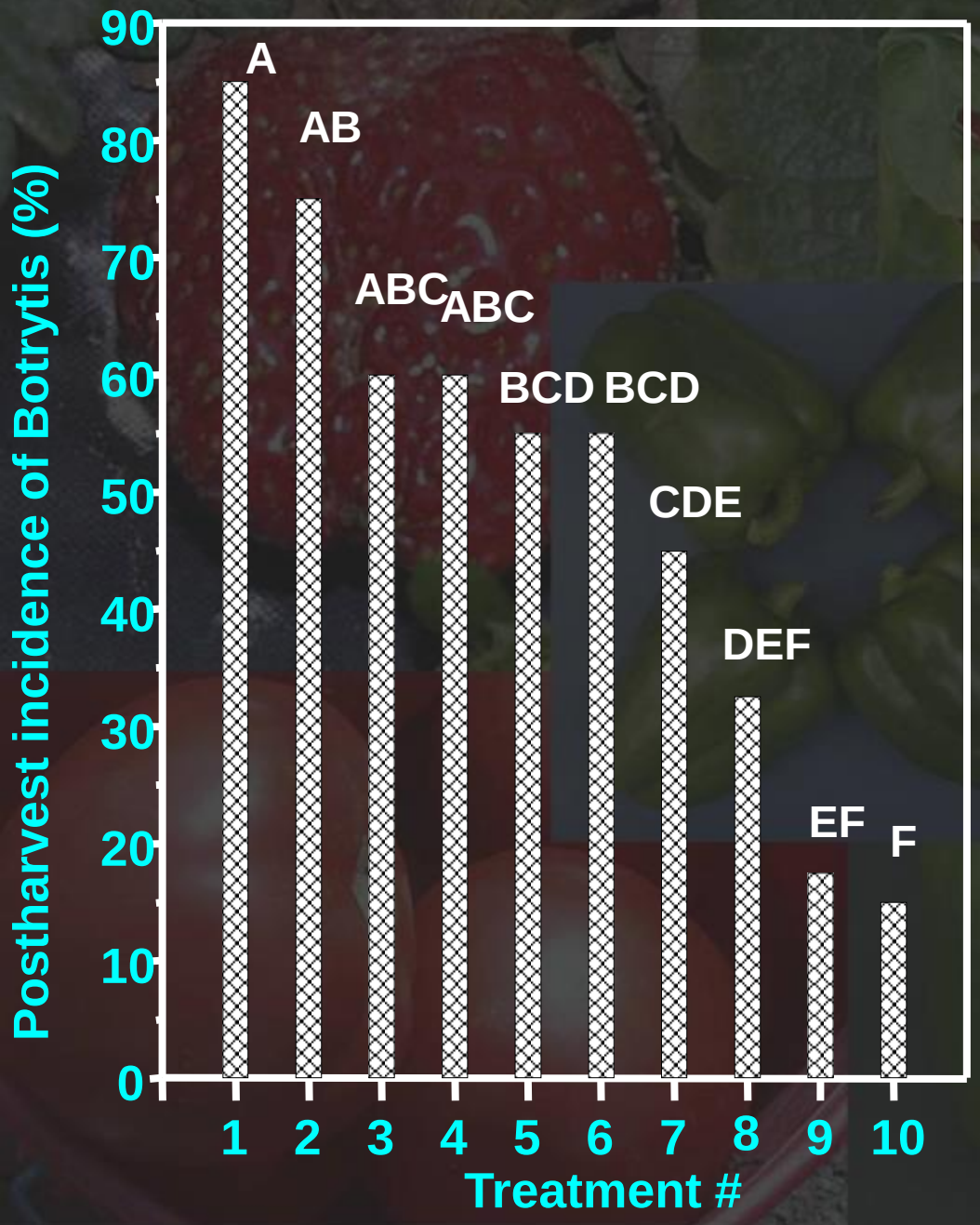

Healthy
Anthracnose
Botrytis
Gnomonia
Hard Rain Damage


Gray mold (Botrytis cinerea) cummulative incidence 1998
Control
Captan
Quadris
Cygnus
Switch
Elevate
Gray mold incidence (# fruit/plot)
Days since harvest start
0
2
4
6
8
10
12
14
16
18
20
22
0
10
20
30
40

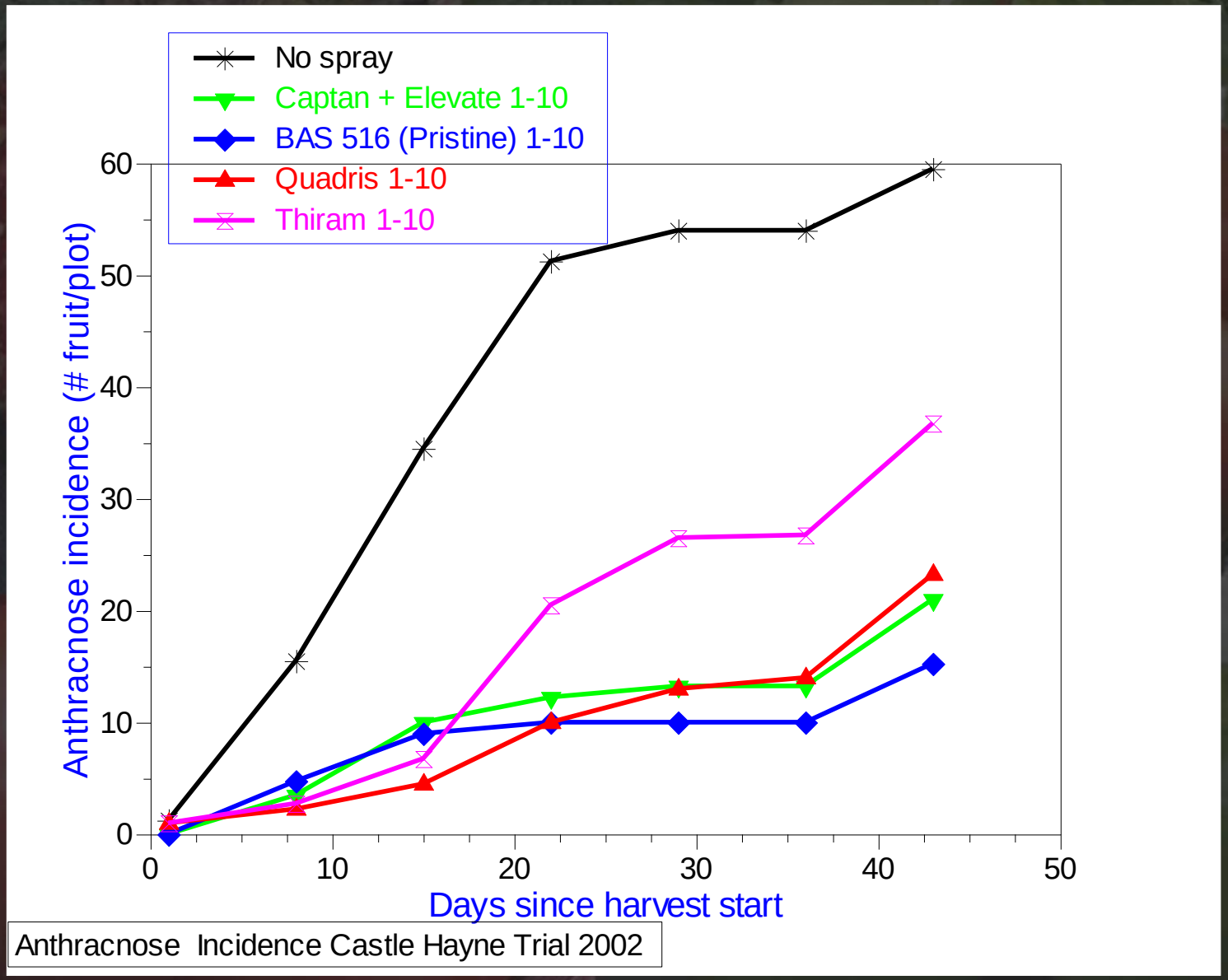
YIELDS FIRST 5 HARVESTS 2009									
				Total	MKTBLE	%MKTBLE		% Gray Mold	
TRT #	Treatment	Fruit with Botrytis (g/plot)		Wt (g/plot)	Wt (g/plot)	(g/plot)		Wt (g/plot)	
4	Captan/P/Sw1-9	221.6	A	13198	12224	92.7	B	1.69	A
12	Capt/TM Fall and 1-9	237.8	A	13438	12280	91.5	B	1.73	A
3	**Captan/P/Sw1-4**	**226.9**	**A**	**12855**	**11312**	**88.1**	**B**	**1.75**	**A**
5	Captan/P/Capt1-9	242.3	A	12390	11370	91.8	B	1.95	A
1	Control	524.8	B	12495	11084	88.7	B	4.22	B
7	Experimental	773.1	C	12875	10528	82.0	A	5.94	C
		0.05		NS	NS	0.05		0.05	

