



Cornell University
Department of Plant Pathology
and Plant-Microbe Biology



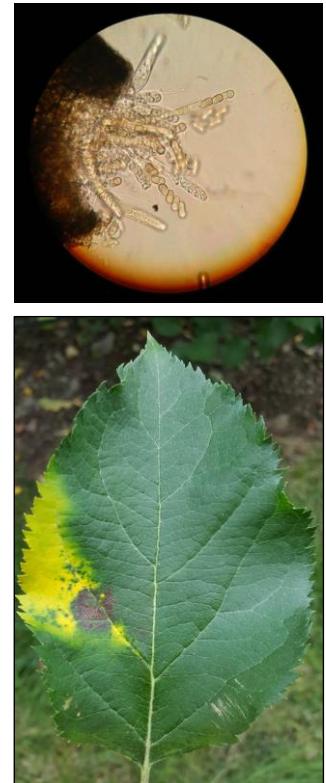
Organic Tools for Apple Diseases

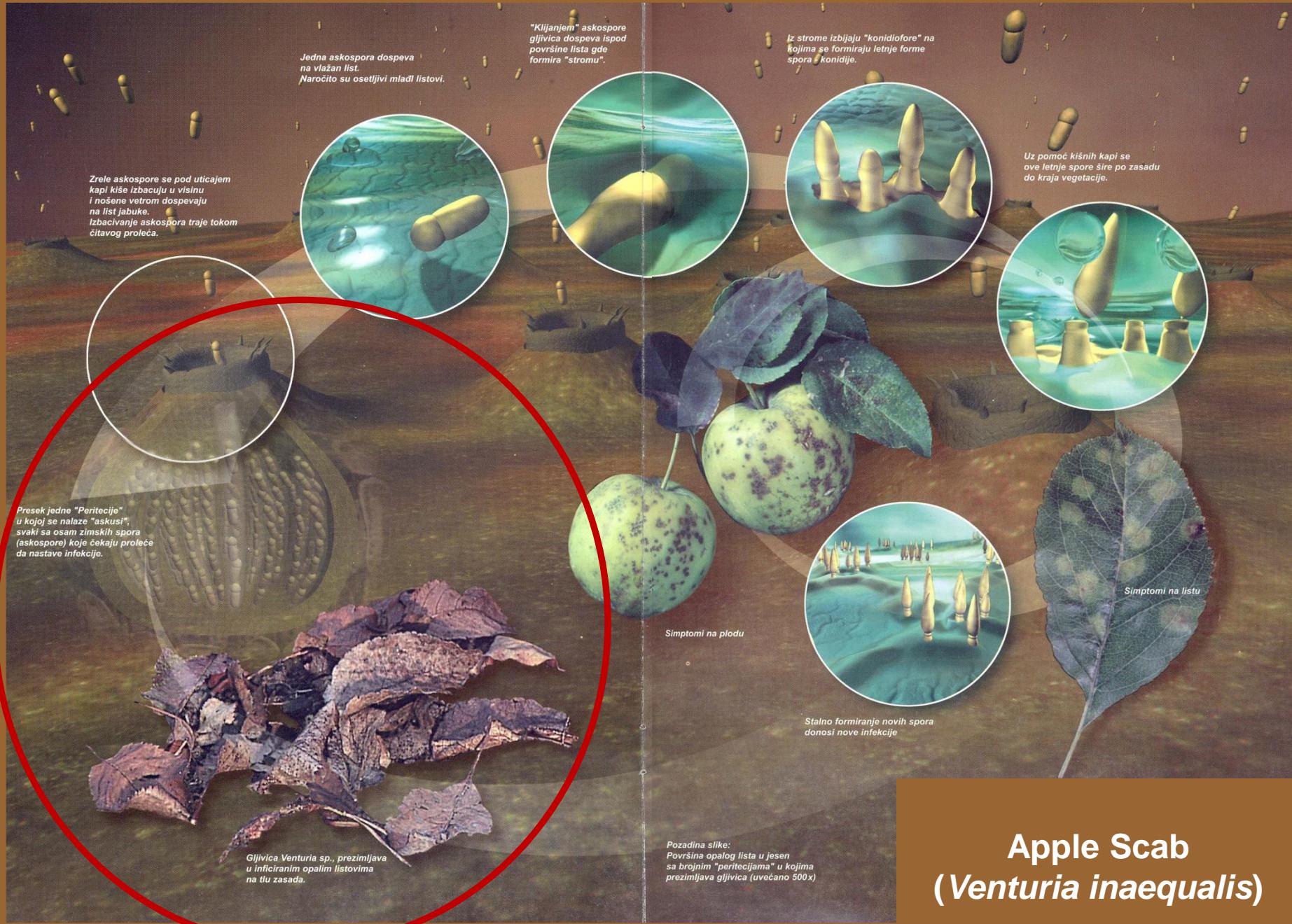
Srdjan G. Acimovic

5 March 2021

Outline

1. Apple Scab
2. Fire Blight
3. Cedar Apple Rust
4. Marssonina Blotch – *Diplocarpon coronariae*
5. Summer Diseases





**Apple Scab
(*Venturia inaequalis*)**

Marssonina Leaf & Fruit Blotch Cycle

- *Diplocarpon coronariae* fungus -



Adapted from: Back & Jung 2014, Journal of Medical Mycology 42(3):183-190

Orchard Sanitation – My Approach

Fire Blight, Apple Scab, MLFB

- Prune out fire blight cankers and strikes
 - *Nectria* blight and canker
 - Remove fruit mummies
- Reduction of overwintering inoculum in leaf litter
 - Fall, spring, spring & fall
 - Before leaf drop – Fall
 - Orchard floor - late Winter, before budbreak
 - Turn air deflectors downward, turn top nozzles off
 - 40 lb urea / A / 100 gals (rinse equipment)
 - Flail mow, dolomitic lime

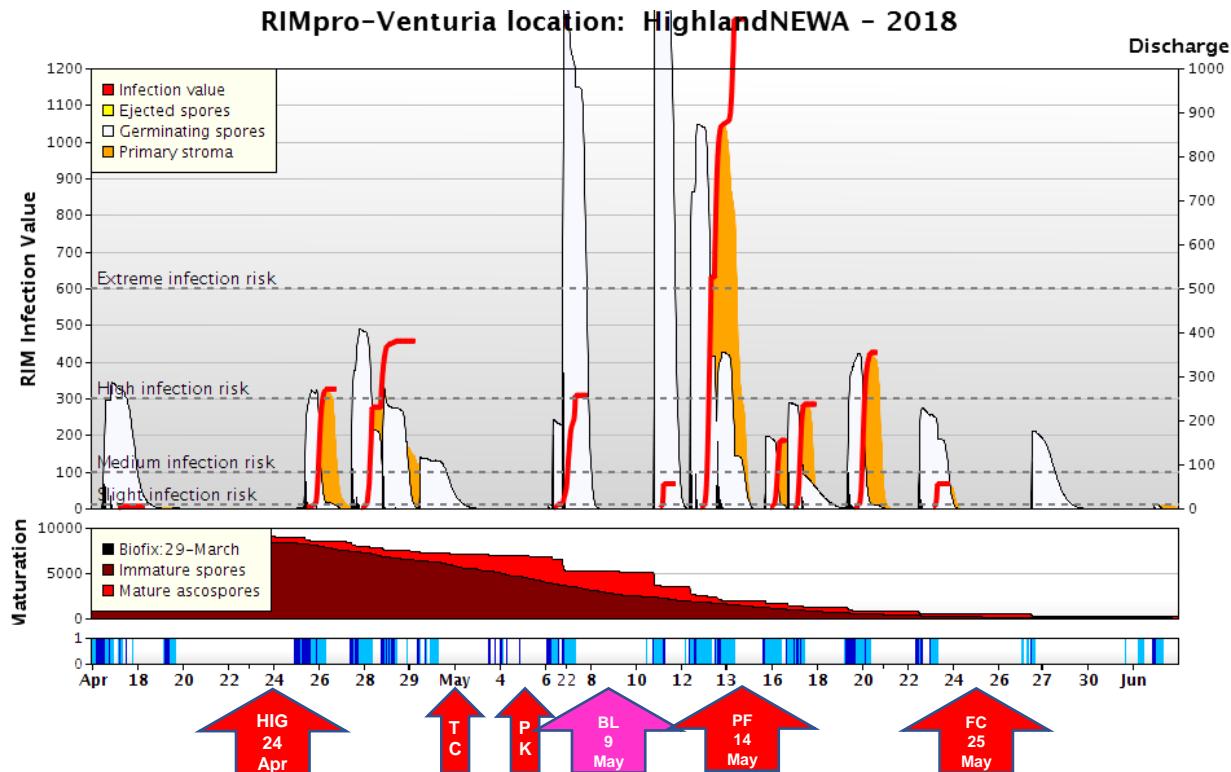
Organic: no urea

- Flail mowing - no snow & no mud
- Dolomitic lime, powder - lime spreader
- After the leaf drop – Fall, early in Winter, late winter (no snow)
 - 2.5 tons / A



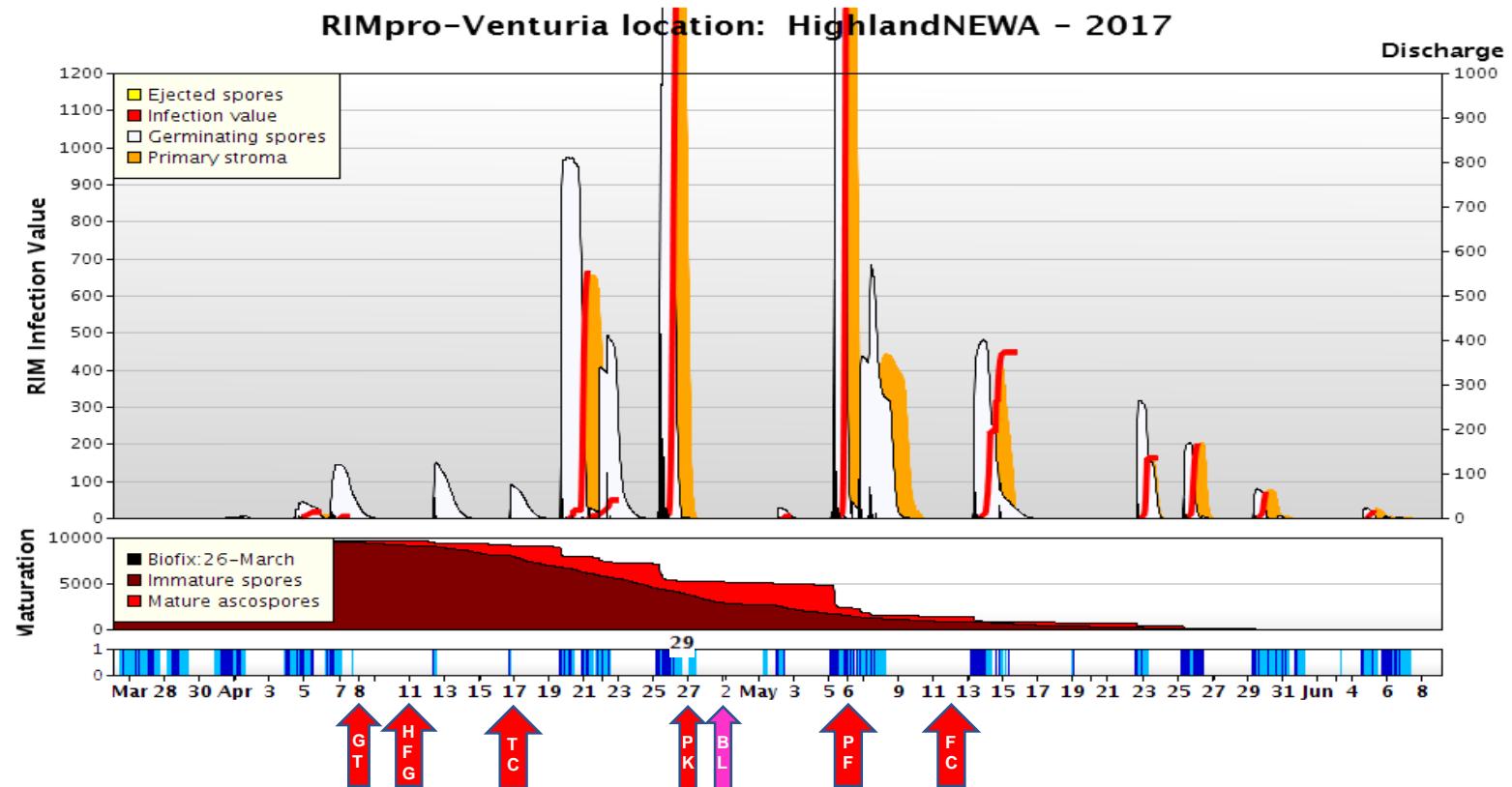
Year Differ – Weather Conditions Differ

- RIMpro apple scab model 2018 -



Year Differ – Use Prediction Models

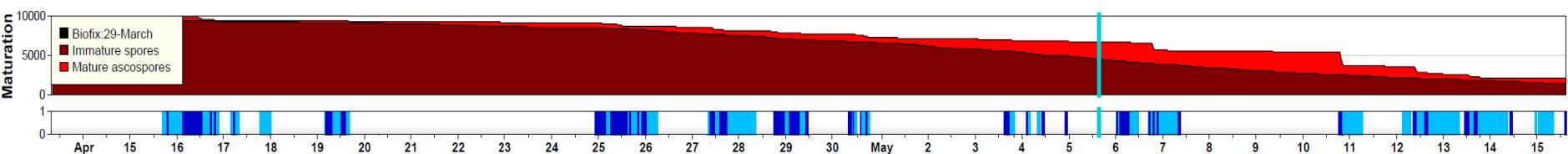
- RIMpro 2017 -



Primary Scab Season End & Cover Sprays

- Continue Two Weeks of Sprays -

- Coverage
- Last-minute infections
- Less than 5% of the season's spores



Scab Control in Organic Apples

- Recommendations -

Choices:

- Scab-resistant cv-s: *Vf* gene: Williams' Pride, Jonafree, Liberty, Enterprise, Prima, Pristine, GoldRush
- **First 4-5 years grow trees using conventional pesticides first (!)**
- Orchard isolated from woodlots, hedgerows, meadows – source of rust, SBFS, bitter rot
- Sites with excellent air drainage so leaves dry quickly, planting design
- Sulfur, liquid lime sulfur (LLS), potassium bicarbonate (PB), copper on susceptible cultivars
- Spray before rain i.e. infection periods & use disease prediction models
- Arrest scab development: PB @ 4.3 lb a.i./A + Sulfur 4.3 lb a.i./A
- After PK bud: PB @ 2.15 lb a.i./A + Sulfur 2.15 lb a.i./A (PB against germinating scab spores)

Problems:

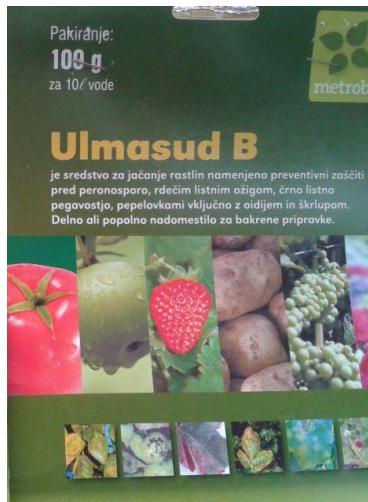
- No antibiotics, fertilizers, synthetic pesticides, plant growth regulators
- 8-10 Sulfur and LLS sprays/year lower productivity 25 to 35% – photosynthesis, thinning
- Copper GT to Pre-PK only at low rates - fruit russetting when slow drying!
- Scab-resistant cultivars still need some sulfur, LLS sprays (mildew and *Vf* gene preservation)
- Sulfur, LLS, and copper not very effective for rusts (LSS burns wet leaves & fruit)
- Scab-resistant cultivars highly susceptible to cedar apple rust
- All apple cultivars susceptible to quince rust
- PB timed precisely to 200 - 540 DH (base 32°F) after criteria for a Mills infection are met



Acid Clays in Apple Scab Control

- Research -

- Clays control plant diseases by increasing aluminum on plant surfaces (Enkelmann and Wohlfarth, 1994).
- Aluminium ions inhibit spore germination of fungal pathogens (Andrivon, 1995; Van Zwieten et al., 2007).
- Clay keeps leaves dry, reducing the risk of pathogen infections (La Torre et al. 2018).



