HOLISTIC IPM - DISEASES

3 Feb 2022

CiderCon – Richmond, VA

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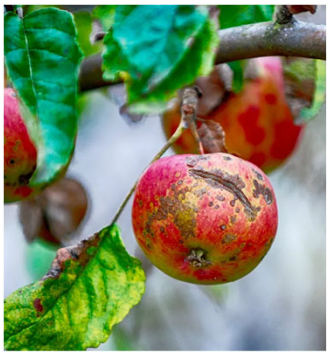

What is a Disease Pest?

Pests are organisms that damage or interfere with desirable plants in our fields and orchards, landscapes, or wildlands, or damage homes or other structures.

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Definition of IPM

- *IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties.* – UCANR

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A Brief History of IPM

- **470 B.C.** - Democritus, cited by Pliny, controls a blight by sprinkling plants with amurca (liquid olive oil waste).
- **300 A.D.** - First recorded use of biological controls in citrus orchards to control caterpillar and beetle pests in China. Colonies of the predatory ants (*Oecophylla smaragdina*) are set up in citrus groves with bamboo bridges, so they could move between trees.
- **1870-1890** - Grape phylloxera and powdery mildew controlled in French wine country through the introduction of Bordeaux mixture, Paris Green, use of resistant root stocks, and grafting.
- **1940** - Use of milky disease to control Japanese beetle (first successful direct use of an insect pathogen for control).
- **1950s-1970s** - Widespread development of resistance to DDT and other pesticides
- **1950s -** First applications of systems analysis to crop pest control
- **1959** - Introduction of concepts of economic thresholds, economic injury levels, and integrated control
- **1960** - First Bacillus thuringiensis (Bt) product registered
- **1962** - Rachel Carson's Silent Spring
- **1980s** - And we're off……..

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WHAT IS HOLISTIC ORCHARD IPM?

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A holistic IPM program is simply good observational science. The fact is that if you don't get out into the orchard and become one with the trees, plants, insects, and the soils, then you'll miss the most important stuff.

A holistic IPM program is an integral part of successful biological agriculture.

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The Basic Tenets of IPM

- Pest Identification
- Monitor Population Numbers and Damage
- Management Thresholds
- Prevent Damage
- Combination of Approaches Deployed
- Assessment of Management

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Pest ID

- **Phenology**
  - *Many insects are very closely related in appearance*
- **Life Stages**
  - *Egg, Larvae, Pupae, Adult, Nymphs, Instars*
  - *Not all life stages cause damage but are still important to management.*
- **Life Cycles**
  - *Overwinter, Emergence, Mating, Maturation, Generations*
- **Damage**
  - *Primary vs Secondary Damage, Cosmetic vs Destructive*

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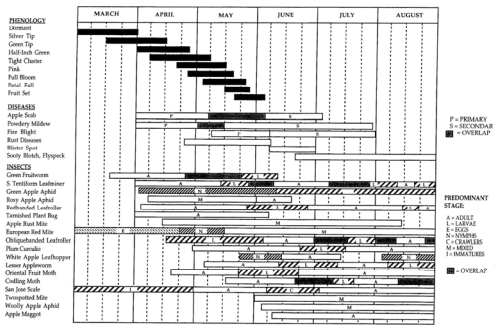
Figure 7.1.9. Apple Events Calendar for the Lake Plains Area of New York



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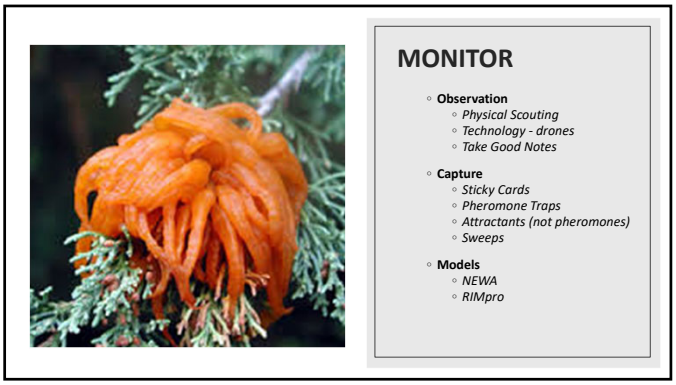
MONITOR
Observation
Physical Scouting
Technology - drones
Take Good Notes
Capture
Sticky Cards
Pheromone Traps
Attractants (not pheromones)
Sweeps
Models
NEWA
RIMpro