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 50WP 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 50WP 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

Treatment and rate/A	Timing*	Anthracnose (%)**	Total yield (lb/plot)	Marketable fruit (%)
Sanitation ……..……..	-	19.3 f	12.4	50.7 a
No spray …….....	-	17.5 ef	13.1	54.6 ab
Captan 50WP 4.0 lb + Quadris 2.08SC 9.0 fl oz	6-9	11.9 de	14.1	70.8 cd
Captan 50WP 4.0 lb + Quadris 2.08SC 9.0 fl oz Switch 62.5 WG 0.88 lb …….....	1,2 3,4	9.9 cd	14.2	64.0 bc
Thiram 65 WSB, 3.0 lb …….....	1-10	9.0 bcd	15.9	68.9 cd
Switch 62.5WG 0.88 lb Quadris 2.08SC 9.0 fl oz ……..	1,3 2,4	8.1 abcd	14.5	63.7 bc
Quadris 2.08SC 9.0 fl oz ……..….....	1-10	5.4 abc	13.6	75.8 de
Elevate 50 WG 1.5 lb + Captan 50WP 5.63 lb ….....	1-10	4.6 abc	15.8	74.8 de
Switch 62.5WG 0.88 lb Elevate 50 WG 1.5 lb Captan 50WP 4.0 lb + Quadris 2.08SC 9.0 fl oz .	1,3 2,4 6-9	4.2 ab	18.2	81.3 e
BAS 516 UDF 38% 1.45 lb …….....	1-10	3.0 a	15.4	83.0 e
LSD (*P*=0.05) …….....		5.5	NS	9.6

* 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.

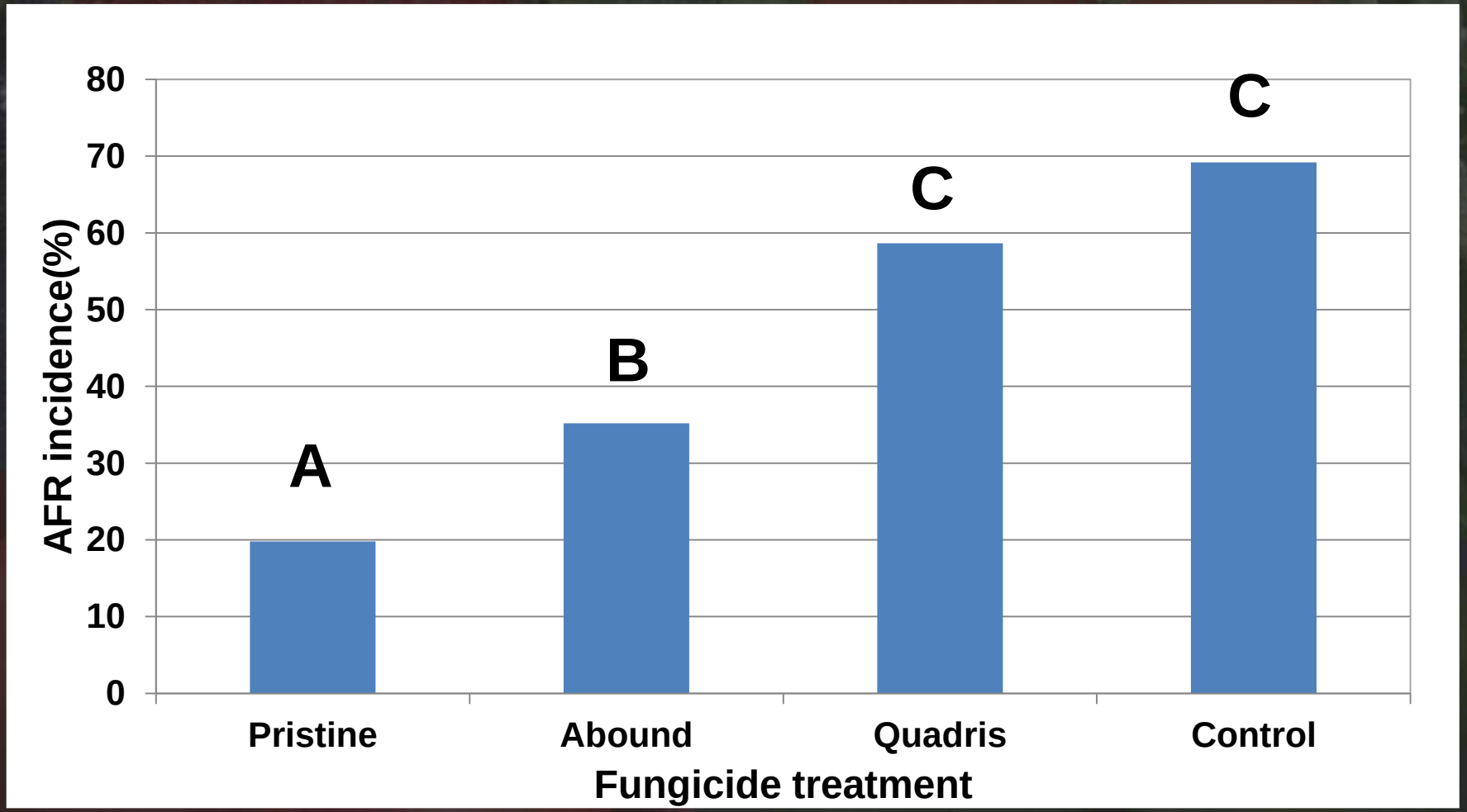
Efficacy of fungicides and biologicals against AFR, 2009

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

[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

Chemical control of AFR, 2010



Only from 6th harvest, fungicides were applied 24 h prior to inoculation

Management | North Ca

https://strawberries.ces.ncsu.edu/strawberries-management/

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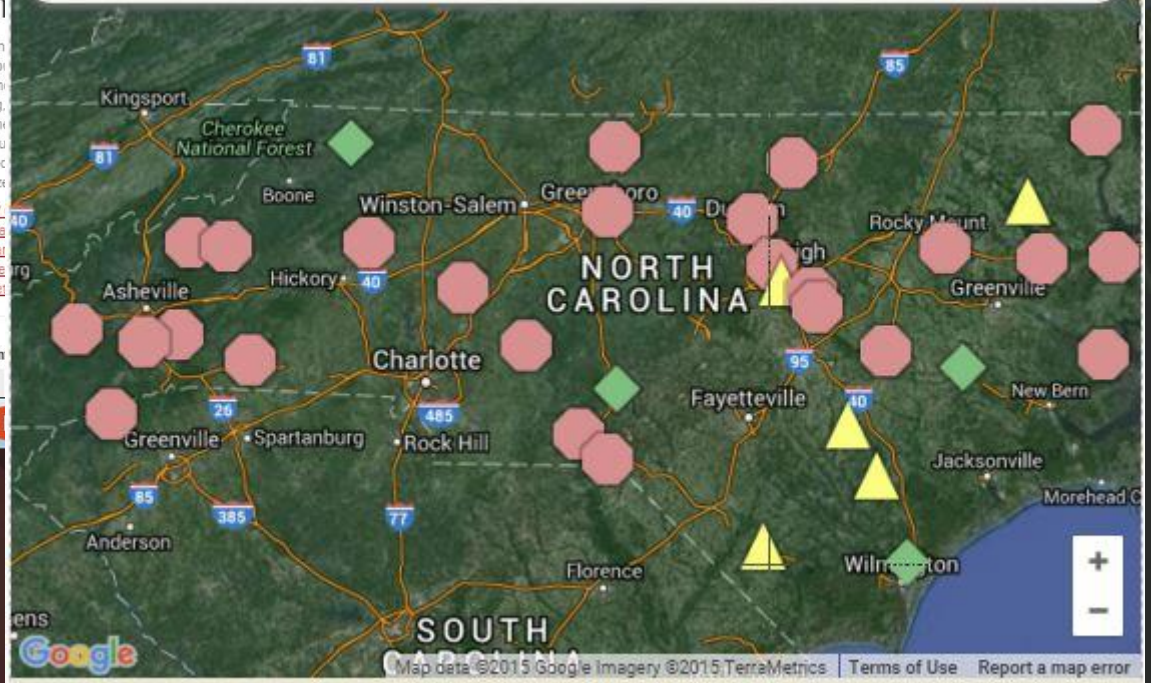
Food Safet

Was the in

YES

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

'Click' marker to view risk information.