Mycosin



Copper Oxychloride



Organic Scab Control - Serbia

- Balaz et al. 2010, AGES Austria visit -

Product	A. I.-s	*Conc. (%)
Acid Clay (Ulmasud B)	Aluminium-oxide 8.7% Silicon dioxide 13.7% Titanium-oxide 0.047% Sulfur 11.8%	1
Acid Clay (Ulmasud B) + Sulfur (Thiovit Jet)	- as above - Inorganic sulfur 80%	0.8 + 0.3
Copper (Funguran OH) + Sulfur (Thiovit Jet)	Copper oxychloride 50% Inorganic sulfur 80%	0.05 + 0.3
Spray standard	Cu, EBDC, dodine dithianon, cyprodinil, difenoconazole, hexaconazole, pirimetanil, fluquinconazol	Label

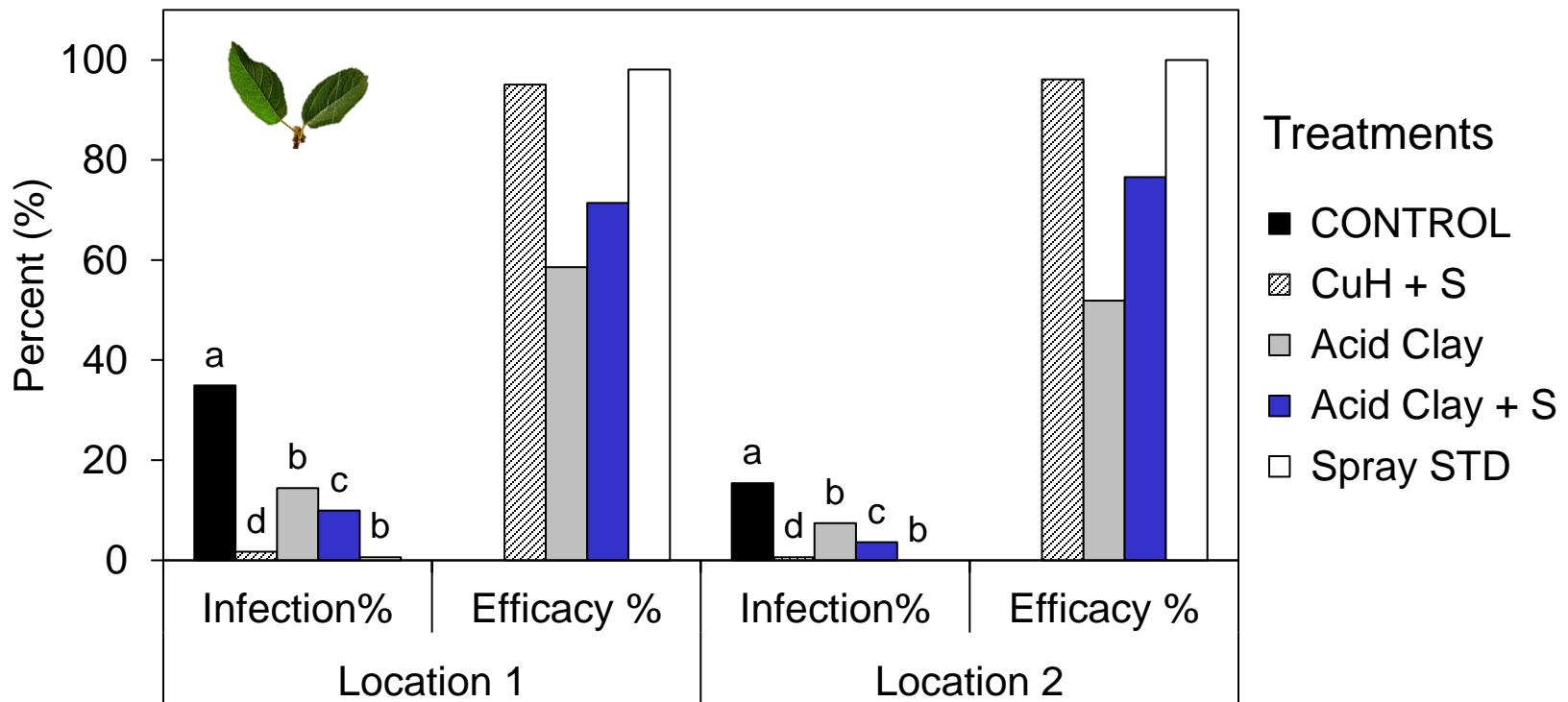
*Sprays during primary infections: 16, 23, 29 April, 6, 13, 19, 25 May

Acid Clay in Scab Control – Low Pressure

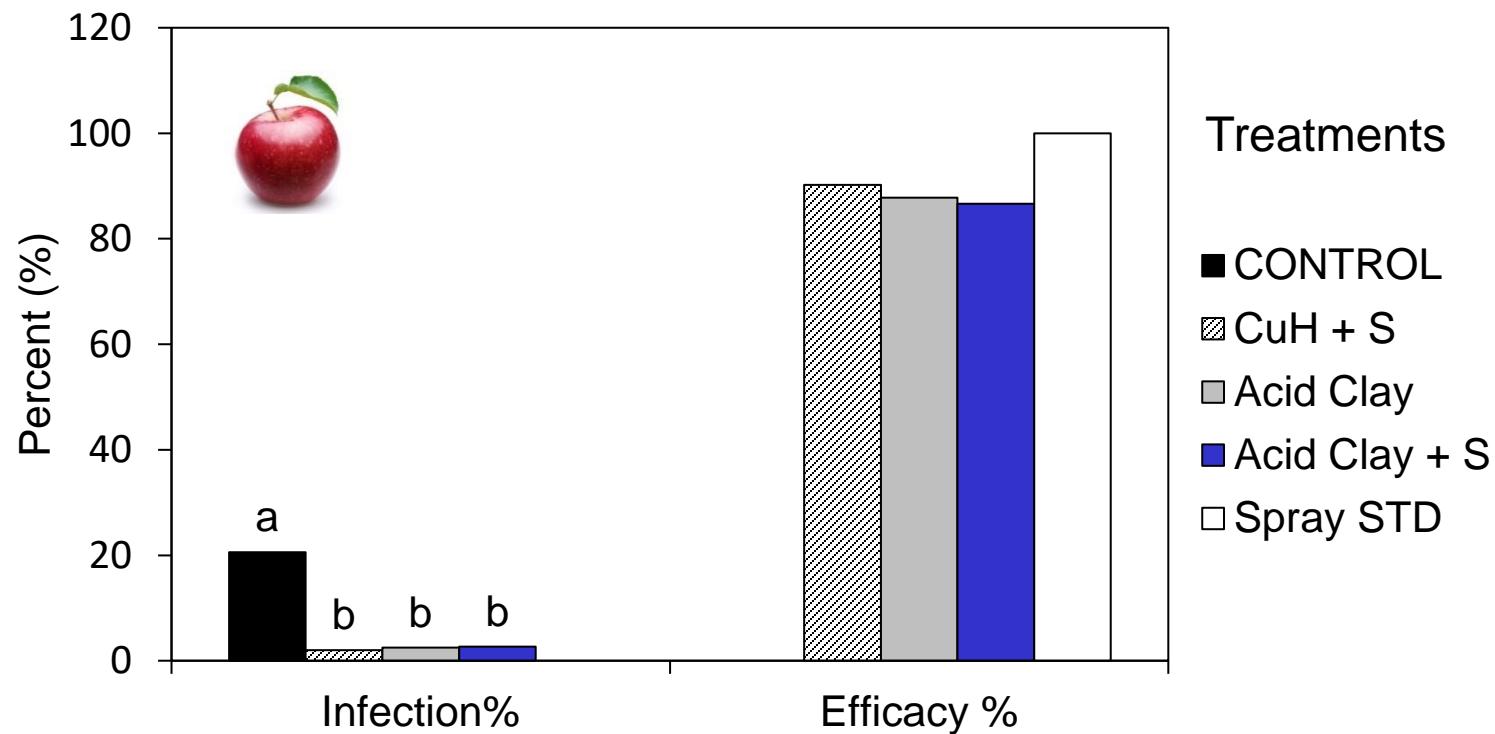
- 10 June 2009 (Balaz et al, 2010) -

Alone on leaves: 52-58 %; Combo 71-77%

Alone on fruit: 88%; Combo: 87%



Alone on fruit: 88%; Combo: 87%



New Zealand - Organic Apple Orchards

- IFTA tour 2018: Visit to Bostoc NZ -

- Avoid planting M.9
- Use fire blight resistant G202 (*M.27 x Robusta 5*) slightly larger than M.26
- **Grow trees with conventional pesticides first 4-5 years (!)**
- **Reach full tree size, then switch orchard to organic protection**
- Sheep in winter eat scab leaves
- Ground cultivation - helps degrade leaf litter
- **Early scab:** Lime sulfur - scab sprays, thins fruit a little
 - They are careful to not reduce photosynthesis
 - 1.9 gal of lime + 1.1 lb Kumulus (sulfur)/A
 - At 10 mm fruit size switch to copper
- **Later scab:** Copper Hydroxide 35% @ 1.1 lb/A
- Higher rate for fire blight when model shows risk
- **Year limit: 2.64 lb/A/year**
- Blossom Bless® (*Pantoea agglomerans* flowable powder)
 - Respiratory and skin sensitizer - toxicant
- Problem are *Botryosphaeria* - black & white rot



1. Apple Scab Trial 2020

3/22/2020 – GT
4/6/2020 – HIG
4/14/2020 – TC
4/23/2020 – TC2
4/29/2020 – PK
4/29/2020 – EB
5/4/2020 – MB
5/16/2020 – PF
5/26/2020 – 1C
6/13/2020 – 2C
7/7/2020 – 3C

- **Spur leaf scab**
Jul 10 – 14
- **Fruit scab**
Jul 14 – 15
- **Shoot leaf scab**
Jul 17 – Aug 4

Mefenpropidione | Group 3 Fungicide

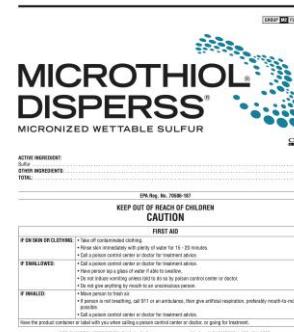
Cevya
Fungicide

EXCALIA
FUNGICIDE

Indiflin, FRAC 7

PYDIFLUMETOGEN | GROUP 7 FUNGICIDE

Miravis[®]