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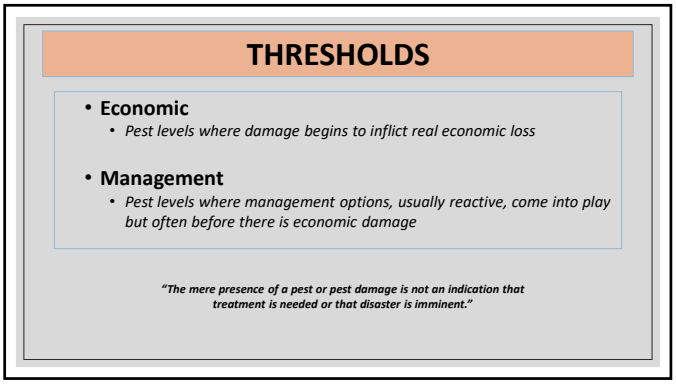
THRESHOLDS
Economic
Pest levels where damage begins to inflict real economic loss
Management
Pest levels where management options, usually reactive, come into play but often before there is economic damage
"The mere presence of a pest or pest damage is not an indication that treatment is needed or that disaster is imminent."

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PREVENTION

- **Proactive**
  - *Management options that utilize biological, cultural, mechanical, or chemical controls to prevent or limit crop plant damage.*
  - *Reducing or Eliminating a Pest Threat before presence or damage occurs.*
- **Reactive**
  - *Management options that are largely "after the fact" sprays where issues have manifested into economic damage or crop destruction.*

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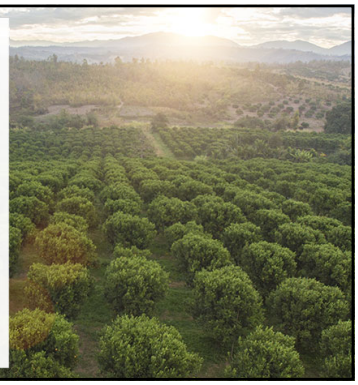
Technology

- ***Aerial Perspective***
  - *Images*
- ***Specialized Uses***
  - *Identify stresses*
- ***Practical applications***
  - *Pollination, sprays, pheromones*
- ***Computer Models***
  - *NEWA*
  - *RIMpro*



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ASSESSMENT

Did my IPM tool actually work?

- *Did it reduce the pest populations below* economic thresholds?
- *Did I eliminate the pest?*
- *What's the likelihood it'll resurge in the near future?*
- *Do I need to treat again?*

"A big part of IPM is the revisiting of observations, assessments, and treatments. Just as pest presence doesn't necessarily indicate a need for treatment, likewise it doesn't mean that it should be ignored."

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PRACTICAL APPLICATION

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TOOLS

- Orchard Scouting
- Weather station data
- Pheromone traps monitoring
- Pest modeling
  - *NEWA*
  - *RIMpro*
- Biological control
  - *Biologicals*
  - *Beneficial Insects and Microorganisms*
  - *Indigenous Microbes*
- Mating disruption
- Resistant varieties

- Management of surrounding habitat
- Sanitation
- Management of plant stress
- Soil health
  - Optimal Nutrition
  - Precision Irrigation

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DEGREE DAY CALCULATIONS

- **Base Degree** – depends on the insect or disease pest
- **Simple** - Easy to calculate.
  - *Degree Days(DD) = Average daily temp. -Base Temp. = (max. + min.) / 2 - Base temp*
- **Baskerville Ermin** - Fits a curve to the maximum and minimum temperature.
  - *Simulate how the temperature varies, then calculates the area of the curve above the base temperature using calculus.*

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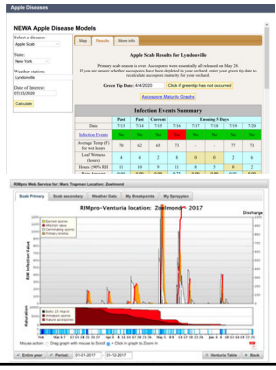