Risk period: Oct 29 12:00AM to Nov 01 12:00AM (72.00 hours)

Very Low Low Moderate High

Small Fruit & Specialty Crop IPM Blog

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ask an EXPERT

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ExtensionVoices

A Twitter list by @ExtensionVoices

Tweets from NC Cooperative Extension and colleagues, nationwide.

Southeast Rx Fire Retweeted

Southern Fi... @SEFireSci...

#PrescribedFire Council annual meetings are coming up across the South! Check our list of upcoming meetings #nxfire owl.ly/q H2q3036p6

10 Aug

NCSU E... @NCSU...

Did you know that the oldest stand of cypress trees in the world is located in NC, just 40 minutes from

Strawberry Fruit Infection Risk Predictions (Aug 06 2016 to Aug 16 2016)

Kinston, NC (Lenoir County) - Cunningham Research Station (KINS)

Pest	Model	Risk
Anthracnose (Colletotrichum acutatum)	FLSAS	High
Grey Mold-Rot (Botrytis cinerea)	FLSAS	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

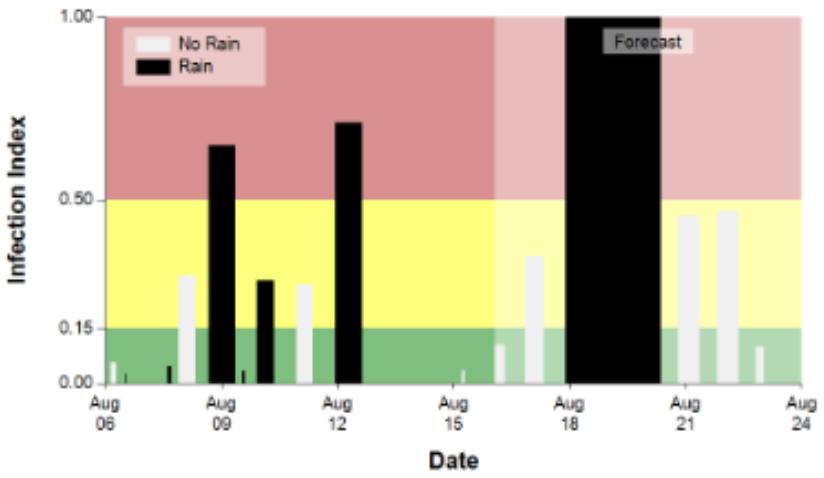
Past 10 Days

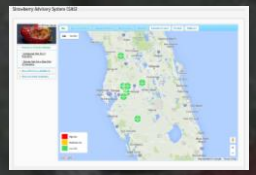
Type	Count	Most Recent Start	Hours
Moderate	3	Aug 10 10:37PM	9.92
High	2	Aug 11 10:42PM	16.58

Forecast

Type	Count	Next Event Start	Hours
Moderate	3	Aug 16 08:30PM	11.00
High	1	Aug 17 09:30PM	59.00

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).