Stargus - 1 × 10⁹ CFU
B. amyloliquefaciens
F727, FRAC BM02

Nu-Film P
Spreader Sticker

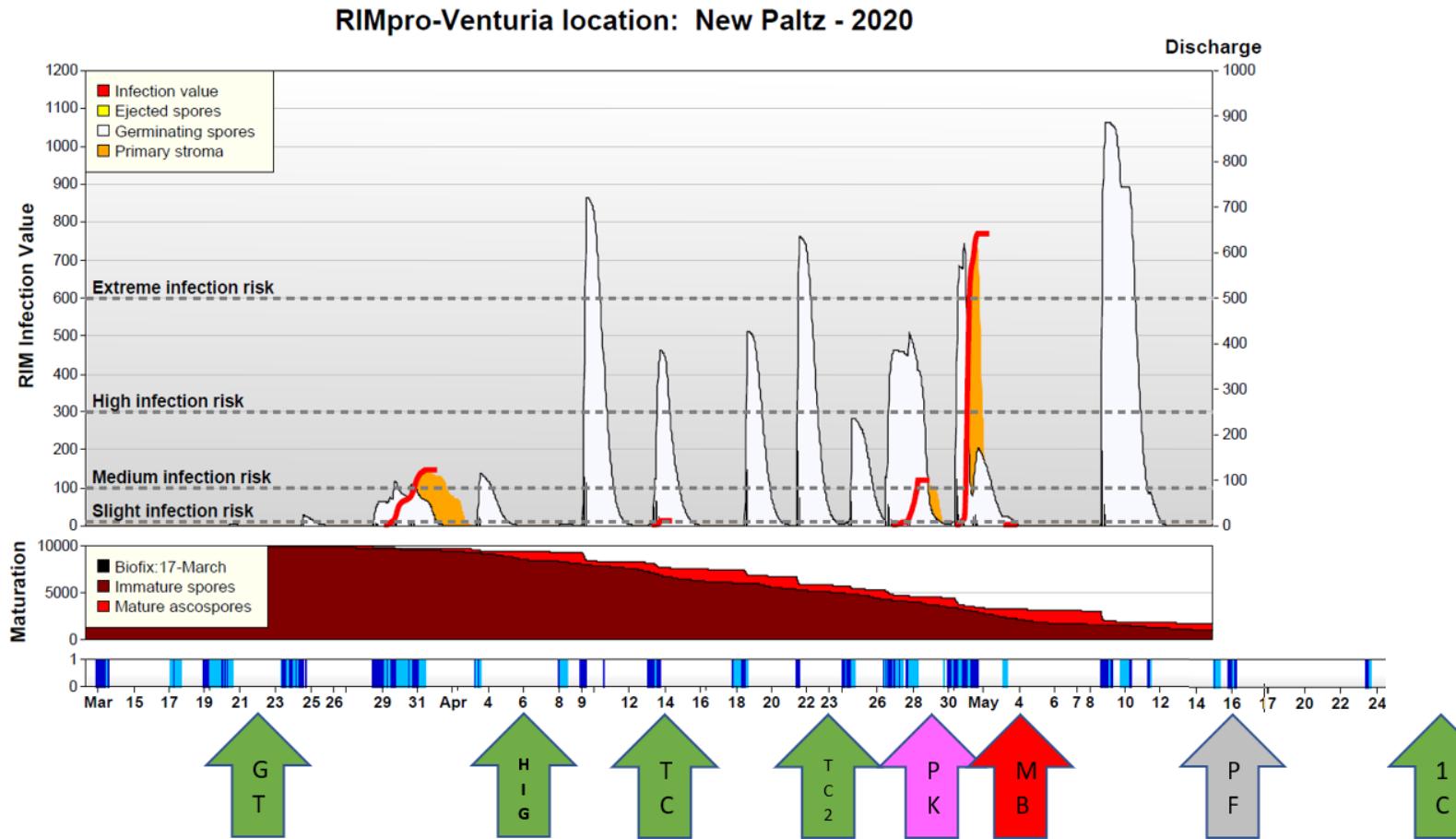
Vacciplant[®]
plant defense stimulant



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1. Apple Scab Trial 2020



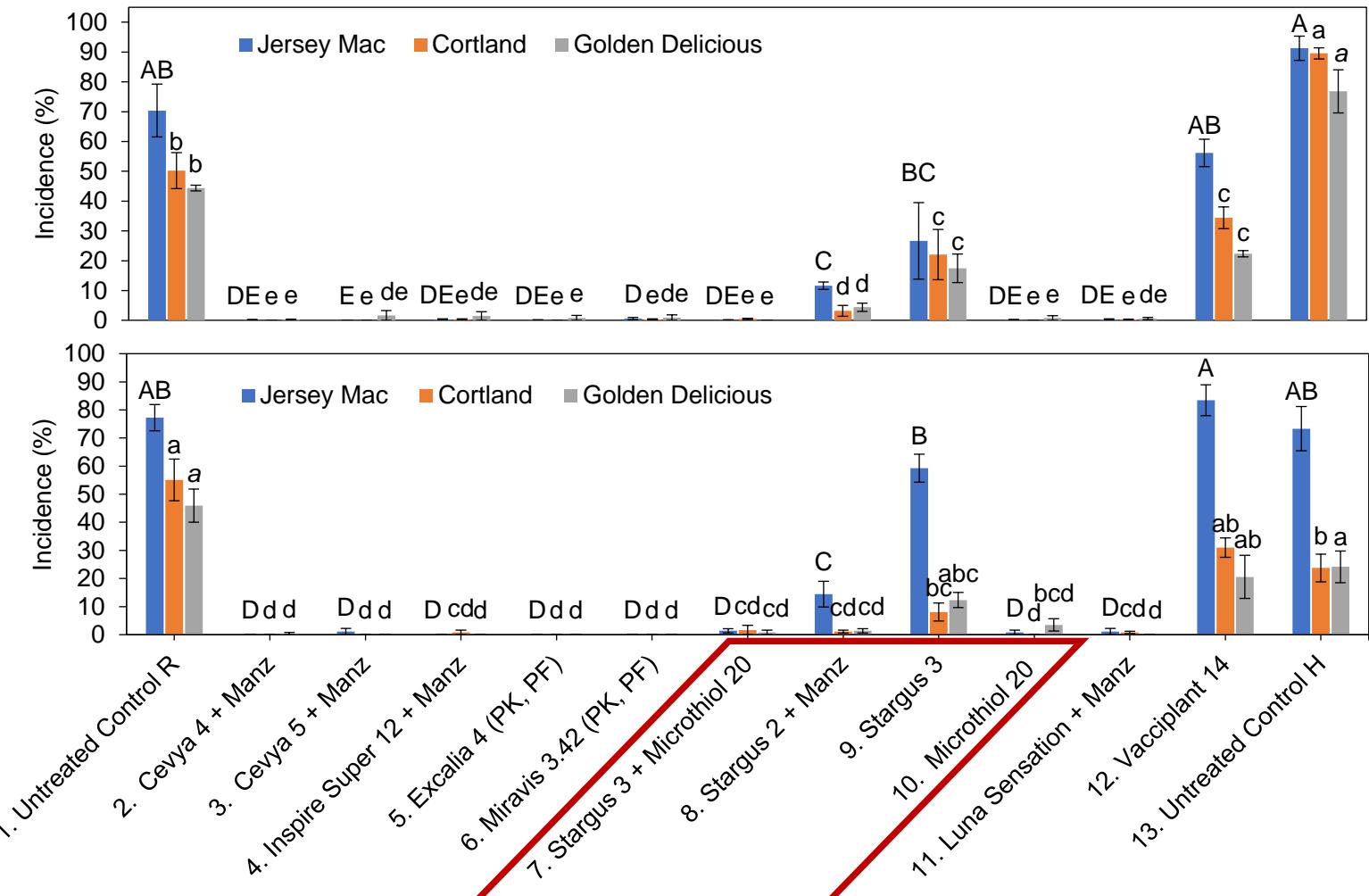
Spray Timing of Fungicides

1 Untreated control regular	/	
2 Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Cevya 4 fl oz + Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Captan 80 WDG 3 lb	HIG TC TC PK, MB, PF 1C 2C, 3C	
3 Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Cevya 5 fl oz + Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Captan 80 WDG 3 lb	HIG TC TC PK, MB, PF 1C 2C, 3C	
4 Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Inspire Super 12 fl oz + Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Captan 80 WDG 3 lb	HIG TC TC PK, MB, PF 1C 2C, 3C	
5 Manzate Pro-stick 75 WG 3lb - Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Excalia 4 fl oz Inspire Super 12 fl oz Excalia 4 fl oz Manzate Pro-stick 75 WG 3lb Captan 80 WDG 3 lb	GT HIG TC TC PK MB PF 1C 2C, 3C	

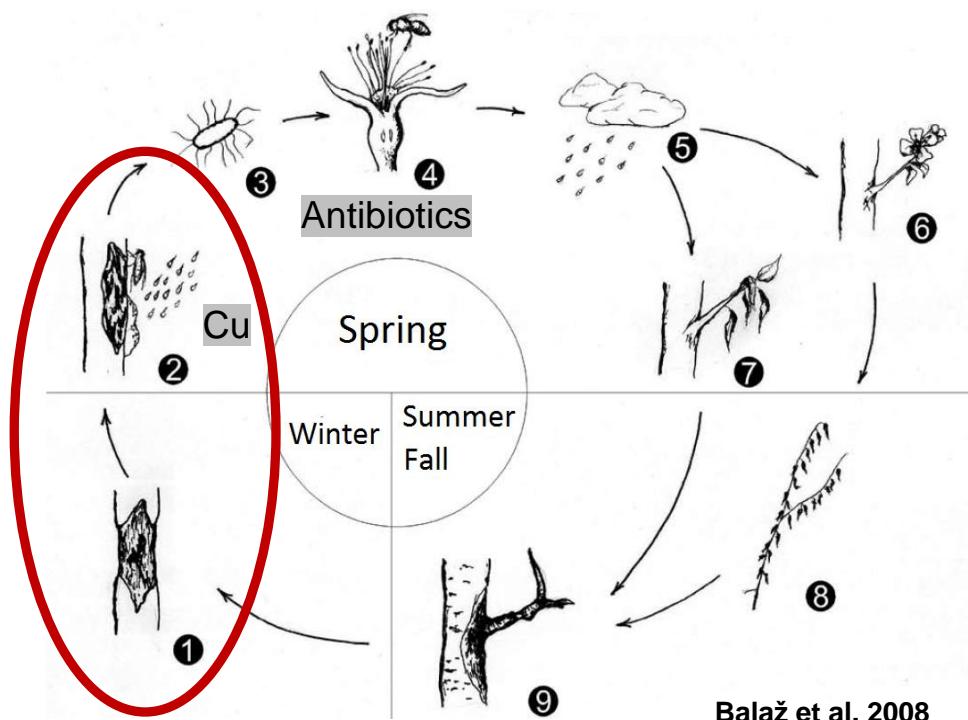
6 Manzate Pro-stick 75 WG 3lb - Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Miravis 3.42 fl oz Inspire Super 12 fl oz Miravis 3.42 fl oz Manzate Pro-stick 75 WG 3lb Captan 80 WDG 3 lb	GT HIG TC TC PK MB PF 1C 2C, 3C
7 Stargus 3 qts + Microthiol Disperss 20 lbs - Stargus 3 qts + Microthiol Disperss 20 lbs + NuFilm P 32 fl oz/100 gal	GT HIG TC, TC, PK, MB, PF, 1C
8 Stargus 2 qts + Manzate Pro-stick 75 WG 3lb Stargus 2 qts + Manzate Pro-stick 75 WG 3lb - Stargus 2 qts + Manzate Pro-stick 75 WG 3lb	HIG TC, TC PK, MB, PF, 1C
9 Stargus 3 qts - Stargus 3 qts + NuFilm P 32 fl oz/100 gal	GT HIG TC, TC, PK, MB, PF, 1C
10 Microthiol Disperss 20 lbs - Microthiol Disperss 20 lbs + NuFilm P 32 fl oz/100 gal	GT HIG TC, TC, PK, MB, PF, 1C
11 Indar 8 fl oz + Manzate Pro-stick 75 WG 3lb Rally 8 oz + Manzate Pro-stick 75 WG 3lb Luna Sensation 4.17SC 5 fl oz + Manzate Pro-stick 75 WG 3lb Manzate Pro-stick 75 WG 3lb Captan 80 WDG 2.5 lb	TC, TC PK MB, PF 1C 2C, 3C
12 Vacciplant 14 fl oz	TC, TC, PK, MB, PF, 1C
13 Untreated control high	/



1. Apple Scab Trial 2020



2. Fire Blight Bacterium *Erwinia amylovora*



Fire Blight Prediction EIP (MaryBlyt)

- Model -

Map Results More info

Fire Blight Risk Predictions for New Paltz (WG Minard)

Orchard Blight History: Fire blight occurred in your neighborhood last year. Select the fire blight history in your orchard block of interest and the tool will calculate risk. Toggle orchard blight history to recalculate risk.

First blossom open date: 4/13/2020

The first blossom open date above is estimated based on degree day accumulations. Enter the actual first blossom open date for your orchard block of interest and the tool will calculate the protection period during bloom more accurately.

Accumulated degree days (base 43°F) through 5/23/2020: 570 (0 days missing)

	Past	Past	Current	Ensuing 5 Days				Current	Ensuing 5 Days				
Date	5/21	5/22	5/23	5/24	5/25	5/26	5/27	5/28	5/29	5/30	5/31	6/1	6/2
Cougarblight 4-Day DH	Caution 227	High 434	High 459	Extreme 509	Extreme 516	Extreme 607	Extreme 843	Extreme 975	Extreme 1215	Extreme 1132	Extreme 845	Extreme 639	High 335
Infection Potential EIP value	Moderate 56	Infection 106	Infection 112	High 131	Infection 152	Infection 161	Infection 241	Infection 242	Infection 251	Infection 217	High 106	Moderate 36	Moderate 49

Wetness Events

Rain Amount	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.02
Dew ?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Leaf Wetness (hours)	0	0	8	0	0	0	0	7
Hours >90% RH	5	4	14	7	10	14	8	11
RH max/min	195/27	168/49	95/66	137/43	97/62	255/53	180/50	255/78
Temp avg F	55	63	60	57	61	70	70	69

NA - data not available [View Cougarblight Charts](#) Download Time: 5/29/2020 23:00

1. Open flowers
2. Accumulate heat units in bloom for inoculum to reach threshold
3. Wetting event after this point to wash bacteria flower down in flower
4. Average temperature above 60F.

- EIP (Epiphytic Infection Potential) - index for infection risk for enough heat
- Threshold for infection is $EIP \geq 100$



Fire Blight – Risk of Production

- *Erwinia amylovora* -

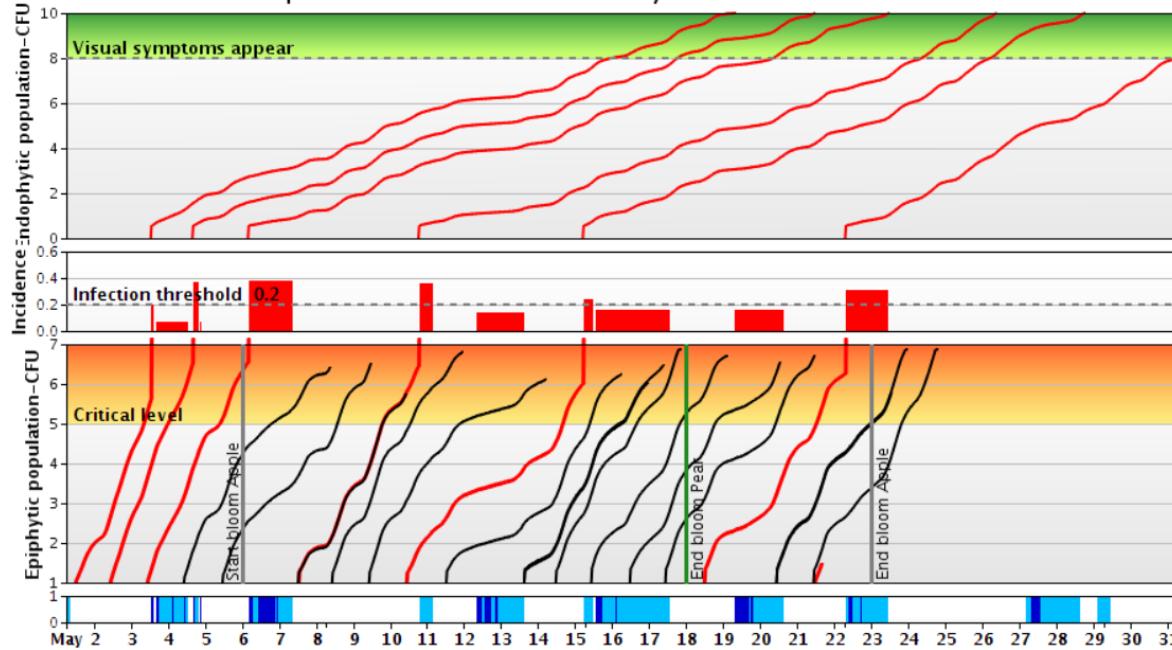
Flower Infections

Weather Data

RIMpro-Erwinia location

- 2018

Indicated potential infection events only relevant for trees in bloom.