PREDICTIVE MODELING

- NEWA
- RIMpro
- Mills Chart
- Maryblight
- Cougarblight

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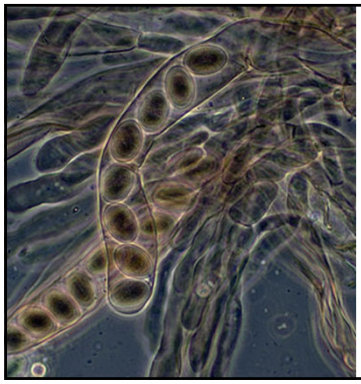

WHAT IS A DISEASE?

- *a <u>disorder of structure or function</u> in a human, animal, or plant, especially one that produces specific signs or symptoms or that affects a specific location and is not simply a direct result of physical injury.*
- *There can be fungi, bacteria, and viruses – even mycoplasmas – that infect and affect apples.*

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- Microbes don't know whether they are good or bad. All are generally created equal, some just have a deleterious effect on us, our crops, or animals – even other microbes.
- Pathogens tend to be weak competitors and generally become problematic only because we allowed or created the right conditions.
- The conventional farming approach to dealing with plant diseases is to spray some substance (e.g., fungicide) that kills it. The "conventional" organic approach is the same.
- An integrated or holistic approach balances the two theories with implementable strategies.
- By creating a stronger more intimidating environment with competitive microbes, and balanced nutrition and fertility.

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Bacterial

- **Fireblight** (*Erwinia amylovora)*

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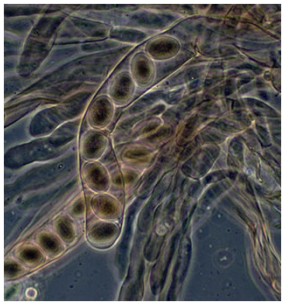

Fungal

- **Apple Scab**
  - *Venturia inaequalis*
- **Cedar Apple Rust**
  - *Gymnosporangium juniperi-virginianae*
- **Powdery Mildew**
  - *Podosphaera leucotricha*
- **Marsonnina Leaf Blotch**
  - *Marsonnina coronaria*
- **Anthracnose**
  - *Neofabraea malicorticis*
- **Phytophthora**
  - *Phytopthora spp.*
- **Black and White Rot**
  - *Botryosphaeria spp.*
- **Bitter Rot**
  - *Colletotrichum gloeosporiodes, C. acutatum and Glomerella cingulate*

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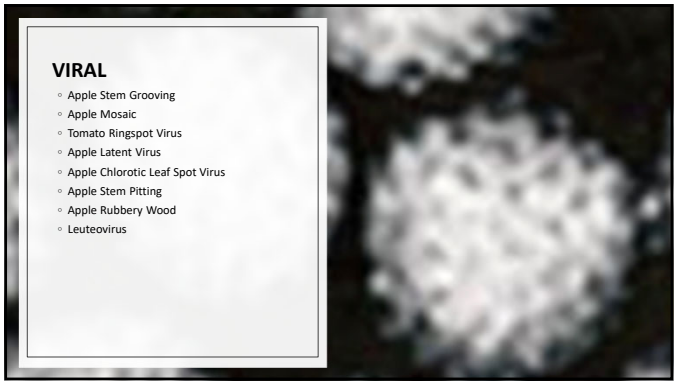
VIRAL
Apple Stem Grooving
Apple Mosaic
Tomato Ringspot Virus
Apple Latent Virus
Apple Chlorotic Leaf Spot Virus
Apple Stem Pitting
Apple Rubbery Wood
Leuteovirus

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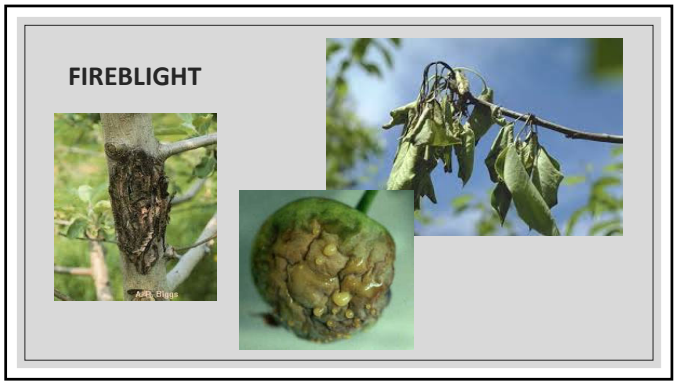
FIREBLIGHT
A.R. Biggs