SAS developed by Natalia Peres

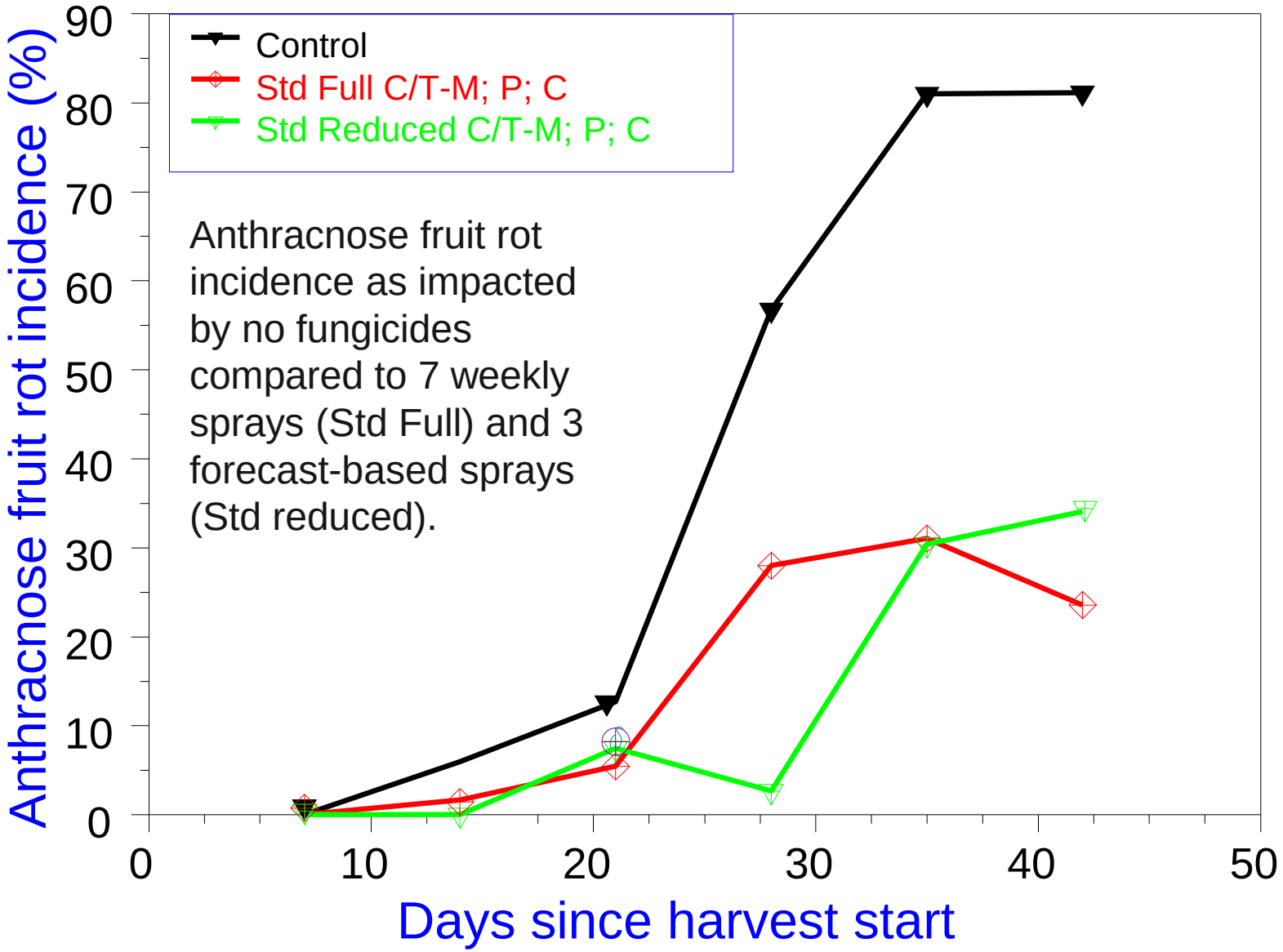
Prediction based spray schedule

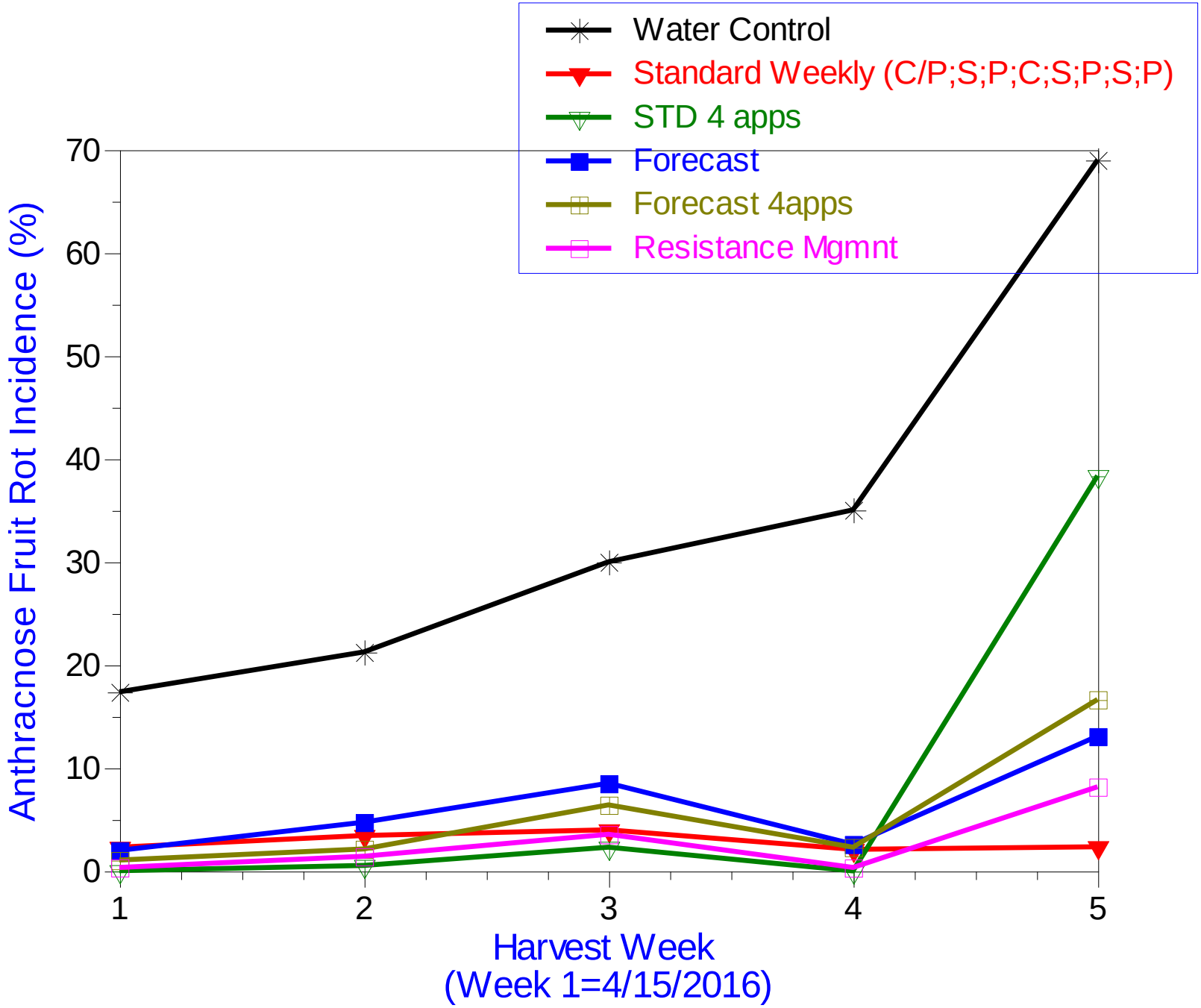
Treatments	# of sprays applied	AFR incidence (%)[ab]	Marketable yield (lb/plant)[b]
Non treated control	**-**	**8.5 a**	**0.73 b**
Regular Schedule			
Captan 50WP 4.0 lb + Topsin M 70W 1.0 lb	**1**		
Pristine WG 1.45 lb	**2, 4**		
CaptEvate 68WDG 4.5 lb	**3, 5, 7**	**3.2 b**	**0.87 a**
Pristine WG 1.45 lb ……	**6, 8**		
Prediction based schedule			
Captan 50WP 4.0 lb	**1**		
Captan 50WP 4.0 lb	**2**		
Pristine WG 1.45 lb	**3**	**4.4 b**	**0.75 ab**

[a]Disease incidence was calculated from all harvested fruits over 8 weeks

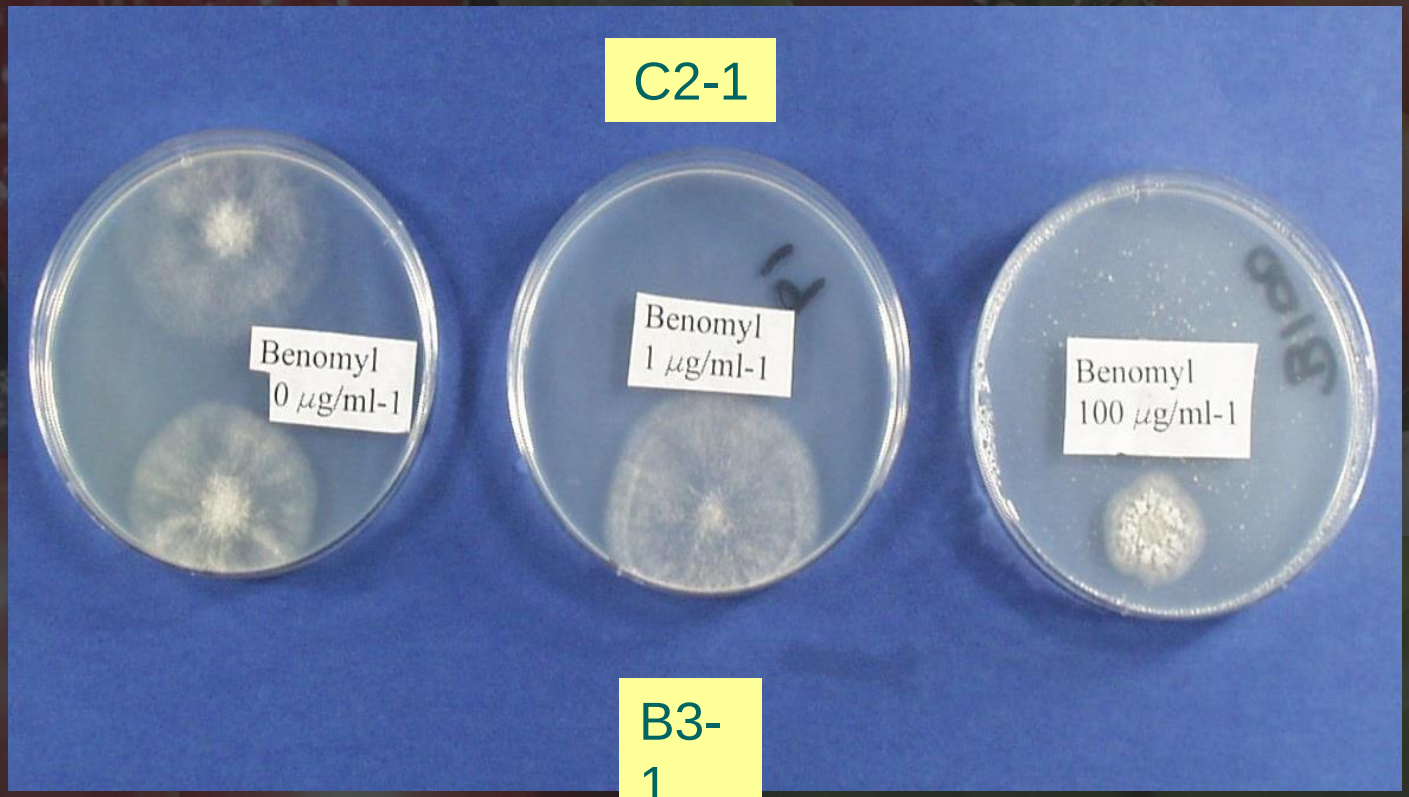
[b]Means in a column followed by the same letter are not significantly different by Fisher's protected LSD test ($\alpha \leq 0.05$).