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Winter Pruning - Removal of Cankers

- Acimovic et al. 2014 -

Grower orchard	Cankers left after crew pruning		Average possible symptoms / 2.5 Acres	Standard error	Min. for blight renewal*
	Average / 0.2 Acres	%			
1. Golden BP	0.14	51.85	1.75	0.175	1 - 4
2. Idared BP	0.59	44.70	7.38	0.738	1 - 4
3. Idared RS	0.00	0.00	0.00	0.000	1 - 4

*Brooks 1926, Tullis 1929

New vs. Old Copper Formulations

Traditional vs. new formulations - Maximize Cu ion effectiveness

- **Reduce the particle size** - micronization of the A.I. to improve coverage of treated surfaces: High surface/volume ratio gives better uniformity in coverage, distribution and adhesion, increased resistance to run-off.
- **Copper microencapsulation** - control the release of A.I.-s and improve product adhesiveness, rainfastness.
- **Combining with zeolites, clay-like bentonite** - Zeolites adhere firmly to leaves – metal has different modes of action and release (release one Cu part fast, second slow).
 - Release Cu at foliar wetting, hold it in low humidity
 - Clay absorbs water, keeps leaves dry, reduces risk of infections
- **SAR materials** - strengthen plant defenses against pathogens or environment stress reducing copper requirements over long period
- **Terpenic alcohols** of coniferous oils
 - Improve leaf coverage
 - Increase copper efficacy, reduce drainage



Fire Blight on 'Honeycrisp' - Coppers

- Treatments 65-70% Bloom, 50 gal/A -

No.	Product	Number of applications / Amount per acre	Metallic copper / unit product	Metallic copper equivalent sprayed in lb/A
1	Copper Sulfate Crystals	2 x 0.784 lb/A	0.25 lb/ lb	2 x 0.196 lb/A
2	Bordeaux Mixture	2 x 0.784-0.784-50 (0.784 lb copper sulfate + 0.784 lb lime + 50 gal water/A)	0.25 lb/ lb	2 x 0.196 lb/A
3	Camelot O	2 x 1.225 gal /A	0.16 lb/ gal	2 x 0.196 lb/A
4	Camelot O	2 x 2.45 gal/A	0.16 lb/ gal	2 x 0.392 lb/A
5	Champ WG	2 x 0.392 lb/A	0.50 lb/ lb	2 x 0.196 lb/A
6	COC DF + ZnS	2 x 0.392 lb/A + 0.073 oz zinc sulfide/A	0.50 lb/ lb	2 x 0.196 lb/A
7	CS 2005	2 x 0.469 gal/A	0.418 lb/gal	2 x 0.196 lb/A
8	Cuprofix Ultra 40 Disperss	2 x 0.49 lb/A	0.40 lb/ lb	2 x 0.196 lb/A
9	Nordox 75 WG	2 x 0.261 lb/A	0.75 lb / lb	2 x 0.196 lb/A
10	Badge X2	2 x 0.695 lb/A	0.282 lb/ lb	2 x 0.196 lb/A
11	C-O-C-S WDG	2 x 0.382 lb/A	0.5125 lb/ lb	2 x 0.196 lb/A
12	Copper Count N	2 x 1 qt/A	0.773 lb/ gal	2 x 0.196 lb/A
13	Basic Copper 53	2 x 0.37 lb/A	0.53 lb/ lb	2 x 0.196 lb/A
14	CS2005 + Regalia	2 x 16 fl oz/A + 32 fl oz/A	0.418 lb/gal	2 x 0.052 lb/A
15	CS2005 + Regalia	1 x 47.7 fl oz/A + 95.4 fl oz/A (150 gal/A)	0.418 lb/gal	1 x 0.160 lb/A
16	Fireline 17 WP	2 x 1 lb/A (100 gal/A)	/	/
17	Harbour + Regulaid	2 x 1.5 lb/A + 3 pts/ 100 gal/A	/	/
18	Untreated Control	/	/	/

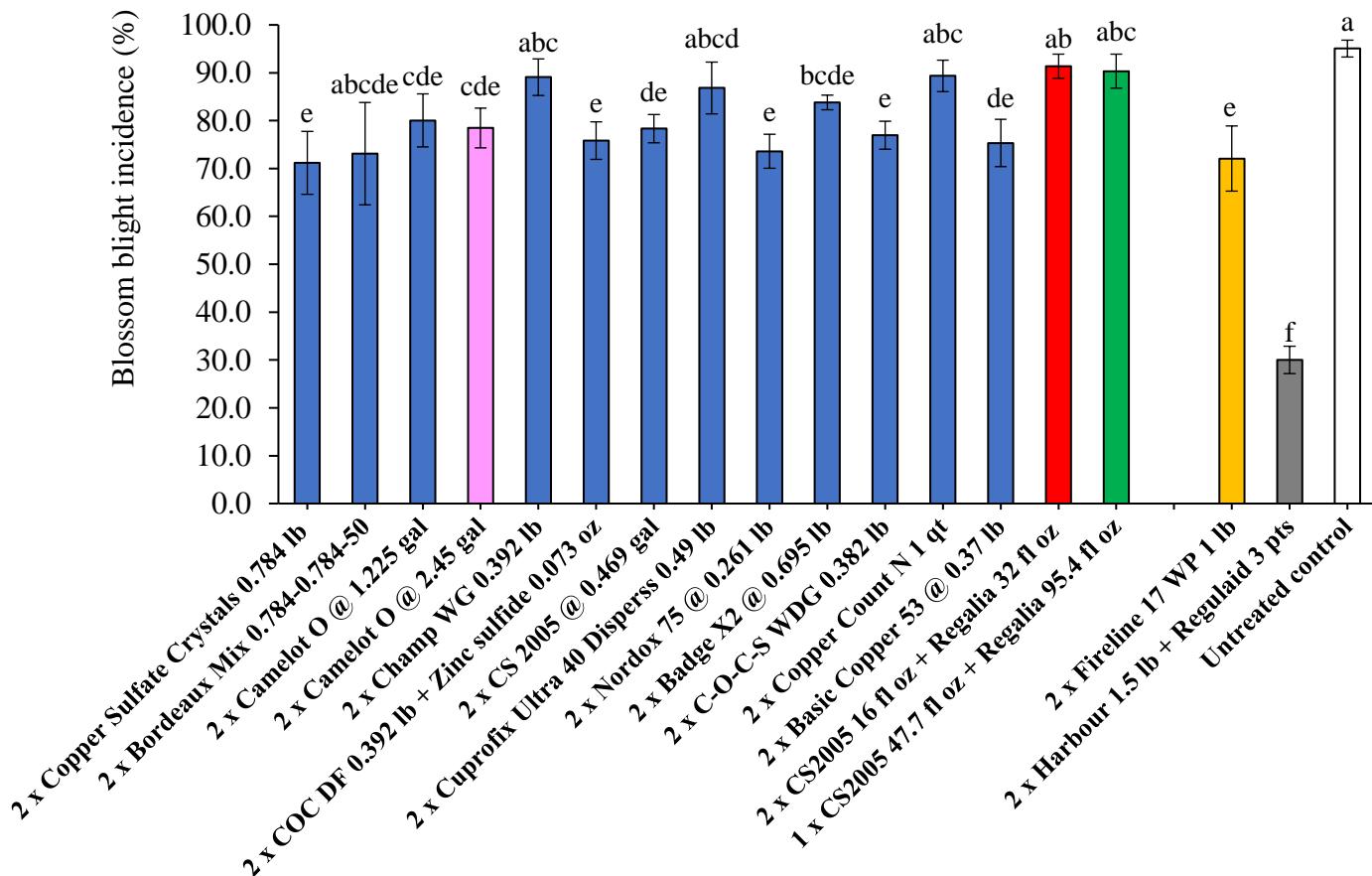
Inoculation *Erwinia amylovora*: 30 Apr 2017. Explosive bloom: PK 26 Apr, KBL 63% 27 Apr