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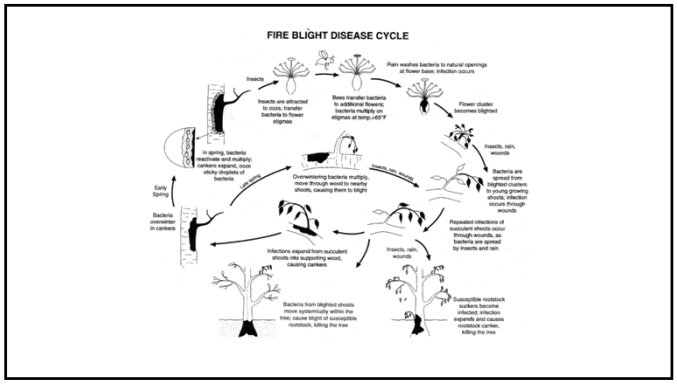
FIRE BLIGHT DISEASE CYCLE
Insects
Rain washes bacteria to natural openings at flower base; infection occurs
Insects are attracted to ooze, transfer bacteria to flower stigmas
Bees transfer bacteria to additional flowers; bacteria multiply on stigmas at temp.>65° F
Flower cluster becomes blighted
Insects, rain, wounds
In spring, bacteria reactivate and multiply; cankers expand, ooze sticky droplets of bacteria
rain, wounds
Bacteria are spread from blighted clusters to young growing shoots; infection occurs through wounds
Overwintering bacteria multiply, move through wood to nearby shoots, causing them to blight
Early Spring
Bacteria overwinter in cankers
Repeated infections of succulent shoots occur through wounds, as bacteria are spread by insects and rain
Infections expand from succulent shoots into supporting wood, causing cankers
Insects, rain, wounds
Bacteria from blighted shoots move systemically within the tree; cause blight of susceptible rootstock, killing the tree
Susceptible rootstock suckers become infected; infection expands and causes rootstock canker, killing the tree

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Fireblight
Erwinia amylovora

- **Susceptible Varieties**
- **Mature Inoculum**
  - Maturation Cycle, Degree Days
- **Adequate Temperatures**
  - 41-86°F
  - 81°F optimum
- **Free Water/High Relative Humidity**
  - 96-100%
- **Open Blossoms**
- **Damaged Tissue**

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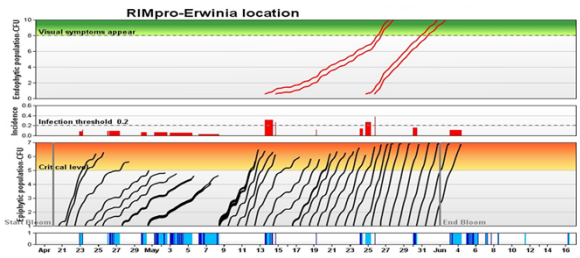

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Fireblight
Erwinia amylovora

CONTROL STRATEGIES

- **Resistant Varieties**
  - PRI series
  - Rootstocks too!
- **Orchard Sanitation**
  - Remove infected tissue
- **Cultural**
- **Nutrition**
- **Protective Sprays**

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Brand Name	Active Ingredient	Mode
Lifegard LC	Bacillus mycoides isolate J	SAR
BlightBan A506	Pseudomonas fluorescens A506	CC
Blossom Protect	Aurobasidium pullalans DSM 14940, 14941	CC
Bloomtime FD	Pantoea agglomerans strain E325	stigma
Agriphage Fireblight	Bacteriophage	phage
Thymeguard	23% Thyme Oil, 77% citrate	antib
AgroPest	13% Thyme, 10% Rosemary, 77% citrate	anitb
Cueva	Copper Octanoate	antib
Double Nickel	Bacillus amyloliquifasciens, Bacillus subtillus	antib
Actigard	Acibenzolar-S-methyl	SAR
Regalia	Extract of Reynoutria Sachalinensis	SAR