Anthracnose Incidence 2nd year

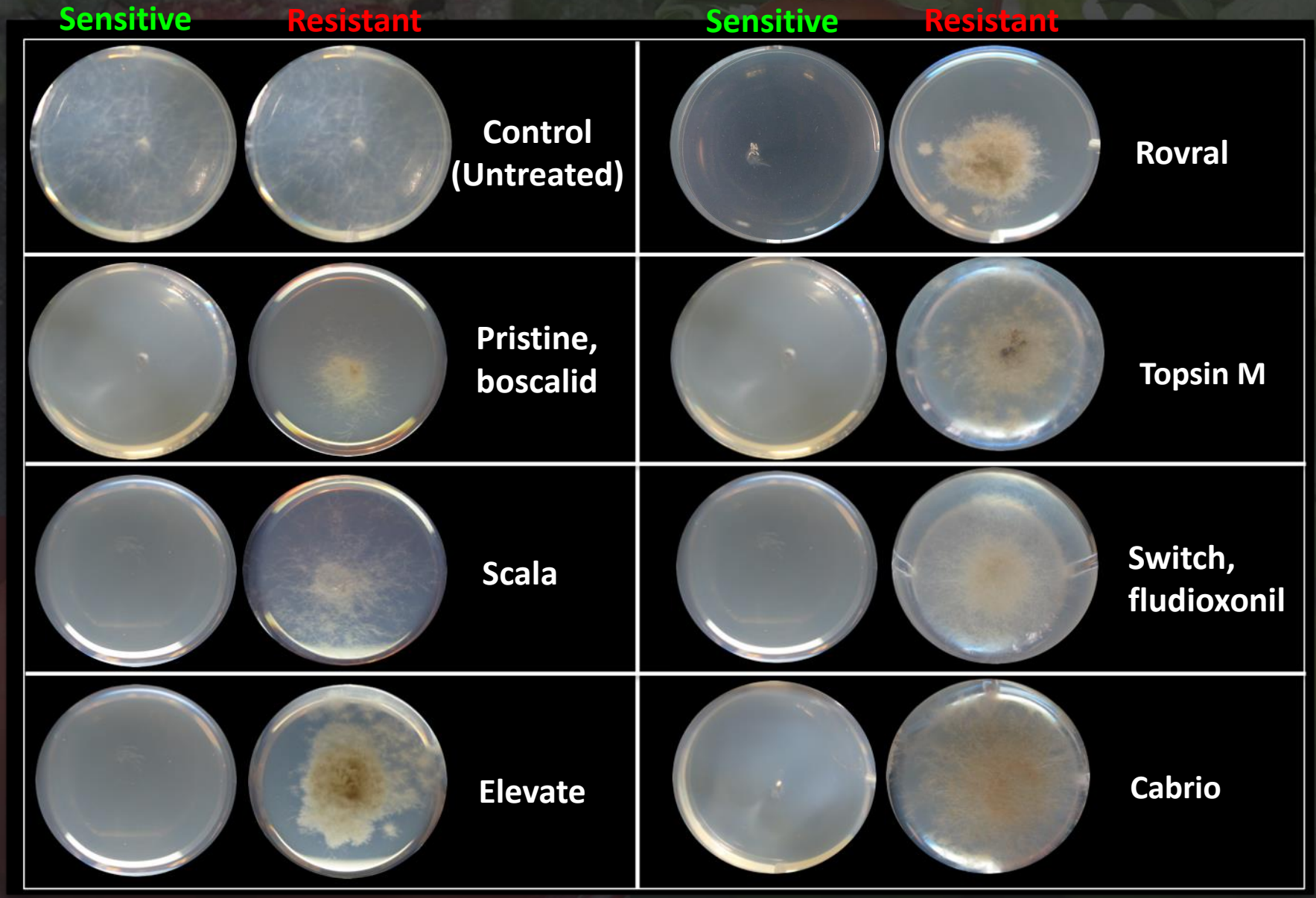



Water Control
Standard Weekly (C/P;S;P;C;S;P;S;P)
STD 4 apps
Forecast
Forecast 4apps
Resistance Mgmnt
Anthracnose Fruit Rot Incidence (%)
0
10
20
30
40
50
60
70
1
2
3
4
5
Harvest Week
(Week 1=4/15/2016)

In vitro resistance to 0, 1.0, 100.0 μg/ml^{-1} benomyl-amended PDA



Growth after 4 days



Botrytis Resistance Profile of Fungicides

Pristine (QoI) (use Cabrio) **pyraclostobin** **boscalid**	 R- High R- High
Fontelis	R- medium
Captan	none
Elevate	R- High
CaptEvate	As above
Scala	R- High
Switch **cyprodinil** **fludioxinil**	 R- medium R- very low
Rovral	R- medium
Topsin-M	R- Very High

Fungicide	Active Ingredient(s)	FRAC CODE	Resistance Risk	Angul leaf spot	Anthrac fruit rot	Anthrac crwn rot	Gray mold	Phytoph root rot	Powdery mildew	REI (h) / PHI (d)	Fungicide Resistance Management Guidelines
				L	H	H	H*	L*	H		
fixed copper	fixed copper	M1	L	x						24h/0d	Protectants, multi-site Mode of Action (MOA), use alone, or tank mix and rotate with high-risk fungicides
Thiram	thiram	M3	L		x		x			24h/3d	
Captan	captan	M4	L		x		x			24h/1d	
Captevate	captan + fenhexamid	M4 + 17	L		x		x			24h/0d	No more than 2 consecutive applications
Topsin M	thiophanate-methyl	1	H*			x	x			12h/1d	Resistance to gray mold extremely wide spread
Rovral	iprodione	2	M*				x			24h/-	Only 1 spray/season allowed @ early bloom
Rally	myclobutanil	3	M						x	24h/0d	Tank mix and rotate with other FRAC codes
Procure	triflumizole	3	M						x	12h/1d	
Ultra Flourish	mefenoxam	4	H*					x		12h/0d	Can be applied as spray or through drip irrigation
MetaStar	metalaxyl	4	H*					x		not rec	
Inspire Super	difenoconazole + cyprodinil	3 + 9	H*				x		x	12h/0d	Tank mix mainly with FRAC code M or other FRAC codes
Abound	azosystrobin	11	H*		x	x				4h/0d	Tank mix with FRAC code M fungicides and rotate with other non-FRAC code 11 fungicides
Cabrio	pyraclostrobin	11	H*		x	x				24h/0d	
Pristine	boscalid + pyraclostrobin	7 + 11	H*		x	x	x			12 h/0d	
Quilt Xcel	propiconazole + azoxystrobin	3 + 11	H*		x	x			x	12h/0d	Tank mix with FRAC code M fungicides and rotate with other non-FRAC code 11 fungicides
Quadris Top	difenoconazole + azoxystrobin	3 + 11	H*		x	x			x	12h/0d	
Adament	tebuconazole + trifloxystrobin	3 + 11	H*		x	x			x	not reg	
Quintec	quinoxyfen	13	H						x	24h/1d	Tank mix and rotate with other FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M		x	x	x			12h/0d	Tank mix and rotate with other FRAC codes
Elevate	fenhexamid	17	H*				x			4h/0d	Tank mix with FRAC code M or other FRAC codes
phosphorous acid	phosphorous acid	33	L					x		12h/0d	See label for use instructions
Aliette	fosetyl-Al	33	L					x		12h/0d	Use as preplant dip or spray application, see label

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

https://strawberries.ces.ncsu.edu

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- New Growers
- NC Plant Disease & Insect Clinic
- Strawberry Fruit Infection Risk Tool
- — Fruit Infection Risk Tool Instructions
- NC Strawberry Diagnostic Key
- SRSFC IPM Guide *(PDF)*
- Small Fruit & Specialty Crop IPM Blog

FEATURED CONTENT

Risk Management Resources for Strawberry Growers

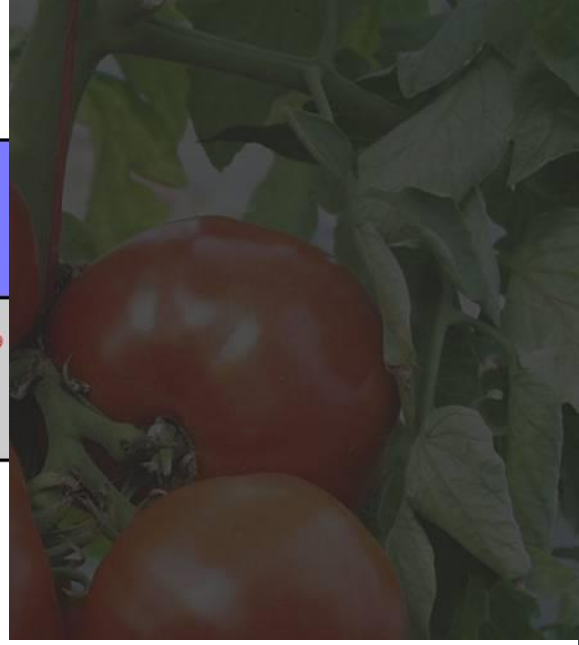
The **risk management materials** on this portal cover topics ranging from marketing and human resources to legal and food safety issues. Crop insurance products are presented in addition to disaster assistance

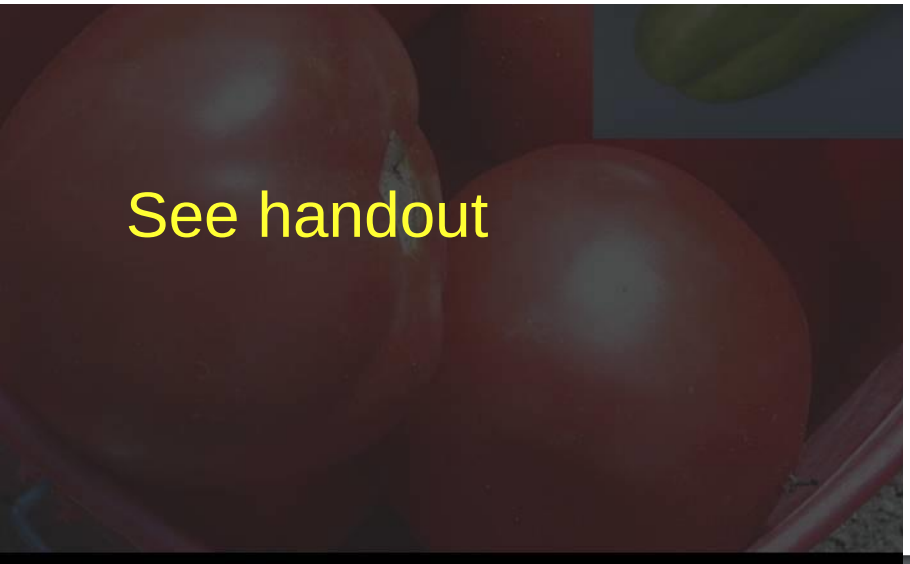
READ THE REST »

- Views from the Field
- Using a Digital Thermometer to Guide...
- New Publication "Sustainable Practices...
- Cold Injury To Strawberry Crowns (V...
- Risk Management Resources for Strawb...