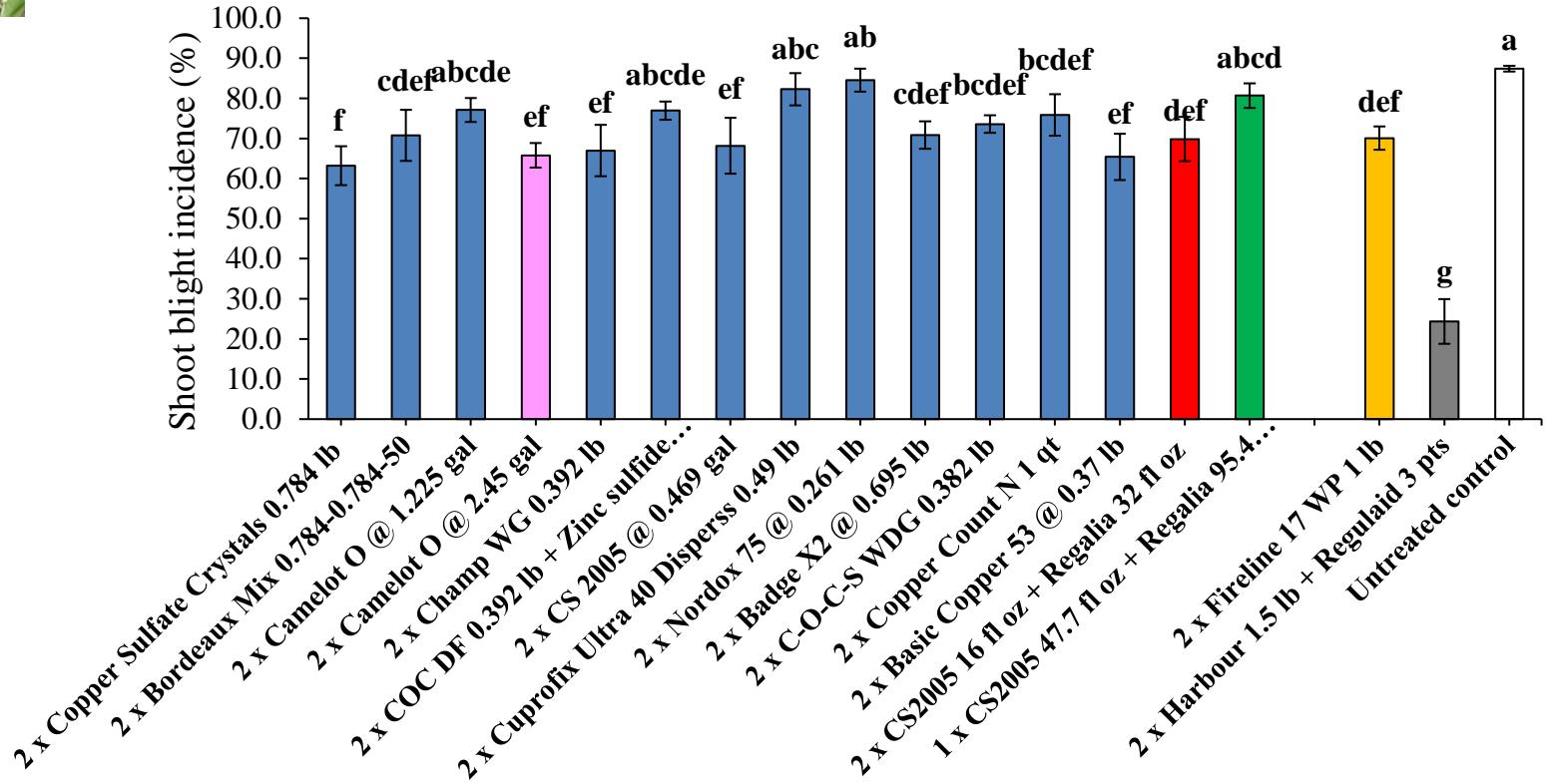
Coppers

- Blossom blight 2017 -



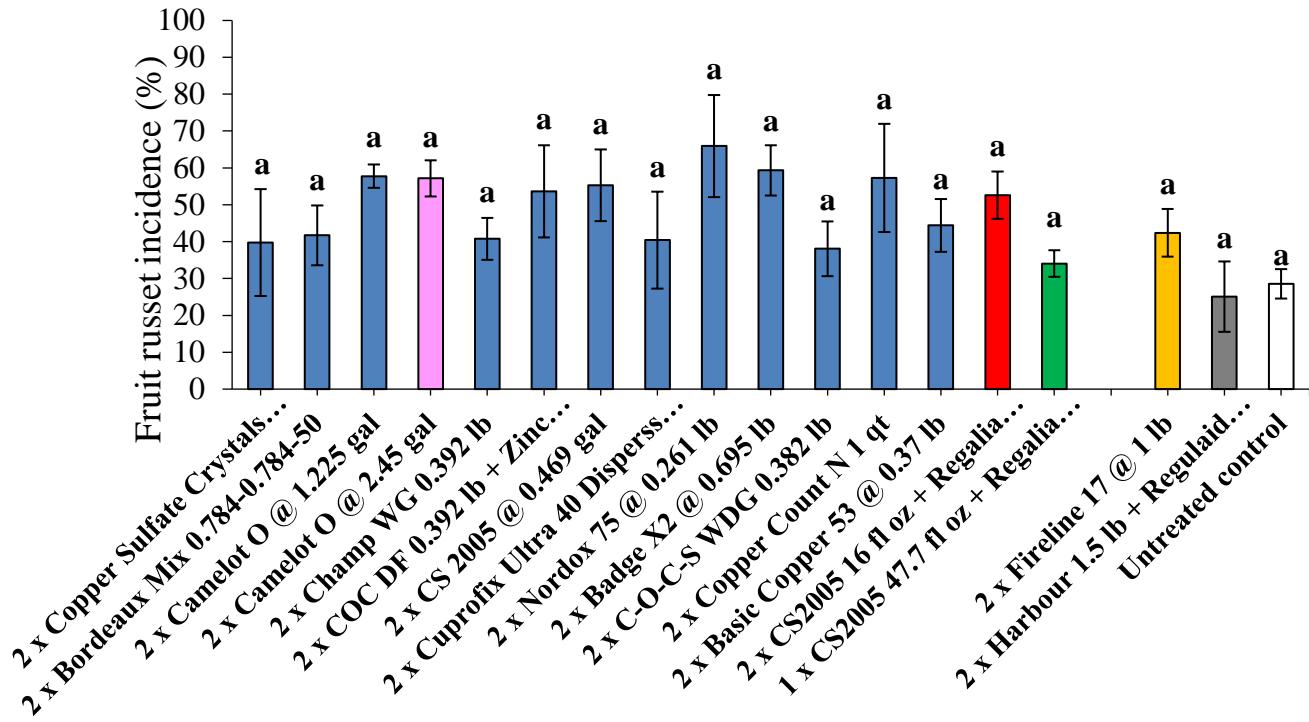
Copper

- Shoot blight -



Copper

- Fruit Russet -



Fire Blight: Biologicals & Regalia

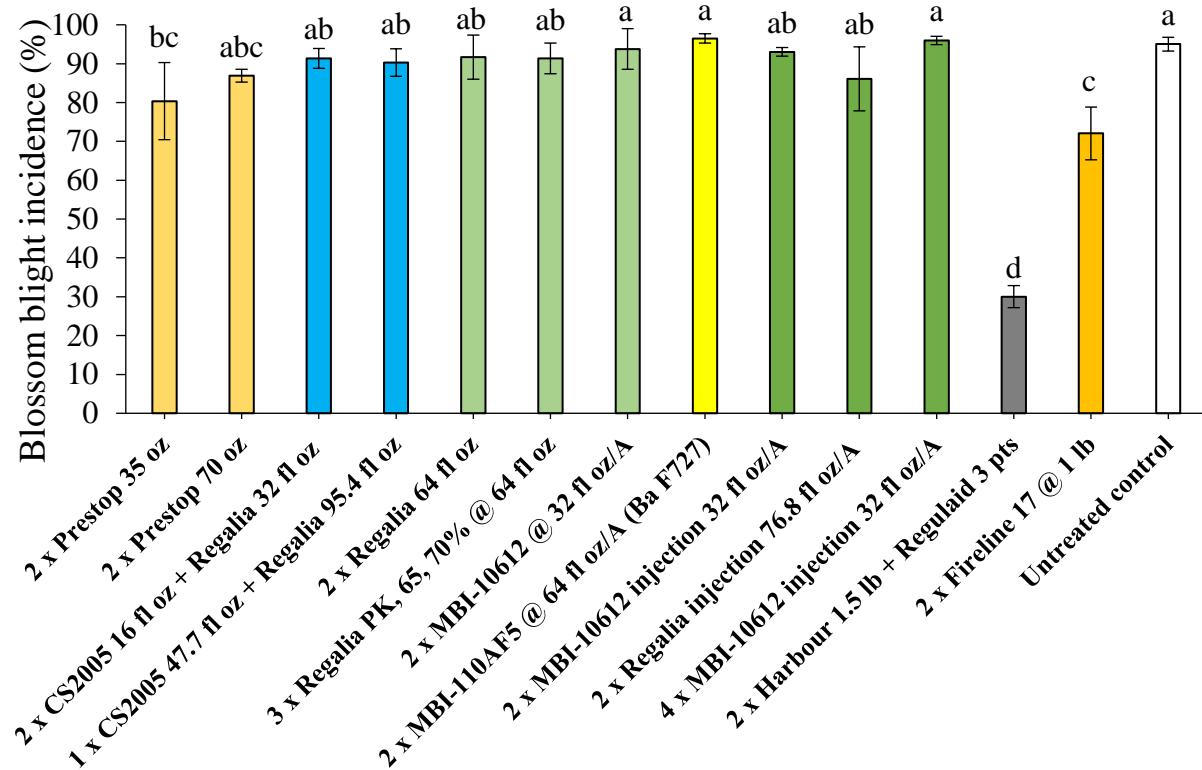
- Treatments -

No.	Product	Active ingredient	Amount per acre	Metallic copper per amount of product	Metallic copper equivalent in lb/A
1	Prestop WG	<i>Gliocladium catenulatum</i> Strain J1446	2 x 35 oz / A	/	/
2	Prestop WG	<i>Gliocladium catenulatum</i> Strain J1446	2 x 70 oz A	/	/
3	CS2005 + Regalia	19.8% copper sulfate pentahydrate + 5% extract of plant <i>R. sachalinensis</i>	2 x 16 fl oz/A + 32 fl oz/A	0.418 lb/gal	2 x 0.052 lb/A
4	CS2005 + Regalia	19.8% copper sulfate pentahydrate + 5% extract of plant <i>R. sachalinensis</i>	1 x 47.7 fl oz/A + 95.4 fl oz/A	0.418 lb/gal	1 x 0.160 lb/A
5	Regalia	5% extract of plant <i>R. sachalinensis</i>	2 x 64 fl oz / A	/	/
6	Regalia	5% extract of plant <i>R. sachalinensis</i>	3 x 64 fl oz / A	/	/
7	MBI-10612	12% extract of plant <i>R. sachalinensis</i>	2 x 32 fl oz/A	/	/
8	MBI-110AF5	B. amyloliquefaciens strain F727	2 x 64 fl oz / A	/	/
9	MBI-10612 – Trunk-injection	12% extract of plant <i>R. sachalinensis</i>	2 x 32 fl oz /A	/	/
10	Regalia – Trunk-injection	5% extract of plant <i>R. sachalinensis</i>	2 x 76.8 fl oz /A	/	/
11	MBI-10612 – Trunk-injection	12% extract of plant <i>R. sachalinensis</i>	4 x 32 fl oz /A	/	/
12	Harbour + Regulaid	17% streptomycin + 90.6% 2-butoxyethanol, poloxalene, monopropylene glycol	2 x 1.5 lb/A + 3 pts	/	/
13	Fireline 17 WP	17% oxytetracycline	2 x 1 lb/A	/	/
14	Untreated Control	/	/	/	/



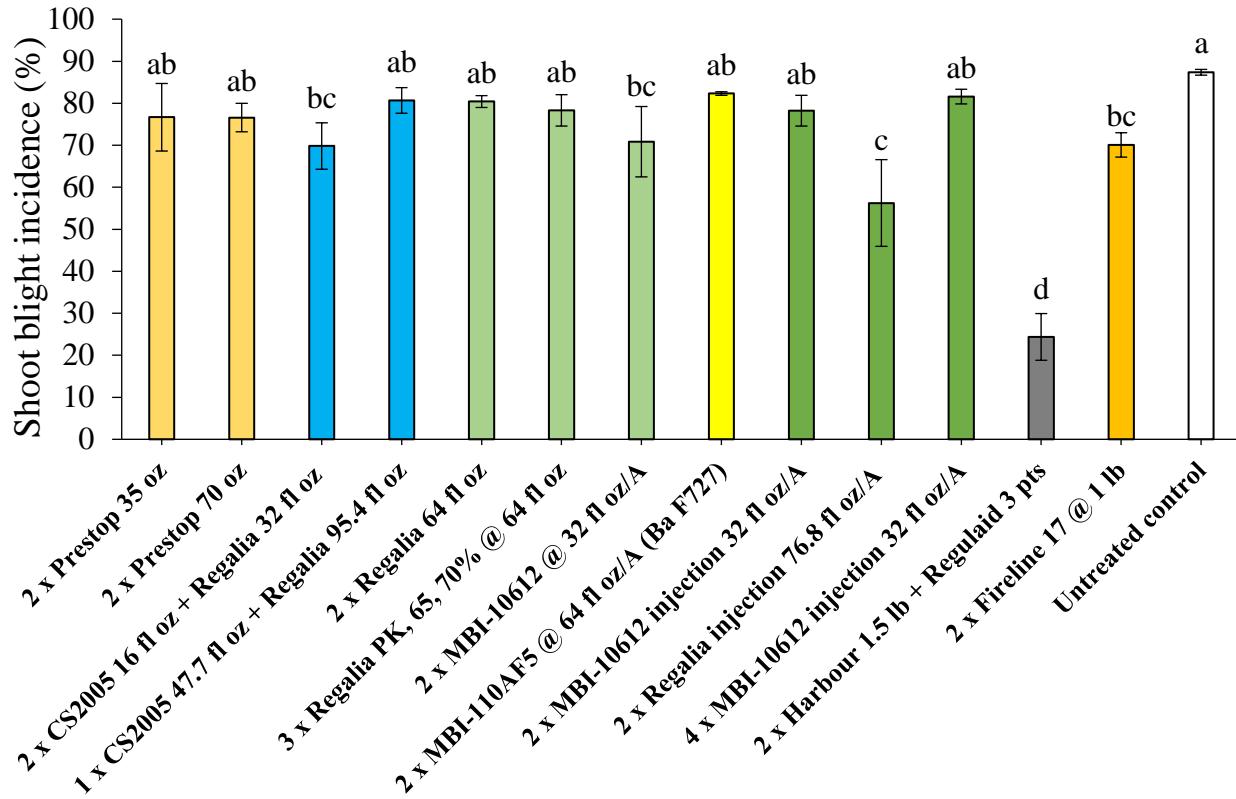
Biologicals & Regalia

- Blossom blight 2017 -



Biologicals & Regalia

- Shoot Blight 2017 -



2018 Fire Blight Trial – Biologicals

- Honeycrisp -

No.	Product	Active ingredient	Amount per acre	Dates Applied	Note/ Amount of metallic copper
2	LifeGard WG	<i>Bacillus mycoides</i> isolate J	9 oz/A		
3	Double Nickel LC + Cueva	<i>Bacillus amyloliquefaciens</i> strain D747	1 qt /A + 2qt /A	7, 13, 30 May, 14 June	Start spraying at PK, every 5-7 days through bloom. Post Bloom - every 14 days until shoot blight period ends. Target at least 2 applications during bloom.
4	FireWall + Regulaid = bloom; Then Apogee program	streptomycin	1.5 lb/A + 1.5 pt/100 (0.1875% v/v) Then Apogee: 36 oz/A	9 May Then 20 May, 3 June	FireWall during bloom. Followed by Apogee at 1-3", 14 days after
21	Harbour + Regulaid	Streptomycin	1.5lb/A + 3pts/100 gal (0.375% v/v)	8, 9 May	20, 50% bloom
22	Untreated Control	/	/	/	/

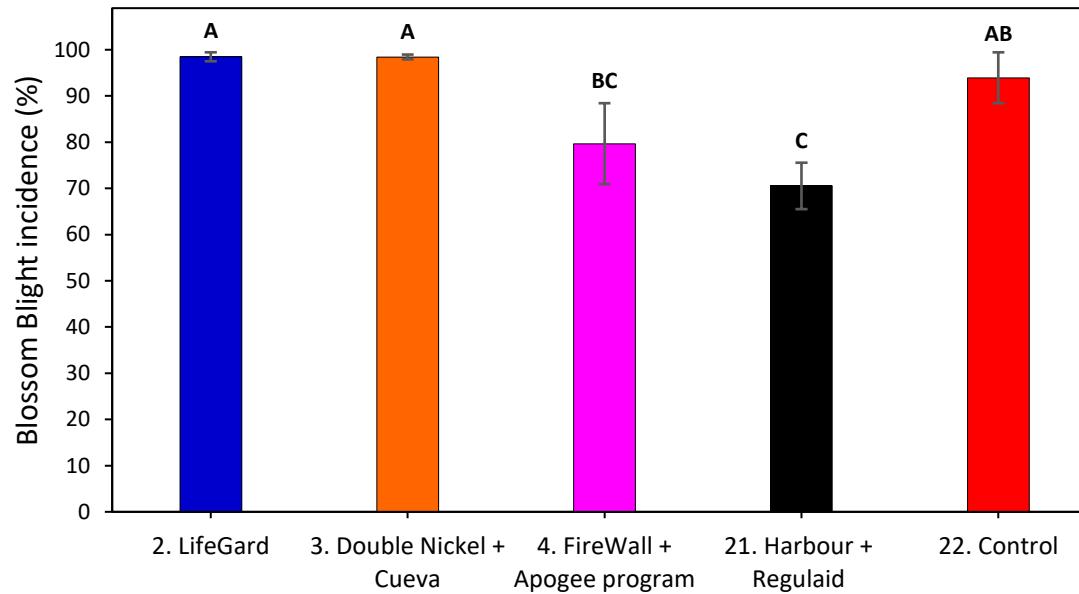
Inoculation 10 May 2018 @ 1.8×10^6 CFU/ml of *E. amylovora*, 80% king bloom



2018 Efficacy Trial - Biologicals

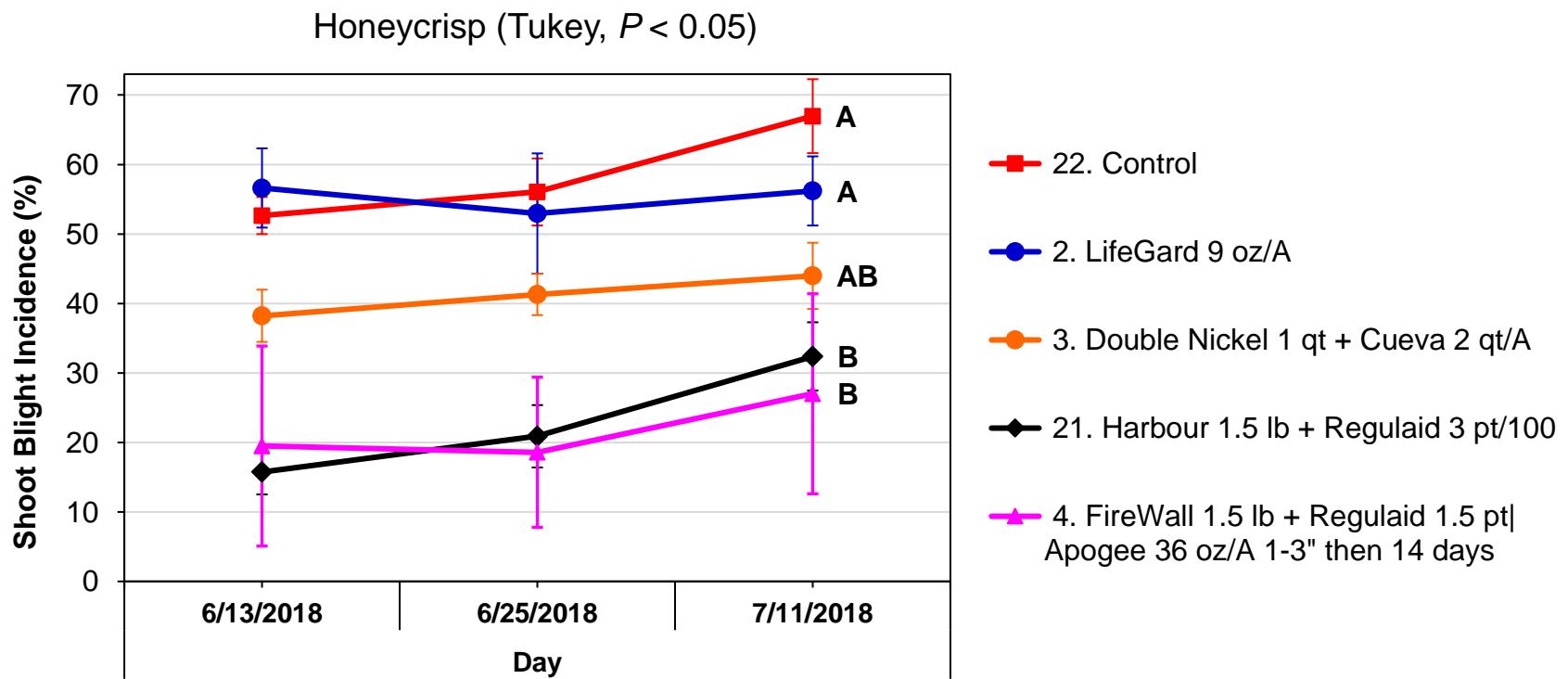
- Blossom Blight -

Honeycrisp (LSD, $P < 0.05$)



2018 Efficacy Trial - Biologicals

- Shoot Blight -



Recommendations

Young Trees - late, lingering bloom: Use conventional pesticides 4-5 years

- Grow a tree then switch to organic program!
- Avoid M.26 and M.9
- Prune ASAP on a cool dry day, No pruning in rain
- If 12" into leader – remove & replant
- Sanitize tools when removing suckers

Mature trees: Use disease prediction models to time sprays Infections:

- From first open flower - terminal bud set (use models: NEWA, RIMpro)
- Spray low-rate coppers until terminal bud set (1-2 oz/A of Cu)
 - Spray ahead of infection periods; Follow lb/A/year limit
 - Avoid slow drying = fruit russet (Double Nickel + Copper = less russet)
 - New summer shoot growth needs to be covered
 - Hand thin on a cool dry day, then apply copper
- Prune wood cankers out, spray copper
 - Scout and cut on a cool dry day
 - 18-24" below visible canker edge, or to older wood (12")
 - Drop cuttings in the middle, let dry, chop with flail-mower, or remove
 - Winter pruning of cankers
- Prevent growth flush
 - Avoid excessive nitrogen, minimal irrigation



Cedar Apple & Quince Rust

- CAR, QR, *Gymnosporangium* spp. -

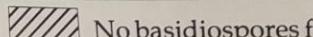
- **Can infect: TC – FC**
- **QR infects fruit from PK – PF**
- **Kick-back activity of DMI for rust on fruit**
- **CAR infects leaves 4 – 6 weeks after PF**
- Not effective: Regalia, copper, sulfur, LLS
 - Start sprays just before orange horns in spring show on cedar galls
- Cut red cedars 500 ft. near orchards
- Suppression (Yoder et al. 2014, 2015):
 - **Regalia 4 qt/A + JMS Stylet oil**
 - **Regalia 2 qt/A, every 7-10 days**
 - **Cueva**
 - **Oso**
- Sulfur, LLS not compatible with oil
- Regalia ineffective for apple scab
- Don't plant susceptible cultivars
- Resistant cultivars need 1 – 2 sprays



Rust Prediction – 4 to 5 days forecast plug into the chart:

Table 11: Temperature and moisture requirements for cedar apple rust infection periods.