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Apple Scab
Venturia inaequalis

- Ubiquitous in most apple growing regions of the world.
- Apples and flowering crabapples (Malus spp.), hawthorn (Crataegus spp.), mountain ash (Sorbus spp.), firethorn (Pyracantha spp.), and loquat (Eriobotrya japonica).
- Affects most common varieties of fresh and processing apples.
- There are varying levels of resistance and some immunity.
- Reasonably easily controlled with conventional fungicides, not so much with organic fungicides.
- Requires specific conditions for infections to occur.
- Primary vs Secondary

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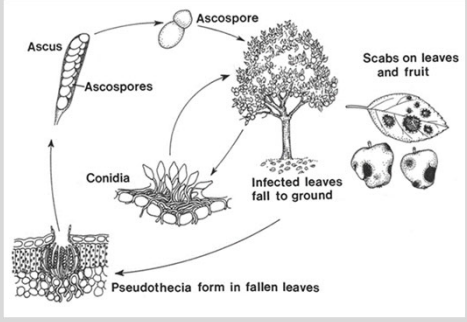

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Apple Scab
Venturia inaequalis

- **Susceptible Varieties**
  - McIntosh, Empire, Golden Delicious
- **Mature Inoculum**
  - Maturation Cycle, Degree Days
- **Adequate Temperatures**
  - 63-72°F
- **Leaf Wetting**
  - >4 hours
- **Green Tissue**
  - Green tip -> harvest

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TABLE 7. Approximate Wetting Period Required for Primary Apple Scab Infection at Different Air Temperatures and Time Required for Development of Conidia[a]

Average Temperature (°F)	Average Temperature (°C)	Wetting Period (hr)[b] Light Infection	Moderate Infection	Heavy Infection	Incubation Period[c] (days)
78	25.6	13	17	26	...
77	25.0	11	14	21	...
76	24.4	9.5	12	19	...
63–75	17.2–23.9	9	12	18	9
62	16.7	9	12	19	10
61	16.1	9	13	20	10
60	15.6	9.5	13	20	11
59	15.0	10	13	21	12
58	14.4	10	14	21	12
57	13.9	10	14	22	13
56	13.3	11	15	22	13
55	12.8	11	16	24	14
54	12.2	11.5	16	24	14
53	11.7	12	17	25	15
52	11.1	12	18	26	15
51	10.6	13	18	27	16
50	10.0	14	19	29	16
49	9.4	14.5	20	30	17
48	8.9	15	20	30	17
47	8.3	15	23	35	...
46	7.8	16	24	37	...
45	7.2	17	26	40	...
44	6.6	19	28	43	...
43	6.1	21	30	47	...
42	5.5	23	33	50	...
41	5.0	26	37	53	...
40	4.4	29	41	56	...
39	3.9	33	45	60	...
38	3.3	37	50	64	...
37	2.7	41	55	68	...
33–36	0.5–2.2	48	72	96	...

[a]Adapted from Mills, 1944, as modified by A. L. Jones.
[b]The infection period is considered to start at the beginning of the rain.
[c]Approximate number of days required for conidial development after the start of the infection period.

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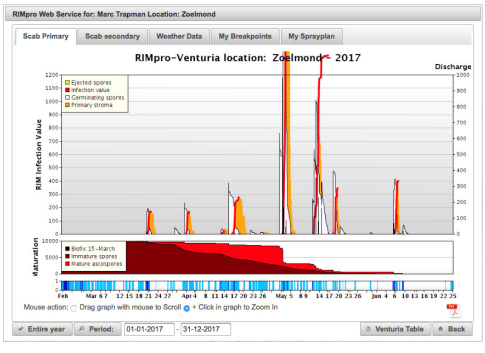

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Apple Scab
Venturia inaequalis

CONTROL STRATEGY

- **Resistant Varieties**
  - PRI, Redfree, Liberty
- **Orchard Sanitation**
  - Vacuum up leaves
  - Urea/Lime Sulfur sprays
- **Cultural**
  - Remove wild apples
- **Nutrition**
  - Cobalt
  - Micronutrients
- **Protective Sprays**