*At the moment, there are **no upcoming events listed**.*

IPM Guide





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.

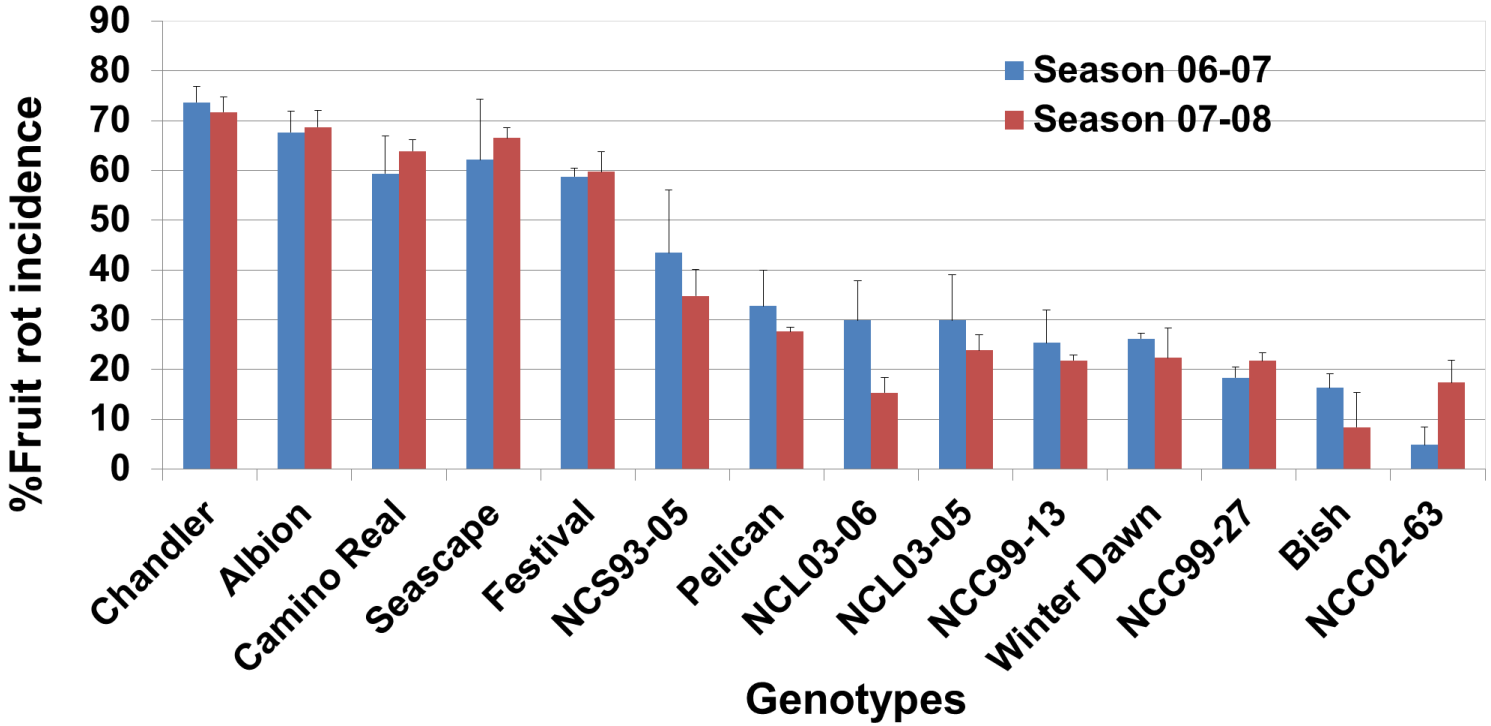
HOST RESISTANCE: Evaluation of Strawberry Selections For Management of Ripe Fruit Rot

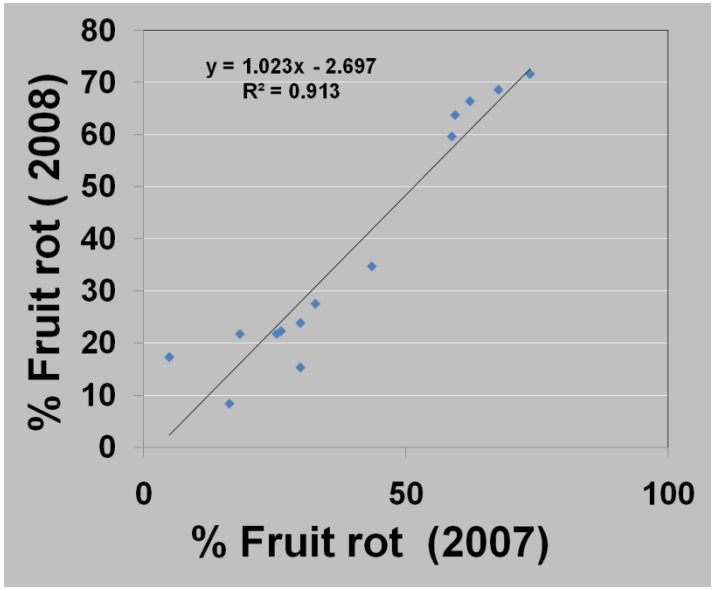
What are the components of field level resistance?

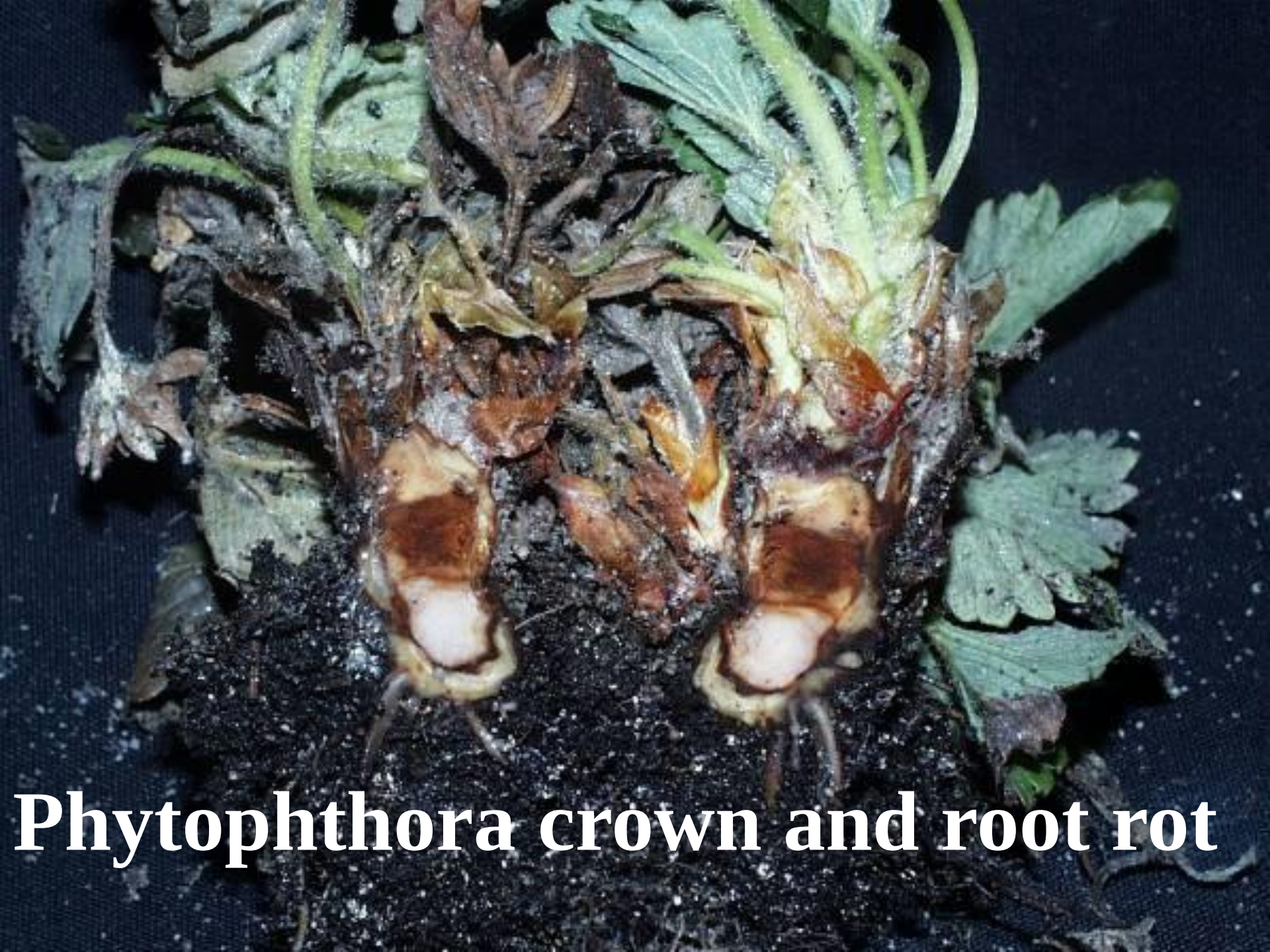
Incidence of quiescent infections?
Fruit rot resistance?
Nursery epidemics?