Temperature (C) (F)	Basidiospore Formation	Hours Wetting Required		Infection Severe
		A Light	B Severe	
2 36		24	-	
4 39		12	24	
6 43		8	10	
8 46	7	6	7	
10 50	5	5	6	
12 54	4	4	5	
14 57	4	3	5	
16 61	4	3	4	
18 64	4	3	4	
20 68	4	2	4	
22 72	4	2	4	
24 75	4	2	4	
26 79		-	-	
28 82		-	-	
30 86		-	-	



No basidiospores form at these temperatures



Light infection -- unlikely to cause economic loss



No infections have been observed at these temperatures

Note: Use this table only when determining cedar apple rust infection on susceptible apple cultivars that are located close to eastern red cedars.

Instructions (Using hourly temperature records):

Basidiospores are formed when the temperature during a wetting period averages 52 - 77 °F for four continuous hours. It takes slightly longer when the temperature averages 45 - 52 °F (column A). Once you have determined basidiospores were formed, determine if infection has taken place (columns B). Average the temperature starting at the time when you determined basidiospores had been formed. The hours listed in columns B are the minimum hours required for light or severe infection.

Source: R. C. Pearson, H. S. Aldwinckle, R. C. Seem (1981): Cedar apple rust – *Gymnosporangium juniperi-virginianae* Schw. Disease Identification Sheet No. 5, Tree Fruit IPM, New York State Agricultural Experiment Station, Geneva, NY.

Regalia & Sulfur Rust Trial 2016

- Treatments -

Treatments	/A	/100 gals
1. Untreated Control	-	-
2. Manzate (Mancozeb 75%)	3 lb	1 lb
3. Luna Sensation (Fluopyram 21.4% + Trifloxystrobin 21.4%)	5 fl oz	1.6 fl oz
4. Luna Tranquility (Fluopyram 11.3% + Pyrimethanil 33.8%)	12 fl oz	4 fl oz
5. Luna Sensation + Manzate	5 fl oz + 3 lb	1.6 fl oz + 1 lb
6. Luna Tranquility + Manzate	12 fl oz + 3 lb	4 fl oz + 1 lb
7. Regalia A* (Extract of <i>Giant Knotweed</i> 5%)	1 qt*	10.7 fl oz
8. Regalia B*	2 qt*	21.3 fl oz
9. Microthiol Sulfur (Sulfur 80%)	15 lb	5 lb
10. Inspire Super + Manzate (Difenoconazole 8.4% + Cyprodinil 24.1%)	12 fl oz + 3 lb	4 fl oz + 1 lb



- First spray on 4/14 with Manzate 3 lb/A instead
- Handgun dilute spray (15 then 20 gal)
- Spray applications on: TC = 4/14, PK = 4/25, BLOOM (Manzate) = 5/4, PF = 5/11, FC = 5/25

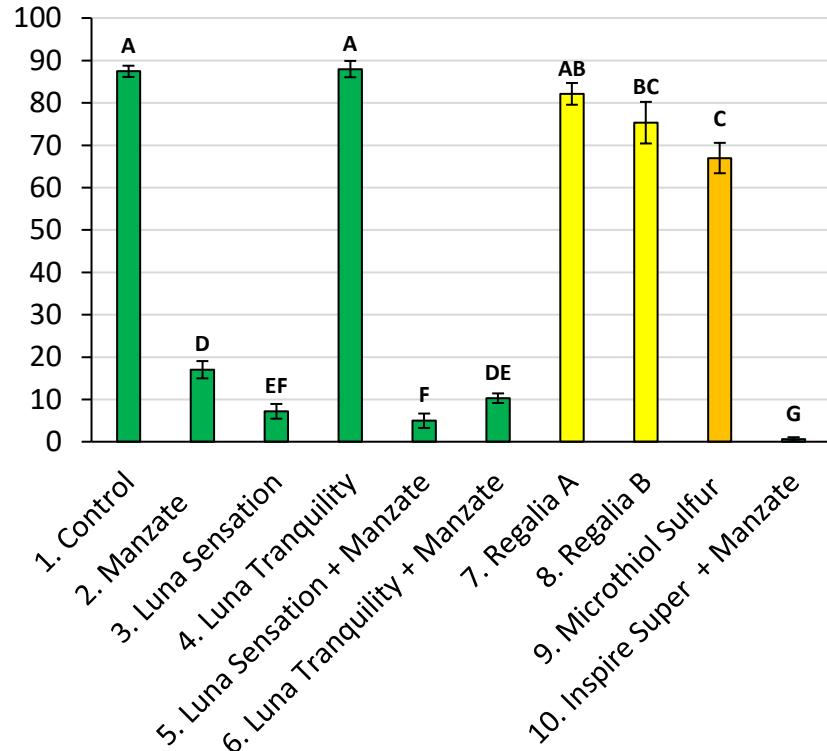


Cedar Apple/Quince Rust 2016

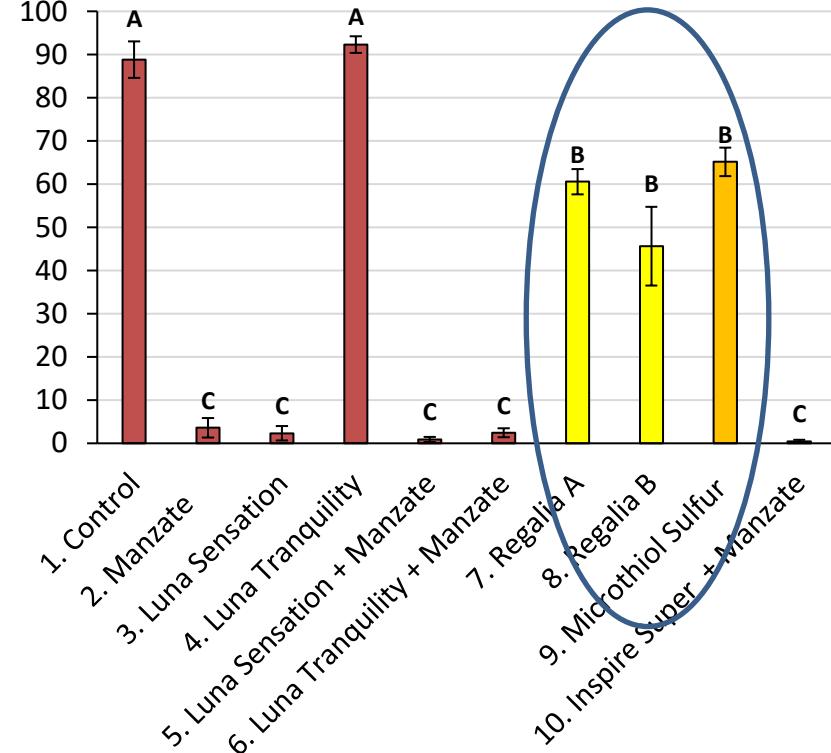
- Ginger Gold (VS) -



SPUR LEAVES RUST INCIDENCE %

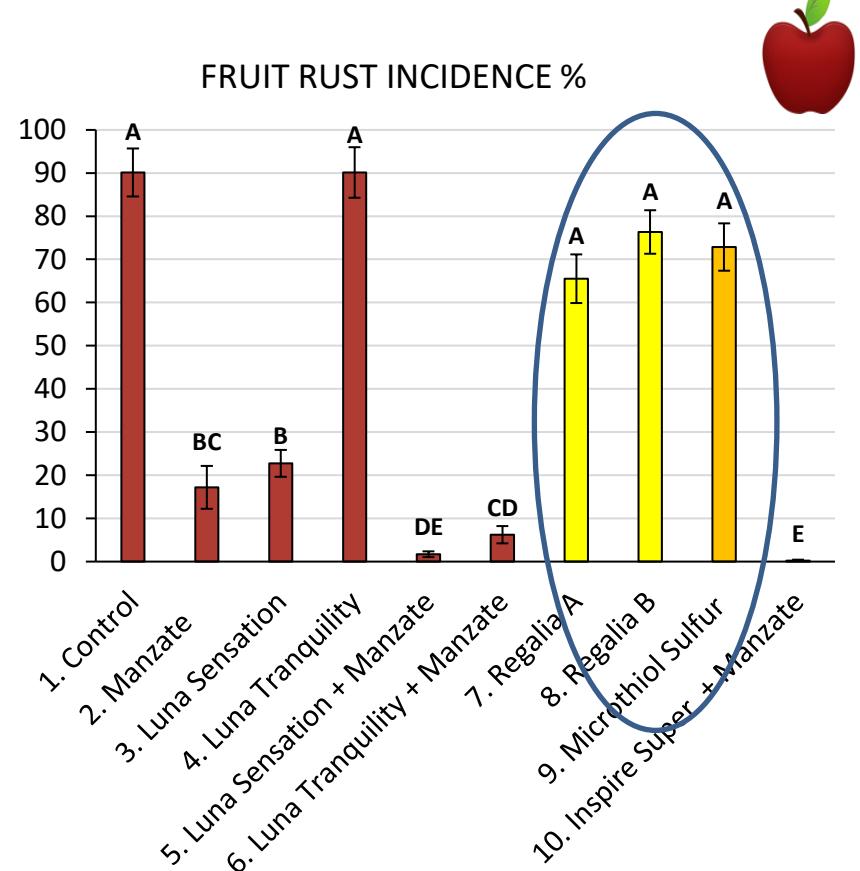
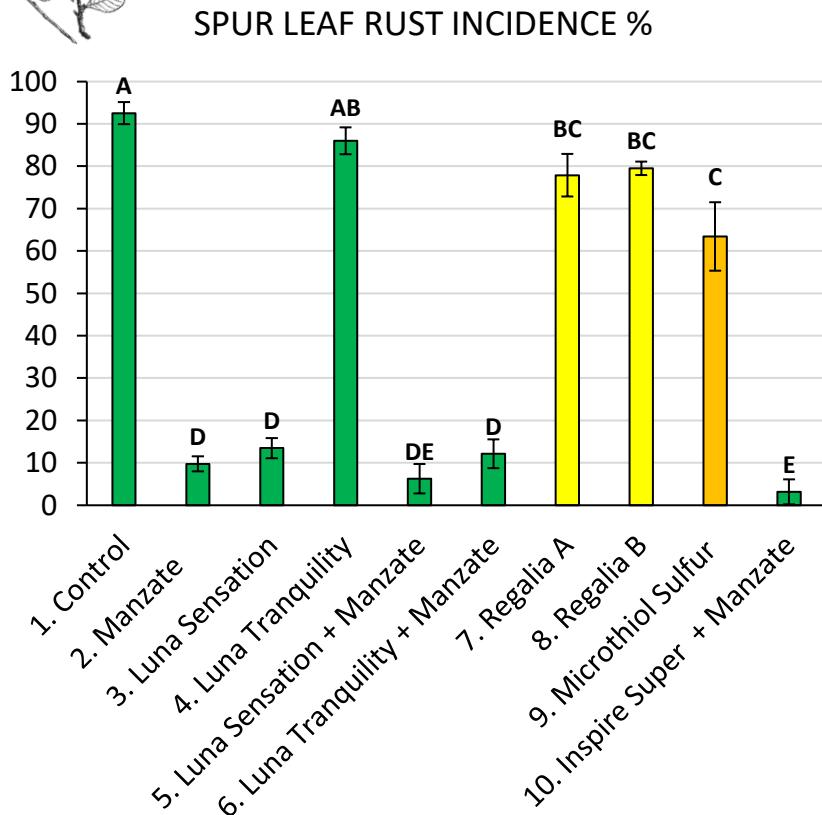


FRUIT RUST INCIDENCE %



Cedar Apple/Quince Rust cont.