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CEDAR APPLE RUST

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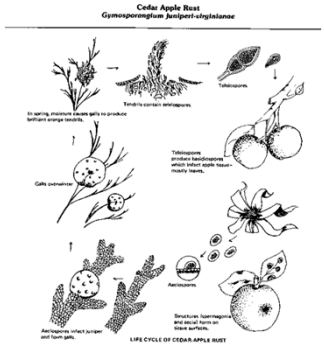

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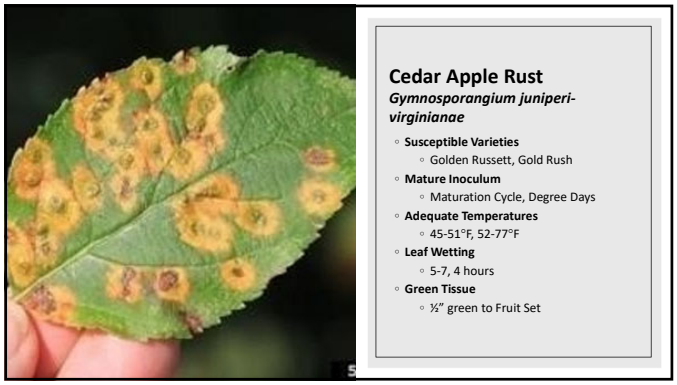

Cedar Apple Rust

Gymnosporangium juniperi-virginianae

- **Susceptible Varieties**
  - Golden Russett, Gold Rush
- **Mature Inoculum**
  - Maturation Cycle, Degree Days
- **Adequate Temperatures**
  - 45-51°F, 52-77°F
- **Leaf Wetting**
  - 5-7, 4 hours
- **Green Tissue**
  - ½" green to Fruit Set

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TABLE 9. Temperature and Moisture Requirements for Cedar Apple Rust Infection Periods on Susceptible Apple Cultivars

	Wetting Period (hr)		
Temperature (°C)	Basidiospore Formation	Light Infection	Severe Infection
2	NB[a]	24	NSI[b]
4	NB	12	24
6	NB	8	10
8	7	6	7
10	5	5	6
12	4	4	5
14	4	3	5
16	4	3	4
18	4	3	4
20	4	2	4
22	4	2	4
24	4	2	4
26–30	NB	NI[c]	NI

[a]NB = no basidiospores formed at this temperature.
[b]NSI = no severe infection observed at this temperature.
[c]NI = no infections observed at this temperature.

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Cedar Apple Rust
Gymnosporangium juniperi-virginianae
CONTROL STRATEGY

- **Resistant Varieties**
  - Empire, Liberty, Priscilla
- **Orchard Sanitation**
  - Remove cedar trees
- **Cultural**
  - Remove cedar trees
- **Nutrition**
- **Protective Sprays**

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POWDERY MILDEW

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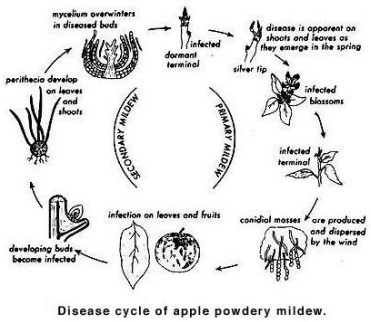

Disease cycle of apple powdery mildew.

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Powdery Mildew
Podosphaera leucotricha

- **Susceptible Varieties**
  - Cortland, Stayman, Golden Delicious
- **Mature Inoculum**
  - Maturation Cycle, Degree Days
- **Adequate Temperatures**
  - 50-77°F
- **High Humidity**
  - 96-100%
- **Green Tissue**
  - ½" green to Fruit Set

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Powdery Mildew
Podosphaera leucotricha
CONTROL STRATEGY

- **Resistant Varieties**
  - PRI series
- **Orchard Sanitation**
  - Remove infected tissue
- **Cultural**
- **Nutrition**
- **Protective Sprays**

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Marsoninna Leaf Blotch
Marsoninna coronaria

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VERY SIMILAR TO APPLE SCAB IN TERMS OF LIFE CYCLE

COOL WET SHADY CONDITIONS ENCOURAGE INFECTIONS

45 DAYS FROM INFECTION TO SYMPTOMS

SYMPTOMS DON'T OFTEN SHOW UP UNTIL JULY OR AUGUST

CAN DEFOLIATE ENTIRE TREES

MOSTLY A FOLIAR DISEASE THOUGH IT HAS BEEN PICKED UP ON FRUIT.