Are the components linked?

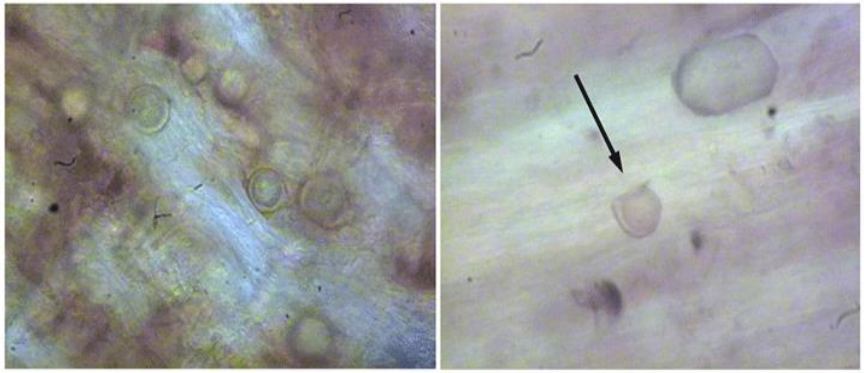
Rahman et al. 2013a;


%Fruit rot incidence
90
80
70
60
50
40
30
20
10
0
Season 06-07
Season 07-08
Chandler
Albion
Camino Real
Seascape
Festival
NCS93-05
Pelican
NCL03-06
NCL03-05
NCC99-13
Winter Dawn
NCC99-27
Bish
NCC02-63
Genotypes


y = 1.023x - 2.697
R² = 0.913
% Fruit rot (2008)
80
70
60
50
40
30
20
10
0
0
50
100
% Fruit rot (2007)

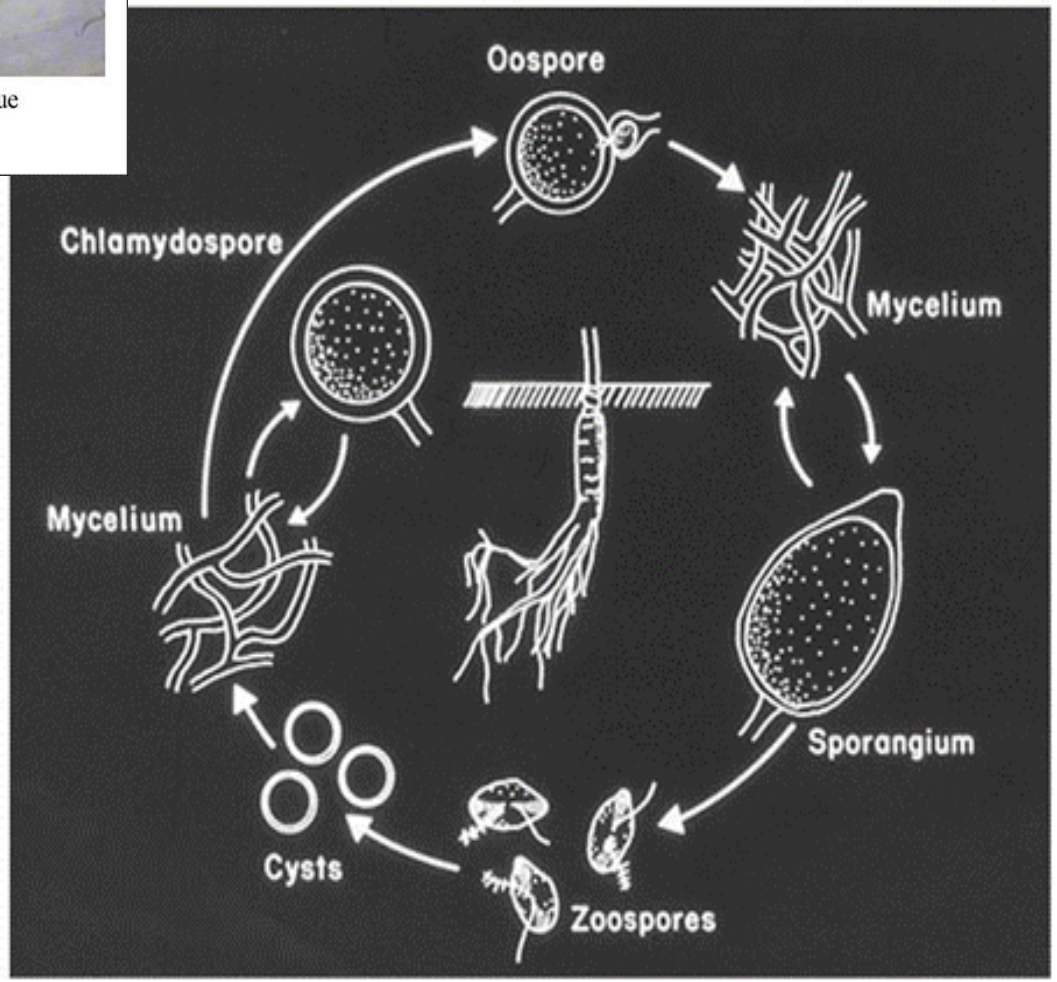


Phytophthora crown and root rot



Oospores of *P. cactorum* can be seen in infected strawberry root tissue

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



Disease Cycle of *P. cactorum*

Site Selection

- Good soil drainage is critical!
- Areas of standing water will increase the possibility of Phytophthora crown and root rot.

Strawberry Integrated Management Guide (continued)

Pre-planting: Disease Control

Pest/Problem	Management Options	Effectiveness (+) or Importance (*)	Comments
Anthracnose Angular leaf spot Phytophthora crown rot Viruses		***** +++++	Use of certified plants or plants produced in a similarly stringent program is the most important method to prevent these diseases.
Nematodes	Sample soil	***	Sample for nematode analysis through local state services to determine which fumigant may be re
	Crop rotation and cover crop selection	***	Selected su ver crops and rotating fields to other crops for 2-3 years can suppress nematode po
Weeds Root and crown rot disorders (Black root rot; Phytophthora crown rot)	Pre-plant fumigation and laying down plastic mulch	+++++	See fumigation Consult with custom applicators and/or Extension agents for product and rate ions.

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.

Relative Efficacy: Currently Registered Fumigants or Fumigant Combinations for Managing Soilborne Nematodes, Diseases, and Weeds[1]					
Product	**Rate per Broadcast Acre[4]**	**Nematodes**	**Disease**	**Nutsedge**	**Weeds: Annual**
Telone C35[3] (1,3-D + chloropicrin)	39 – 50 gal	+++++	+++++	+	+++
Telone C35 + VIF[3]	See comments below	+++++	+++++	+++	+++
Metam sodium[2] (MS)[3]	37.5 - 75 gal	++	+++	+	++++
Chloropicrin[3]	150 - 350 lb	+	+++++	—	—
Pic-Clor 60[3] (chloropicrin + 1,3-D)	19.5 – 31.5 gal	+++++	+++++	+	+++
Chloropicrin + MS[3]	19.5 – 31.5 gal + 75 gal	++	+++++	?	++++
Paladin (dimethyl disulphide) should be formulated with 21% chloropicrin +VIF	35.0 – 51.3 gal	++++	++++	++++	+++[5]

[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.

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 recolonoization by *Phytophthora* species.