- Golden Delicious (S) -

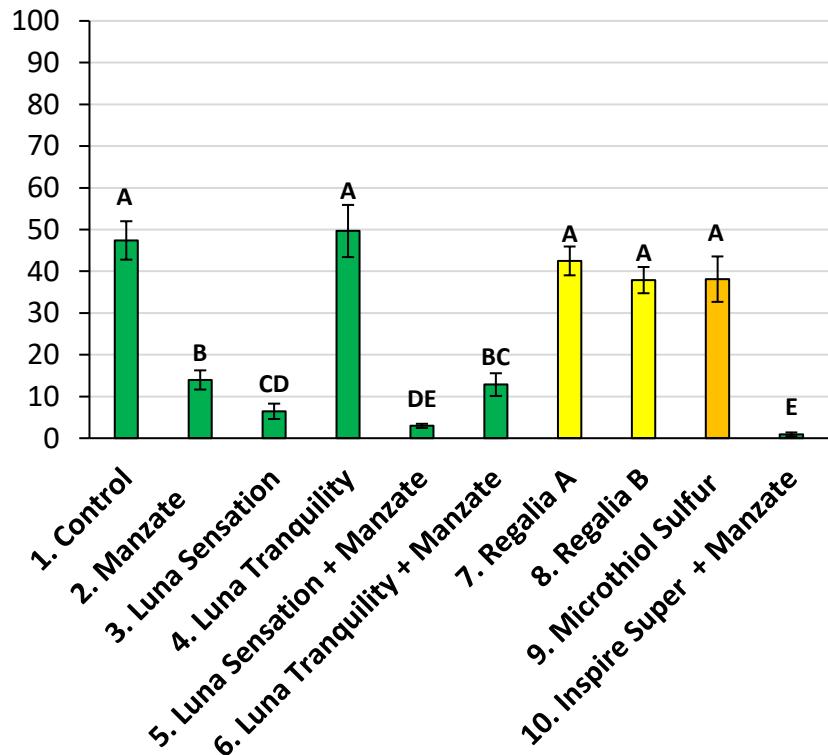


Cedar Apple/Quince Rust

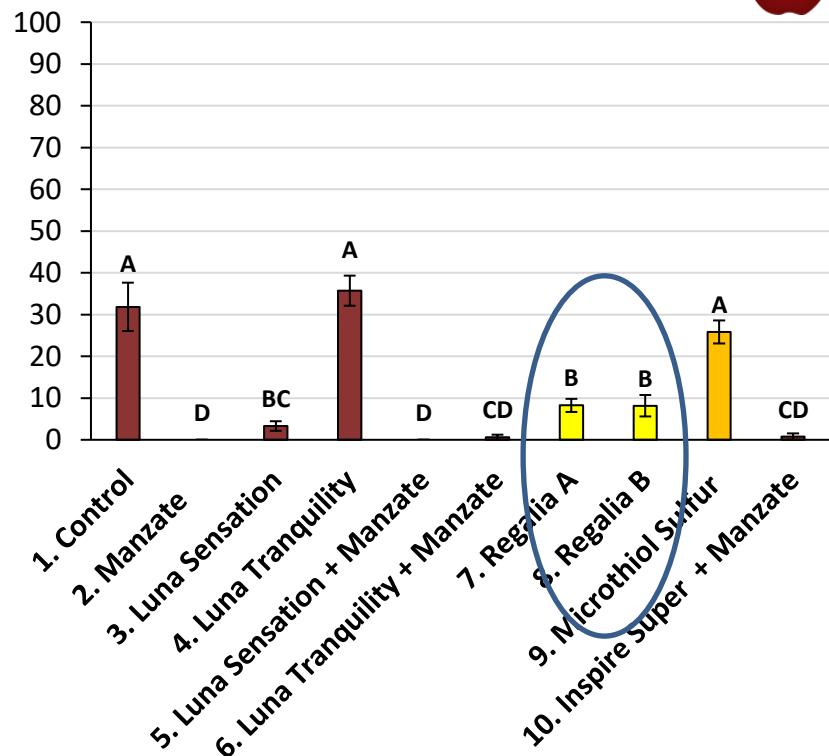
- McIntosh (VR) -



SPUR LEAF RUST INCIDENCE %

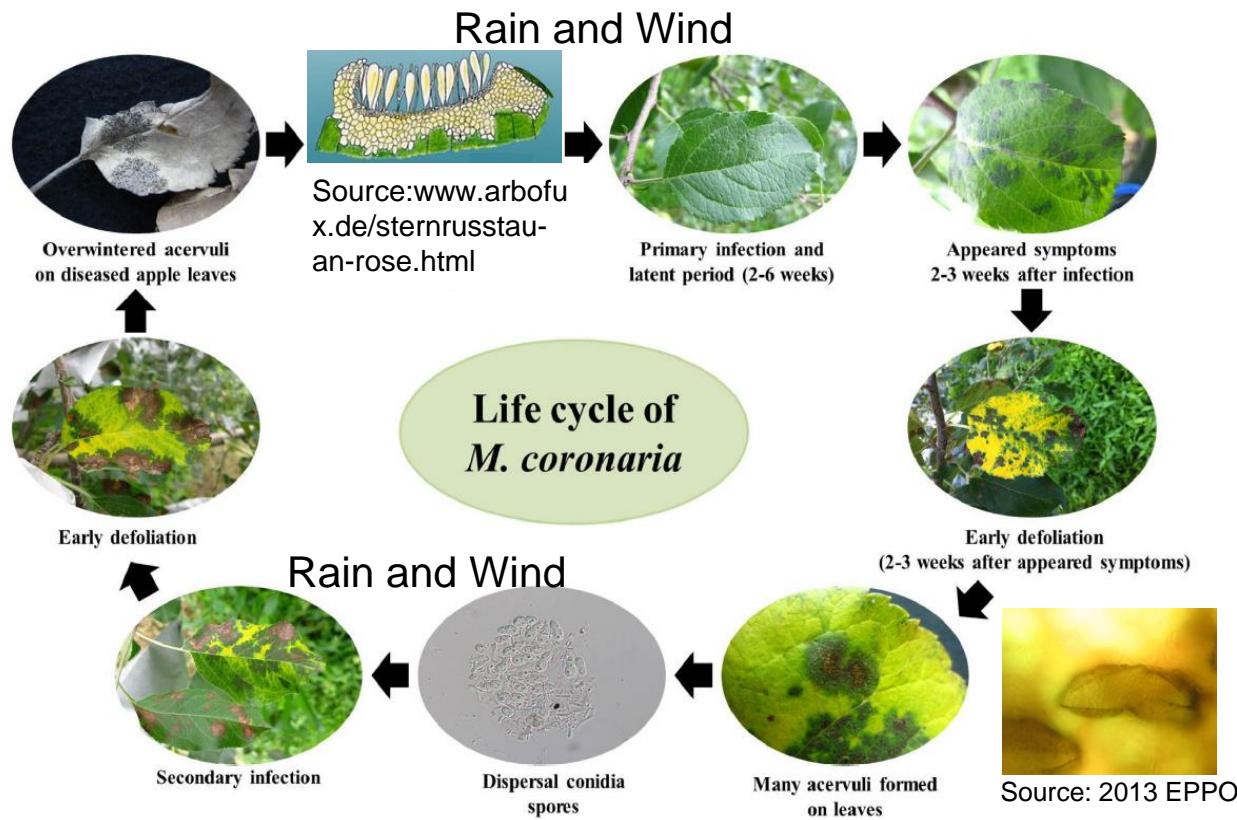


FRUIT RUST INCIDENCE %



4. Marssonina Leaf and Fruit Blotch

- *Marssonina* fungus -



Adapted from: Back & Jung 2014, Journal of Medical Mycology 42(3):183-190

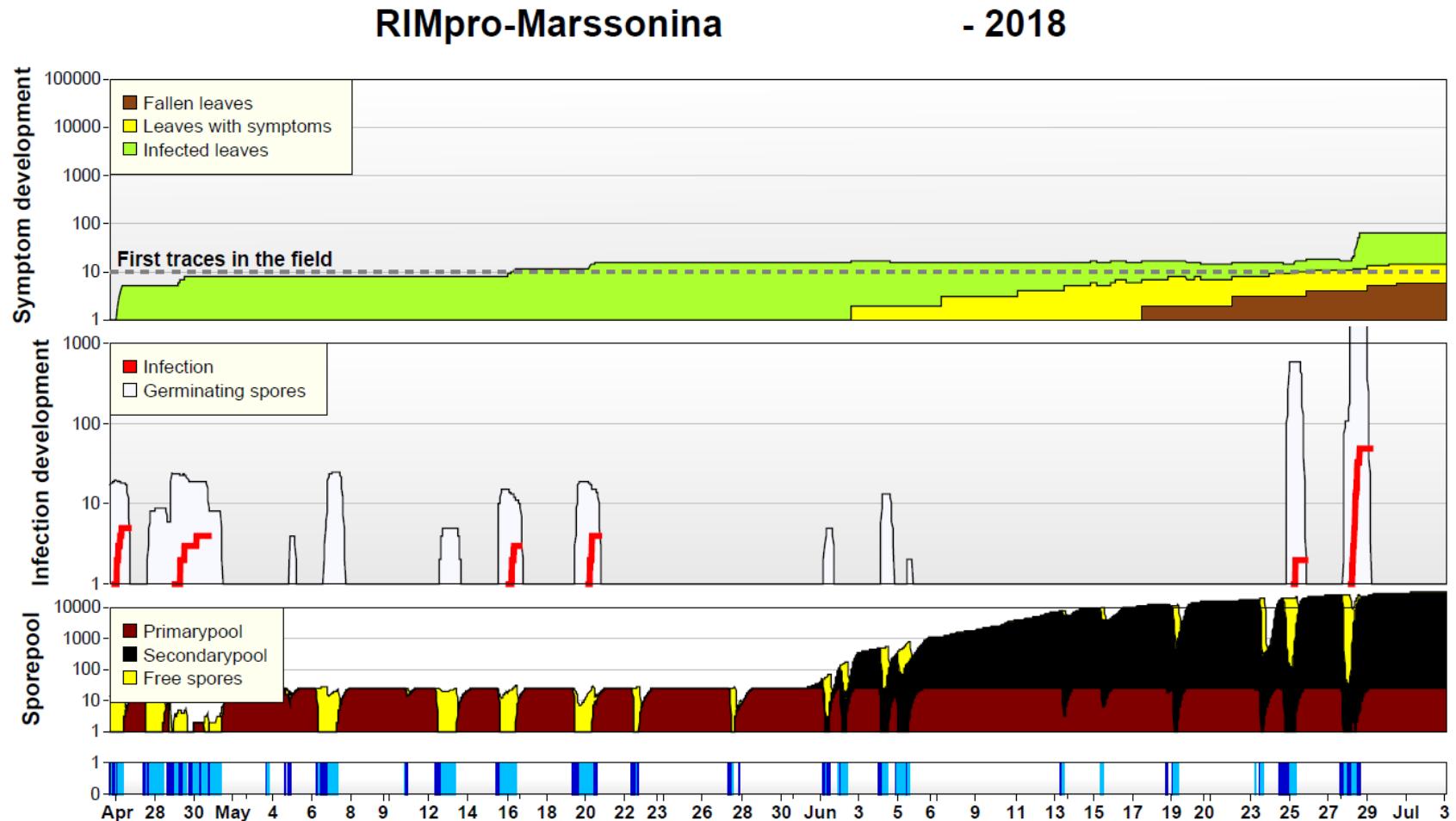
Marssonina Leaf & Fruit Blotch

- Just Starts -



RIMpro MLF Blotch Model

- Predict Fist Infection -



Penn State Preliminary Tests

Peter, 2020

Management: Avoiding premature defoliation (can be severe) and avoiding build up of pathogen



- Sanitation is key to limit disease: Overwinters in infected fallen leaves
 - Uncertain of timing of first spores
- Early season = important

Product	Marssonina control efficacy (preliminary)*
Captan	Excellent
Ziram 76 DF*	Good - Excellent
Mancozeb	Excellent
Sulfur	Good
Omega	Fair – Excellent (high rate)
Cevya, Trionic	Good - Excellent
Inspire Super	Fair – Excellent* (suppresses?)
Luna Sensation, Merivon	Excellent
Flint Extra	Fair – Excellent* (suppresses?)
Luna Tranquility	Excellent
Aprovia*, Fontelis*, Miravis, Excalia, Sercadis	Good - Excellent
Topsin M	Good
Cueva + DN, Regalia* + Stargus, Regalia+ Badge SC, Kaligreen	Poor - Fair

Marssonina Leaf & Fruit Blotch

- History & Control -

Epidemiology & Ecology:

- Symptoms 40~45 days after inoculation
- Successful infection depends on moist incubation at 100% RH, 20°C, prior to drying (Lee et al. 2011):
 - 72% severity at 3-day moist incubation
 - 20% at 2-day moist incubation
 - 0% at 1-day moist incubation
- Needs extended period of moisture for infection
- Explains disease start after ample rains in June and July

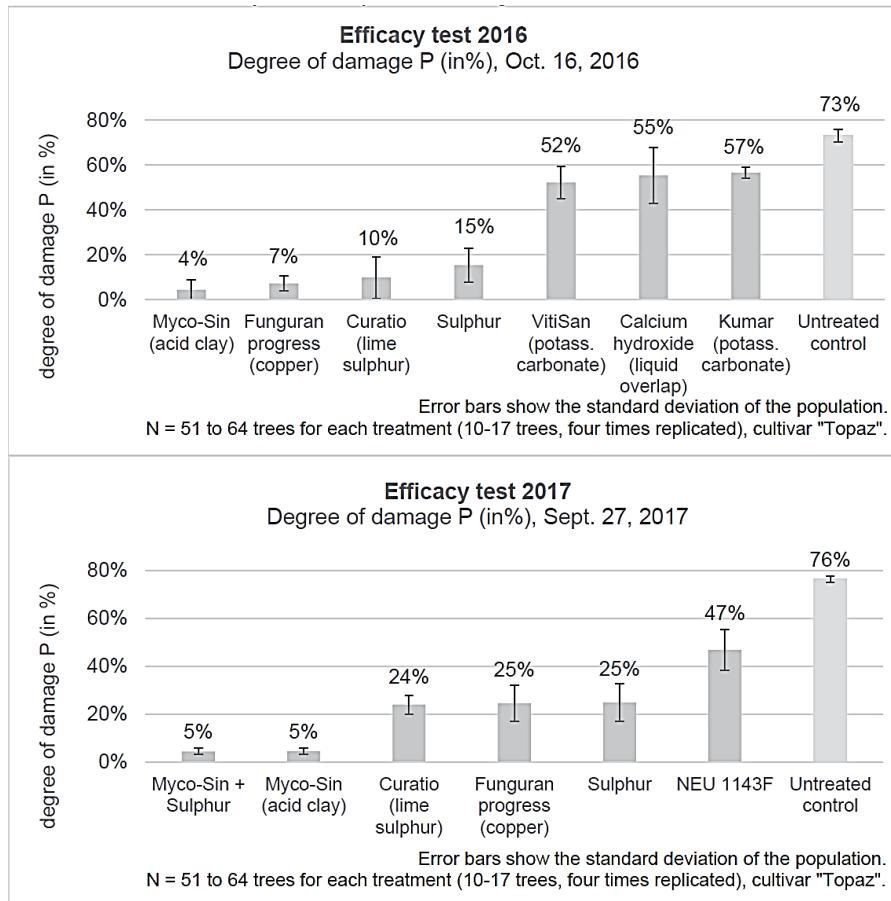
Outbreaks & Control

- NY, PA, WI, VA, NC, Canada, Brazil, EU, Korea, China
- Wet summers of 2001, 2002, 2010, 2011, 2013, 2017, 2018
- **Organic orchards & conventional or reduced spray program –no labelled fungicides (!)**
- **Low sensitivity to copper**
- **Susceptible:** Gala, Mutsu, Fuji, Starkrimson, Northern Spy, Honeycrisp, NY-1, Rome, Topaz, Jonagold, Jonathan, Luna, Delicious, Golden Delicious, Ralls Janet, Starking Red (Wöhner et al, Li et al 2012),
- **Moderately to resistant :** Pinova, Akane, Astramel (Wöhner et al), Elstar, Jiguang, Qinguan, Qinxing, Xiangyanghong, Hongbaoshi, Jiguang (Li et al 2012)
- **Res. rootstocks:** Qingdao 598, Za'ai76, A03, JM7, P22, S64, SH-12, -17, -28 (Li et al 2012)
- Eliminate fallen leaves (urea 40 lb / A in 100 gal, dolomitic lime 2.5 t/A); prune for good air circulation;
- **Fungicides:** Mancozeb, Metiram, Topsin M, Thiophanate-Methyl, Merivon.
- Research: tebuconazole, hexaconazole, propiconazole, tebuconazole+ benzoithiazolinone @ 20-day intervals, early July - late August; Bordeaux mix + tebuconazole or + propiconazole or + tebuconazole with benzoithiazolinone, each @ 25 days (Dang et al. 2017)