EVEN CONVENTIONAL FUNGICIDES DON'T SEEM TO BE VERY EFFECTIVE

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Marsoninna Leaf Blotch
Marsoninna coronaria

- **Susceptible Varieties**
  - All
- **Mature Inoculum**
  - Maturation Cycle, Degree Days
  - 45 days from infection to visible symptom
- **Adequate Temperatures**
  - 70°F optimal
- **Leaf Wetting**
  - Similar to scab
- **Green Tissue**
  - Season-long

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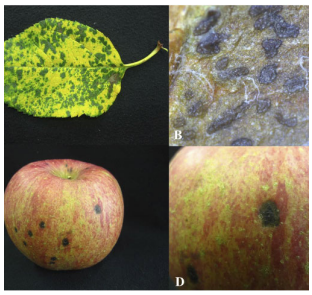

Marssonina Leaf Blotch
Marsoninna coronaria

CONTROL STRATEGY

- **Resistant Varieties**
  - None known
- **Orchard Sanitation**
  - Remove infected tissue
- **Cultural**
- **Nutrition**
- **Protective Sprays**
  - Spray trunks with sanitizing spray
    - Oxidate or LS/Cu

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				Pests of Concern		Sprays					
#	Stage of Growth	Degree Days	Approx Date	Diseases	Insects	Fungicides	Insecticides	Nutrition	Thinning	Biodynamic*	Notes
1	Dormant			none	mites, scale	none	none	none	none		
2	Delayed Dormant		20-Mar	none	mites, scale	copper (NuCop)	dormant oil	none	none	500	
Pear Psylla egg laying (84 DD 43F)											
3	Silver Tip	95	1-Apr	none	mites, scale	copper (NuCop)	dormant oil	none	none	BC	
4	Greentip		4-Apr	scab	none	copper (NuCop or Cueva)	dormant oil	none	none	BC, 501	
5	Quarter inch green		11-Apr	scab	OBLR	Double Nickel, Cueva, Thymeguard	Bt (DiPel)	SeaCrop, SeaShield, Micropak	none	Seq Spray (dry)	
6	Half Inch Green	160	18-Apr	scab	OBLR	Double Nickel, Cueva, Thymeguard	Bt (DiPel)	SeaShield, Micropak, SeaStim	none	505, 508	Bt apps depend on presence of OFM, GM, OBLR
7	Tight Cluster	228	25-Apr	scab	OBLR	Thymeguard or Sulfur (as	Entrust, Surround, Venerate	SeaShield, Micropak, SeaStim	none	505, 508	
OFM - traps out 289 DD (43F)											
8	Pink	289	1-May	scab, CAR	PC, EAS, TPB, leps	Thymeguard or Sulfur (as	Entrust, Surround, Venerate	SeaCrop, Micropak, SeaStim	none	505, 508	
OFM - first catch 229 DD (45F)											
9	King Bloom		5-May	fireblight, scab, CAR, PM, BR	PC, EAS, TPB	DN, Cueva, Thymeguard or Blossom Protect	none	none	none	Seq Spray (dry), 507	
OBLR - overwintering generation sample, codling moth traps out (192 DD 50F)											
10	Full Bloom	378	10-May	fireblight, scab, CAR, PM, BR	EAS	DN, Cueva, Thymeguard, Blossom Protect	none	none	none	Seq Spray (dry)	Need to pay special attention to blossom thinning needs. (Not addressed in this chart)
11	10% Petal Fall		20-May	scab, CAR, PM	PC, TPB	DN, Cueva, Thymeguard, Blossom Protect	Surround/Entrust	none	Regalia + oil	BC	collect PC adults for peppers
12	50% Petal Fall		23-May	scab, CAR, PM	PC, TPB	DN, Regalia,	Bt/PyGanic	none	none	501 (for thinning)	collect PC adults for peppers
OFM 1st flight catch (369 DD 45F), codling moth 1st flight catch (249 DD 50F)											