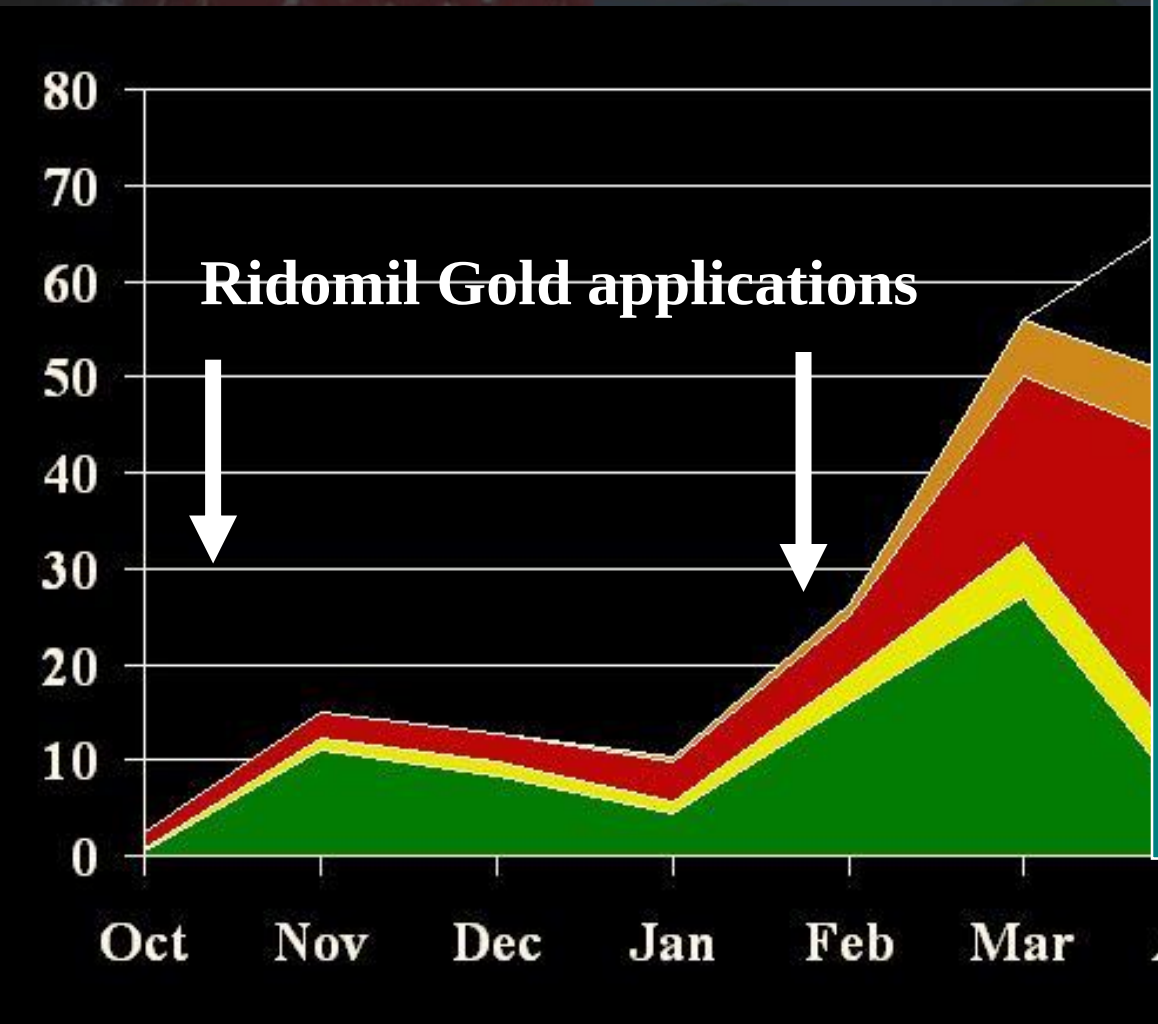
Several products are registered for plant dips to kill pathogens or to protect plants just prior to field setting, but only a limited amount of research has been done with plant dips. In general, these treatments are not recommended except under specific circumstances, for example, if a disease has been 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

Fungicide	Application Rate	REI	PHI	Comments
Ridomil Gold SL	1 pt/acre	12 hrs	0 days	3 applications are allowed.
Phosphites (phosphonates) i.e. Aliette, ProPhyt, etc.	Various rates; see label	12 hrs	0 days	Red Stele and Leather Rot are on the label. Do not tank mix with copper compounds of foliar fertilizers.

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*[a]

Strawberry cultivar	Soil treatment[b]	Chemical treatment program[c]	Marketable yield (total grams per plant)
Diamante	Infestation w/ *P. cactorum*	Aliette plant dip and spray	1031
		Water control plant dip and spray	572
		Ridomil soil drench	1163
		Water control soil drench	659
	Non-infested control	Aliette plant dip and spray	1113
		Water control plant dip and spray	1097
		Ridomil soil drench	1172
		Water control soil drench	1128
Aromas	Infestation w/ *P. cactorum*	Aliette plant dip and spray	1388
		Water control plant dip and spray	938
		Ridomil soil drench	1400
		Water control soil drench	891
	Non-infested control	Aliette plant dip and spray	1481
		Water control plant dip and spray	1250
		Ridomil soil drench	1463
		Water control soil drench	1384
Least significant difference:			**386**

Aliette = dip and five applications
Ridomil = 3 applications

Strawberry disease diagnosis

Cut the crown longitudinally

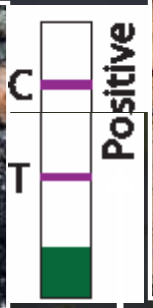
No discolorati-on inside crown

Abiotic causes are most likely

* High salt
* Boron toxicity
*Improper planting depth

Marbled reddish brown-most likely glo crown rot

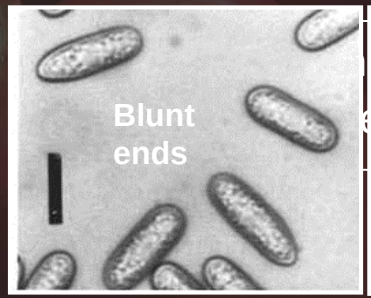
Dull brown color-most likely Phytophthora



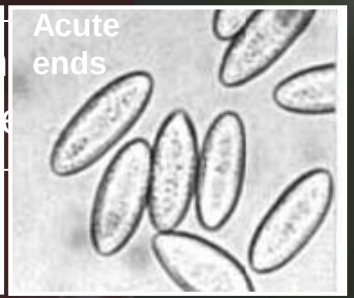
Presumptive quick test with Agdia immunoStrip

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

Oospore (*P. cactorum/fragariae*)



C. gloeosporioides



C. acutatum (rare)

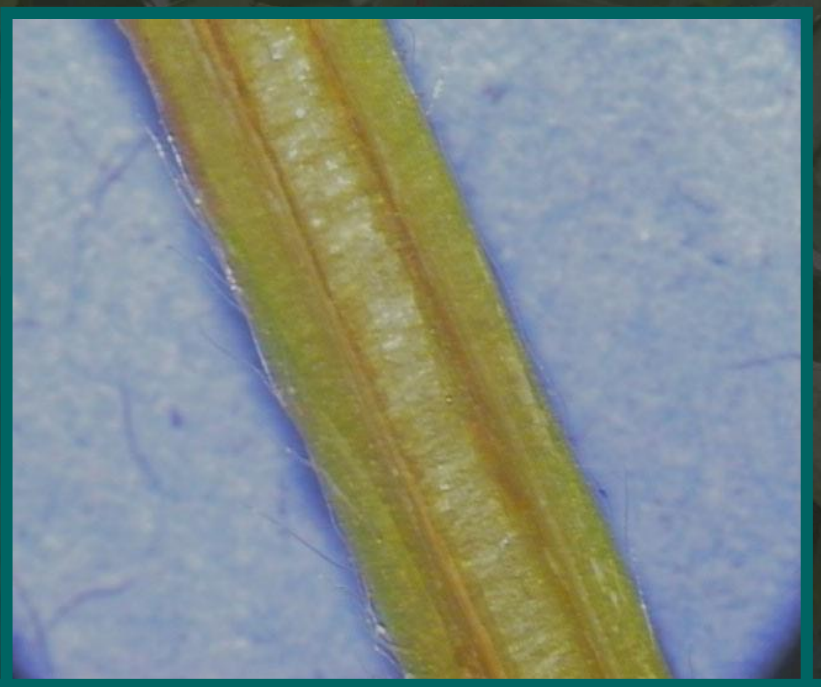
If no conclusion is drawn, proceed with DNA based method

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.