12	90% Petal Fall	479	25-May	scab, CAR, PM	PC, TPB, EAS	DN, Cueva, Thymeguard	Surround/Entrust	none	Regalia + oil	BC	collect PC adults for peppers
Plum Curculio 1st oviposition (555 DD 43F), OBLR traps out (681 DD 43F)											
13	Fruit set (20mm)	681	1-Jun	CAR, PM	PC, CM, Aphids, mites	DN, Cueva, Thymeguard	Bt and/or PyGanic	calcium, SeaCrop, SeaStim, hydrolyzed fish	501		
Codling moth 1st flight peak (442 DD 50F), OBLR 1st adult catch (884 DD 43F), Dogwood borer 1st adult catch (964 DD 43F)											
14	1C	1032	15-Jun	PM, SBFS	PC, CM, Aphids, mites	DN, Cueva	Dipel, granulosis, grandevo, stylet oil, PF97	calcium, SeaCrop, SeaStim, hydrolyzed fish	none		275 LWH for 1st SBFS infections
15	2C		21-Jun	PM, SBFS	OBLR, CM, LH, Aphids, mites	DN, Cueva and/or sulfur	Dipel, granulosis, grandevo, stylet oil, PF97, AzaDirect	calcium, SeaCrop, SeaStim, hydrolyzed fish	hand touch up		
Apple Maggot Traps out, OFM 2nd flight starting (1180 DD 45F), OBLR 2nd gen sampling											
16	3C	1367	1-Jul	SBFS, fruit rots	OBLR, CM, LH, JB Aphids, mites	DN, Cueva	Dipel, grandevo, stylet oil, PF97, AzaDirect	calcium, SeaCrop, SeaStim	none		
Apple Maggot 1st adult catch 1509 DD 43F), OFM 2nd flight peak (1450 DD 45F)											
17	4C	1800	11-Jul	SBFS	OBLR, CM, LH, JB Aphids, mites	DN, Cueva	Dipel, PyGanic, Entrust, grandevo, stylet oil, PF97, AzaDirect	calcium, SeaCrop, SeaStim	none		
Codling Moth 2nd gen flight begins (1251 DD 50F)											
18	5C		21-Jul	SBFS	SBFS, AM, LH, JB, aphids, mites	DN, Cueva	Entrust or PyGanic	calcium, SeaCrop, SeaStim	none	501 or 505	
19	6C	2167	31-Jul	SBFS	SBFS, AM, LH, JB, aphids, mites	DN, Cueva	Dipel, granulosis, grandevo, stylet oil, PF97	calcium, SeaCrop, SeaStim	none		
Apple Maggot flight peak (2394 DD 43F), Codling Moth 2nd gen peak flight (1585 DD 50F), OBLR 2nd gen flight (2413 DD 43F), OFM 3rd gen flt (2275 DD 45F)											
20	7C	2450	10-Aug	SBFS	SBFS, AM, LH, JB, aphids, mites	DN, Cueva	Dipel, granulosis, grandevo, stylet oil, PF97	calcium, SeaCrop, SeaStim	none		
OFM 3rd flt peak (2625 DD 45F)											
21	8C	2715	20-Aug	SBFS	apple maggot, BMSB	DN, Cueva	Entrust, PyGanic, DiPel, Grandevo		none		
22	9C	2800	30-Aug	SBFS	CM, OFM	DN, Cueva	Grandevo		none		
23	Pre-Harvest		7-Sep	SBFS	CM, OFM	DN, Cueva	Grandevo		none		

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- We are currently in the process of cataloging commercial biological sprays and updating our **Biointensive Spray Guidelines.**
- **Holistic Orchard Webinar Series** - 16 seminars, starting Feb 19. www.knowyouroots.com
- **Biodynamic Orcharding** – Josephine Porter Institute, Floyd, VA – March 12
- eNewsletter – available by subscription
- Volunteer, Inter, Employment, and Learning Opportunities. **Sign up today!**

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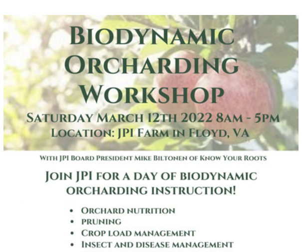

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