Bohr et al. 2018 - Germany

From: www.ecofruit.net/2018/12_Bohr_36-42.pdf



10-12 spray
applications of
each from 10 or
12 Jun - 30 Aug

5. Other Summer Diseases

- Rots in Organic Orchards -

- Dormant copper - reduces overwintering inoculum (not enough)
- Sulfur, fine ground, in summer; Can burn leaves at T > 90°F; PF limited
- Cueva, Badge X2, low rates, avoid fruit russet; LLS + low copper rate.
- LLS in summer for SBFS and Oil \geq 1% injures fruit = increases rots!
- Cultural practices to suppress fungi:
 - Prune out dead wood, rotted fruit mummies on tree or ground
 - Tree pruning = increase wind and light penetration
 - Avoid poor planting sites for an orchard
 - Irrigate well ahead of heat waves = Prevent tree drought/heat stress
- Differences in cultivar susceptibility to bitter rot (very relative):
 - **Moderately Susceptible/ Resistant:** Gala, Fuji, Jonalicious (Daniels), Jonadel, Jonagold, Winesap, Melrose, Red Delicious, Rome Beauty, Stayman, Arkansas Black, Dayton, Melrose, Akane
 - **Susceptible:** Honeycrisp, Priscilla, Liberty, Elstar, Ed Fackler, Empire, King David, Golden Delicious, Freedom, Wolf River, Rome Beauty, Jonathan, Blushing Gold, Sir Prize.
- Cool harvested fruit below 42 - 44°F asap (*Botryosphaeria*, *Colletotrichum*)
- Recently tested: Cueva, Double Nickel, Serenade Optimum, Oso (cell wall biosynthesis)



SBFS NEWA Model

- 190 ALWH from PF; 250 ALWH from 10 DAPF -



Sooty Blotch and Flyspeck Risk Predictions for Highland HVL 2

Petal fall date for McIntosh: Click if petal fall has not occurred

Petal fall date above is estimated based on degree day accumulations or user input.

Enter the actual date for blocks of interest and the model will calculate the accumulated leaf wetness hours since 10 days after petal fall more accurately.

Most recent fungicide application date:

If petal fall has passed, enter the date of your most recent fungicide application.
If no fungicide applications have been made, do not enter a date.

In the Risk Summary table, note the accumulated leaf wetness hours since petal fall (Leaf Wetness Hours) and the Risk Level. Leaf wetness hours, rain events, and the last fungicide application date are taken into consideration in assessing risk level. To estimate risk in the near future, look at the probability of rain.

Consult the Risk Level IPM Guidelines below the Risk Summary table.

Sooty Blotch and Flyspeck Risk Summary - Northeastern US Model

	Past	Past	Current	Ensuing 5 Days				
Date	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25
Days since petal fall	63	64	65	66	67	68	69	70
Accumulated Leaf Wetness Hours - ALWH	172	175	181	181	183	186	197	197
Risk Level	High	High	High	High	High	High	High	High
Rain Events								
Daily rain amount (inches)	0.00	0.27	0.03	0.00	0.08	0.06	0.02	0.00
Rain probability (%) Night Day ?			- -	- -	- -	- -	- -	- -

NA - data not available.

Download Time: 7/26/2020 23:00

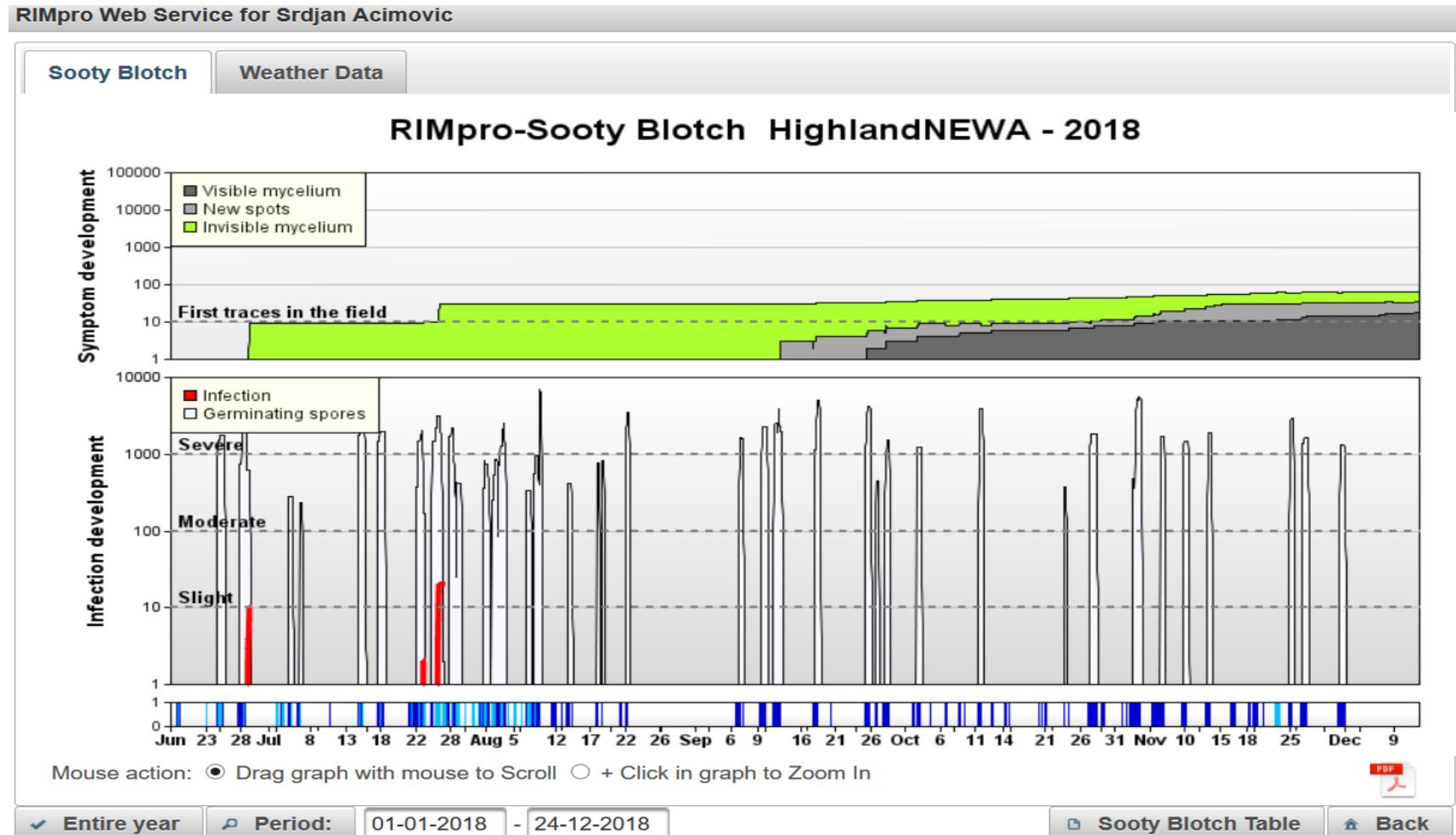


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RIMpro Sooty Blotch Model

- Predict First Infection -



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Sooty Blotch & Flyspeck Trial

- Spray Programs 2018 -

Maintenance sprays: Apple scab and cedar apple rust at the beginning of the season, plus these sprays:

5/18/2018	3oz Rally + 3lbs Manzate
5/31/2018	3oz Rally
6/19/2018	3oz Rally

1.07% Citric acid

Spray dates for all treatments:

6/11/2018
 6/25/2018
 7/9/2018
 7/21/2018
 7/23/2018
 8/4/2018
 8/18/2018
 8/31/2018 - Golden Del. & McIntosh only
 9/11/2018 - Golden Del. & McIntosh only

Harvested:

8/30/2018 – Ginger Gold
 9/21/2018 – McIntosh
 9/29/2018 – Golden Delicious



Treatments/Programs:

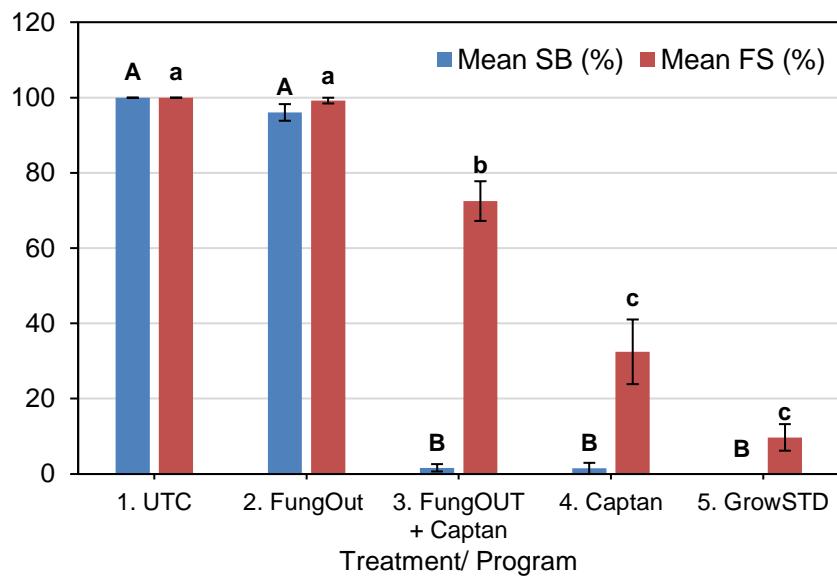
- 1- Untreated Check – UTC**
- 2- FungOut @ 3.75 GL/A (9 sprays)**
- 3- FungOut @ 3.75 GL/A (9 sprays)
+ Captan 80 WDG @ 2.5 LB/A**
- 4- Captan 80 WDG @ 2.5 LB/A (9 sprays)**
- 5- Grower Standard (9 Covers):**
 - 2 X Captan 80 WDG @ 2.5 LB/A
+ Prophyt @ 64 FL/A**
 - 4 X Captan 80 WDG @ 2.5 LB/A
+ Topsin M @ 1 LB/A**
 - 2 X Captan 80 WDG @ 2.5 LB/A
+ Merivon @ 5.5 FL/A (2nd on 8/31/2018)**
 - 1 X Captan 3 lb/A (9/11/2018)**



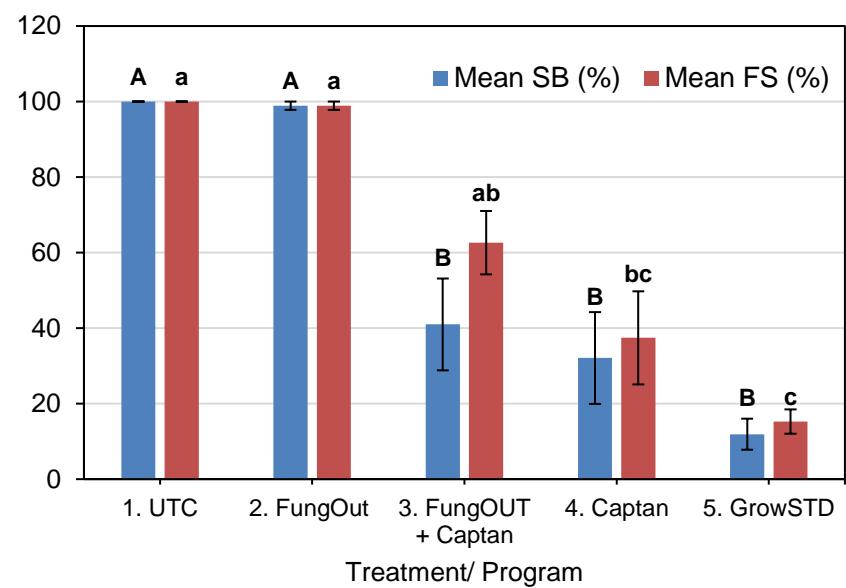
2018 SBFS Results

- Ginger Gold -

Incidence % on Ginger Gold at harvest on 30 Aug
2018 Tukey ($P<0.05$)



Incidence Ginger Gold 2-week postharvest (%)
Tukey ($P<0.05$)



SBFS Trial 2020

Maintenance sprays: Apple scab and cedar apple rust at the beginning of the season.

Treatments/Programs (100 Gal/A):

7 and 21 Jul; 3, 18 Aug; 3, 21 Sep; 1 Oct

1. Untreated Control
2. Buran 1.2% (v/v) + Agral 90 0.1% (v/v)
3. Buran 1.2% (v/v) + PureSpray GREEN 1% (v/v)
4. PureSpray GREEN 1% (v/v)
5. Captan 2.67 lbs/A



Agral 90 – non-ionic liquid wetting and spreading agent: nonylphenoxy polyethoxy ethanol 90%



Garlic powder 15%

intelligro™



PureSpray™ is an Intelligro brand.
PURESPRAY™
green

A HORTICULTURAL SPRAY OIL
FOR LISTED INSECT, MITE
AND DISEASE CONTROL

Mineral Oil 98%



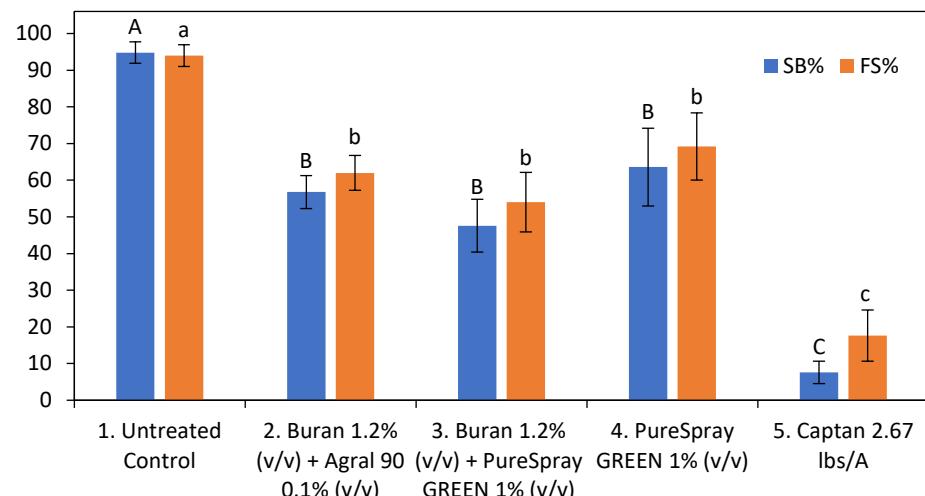
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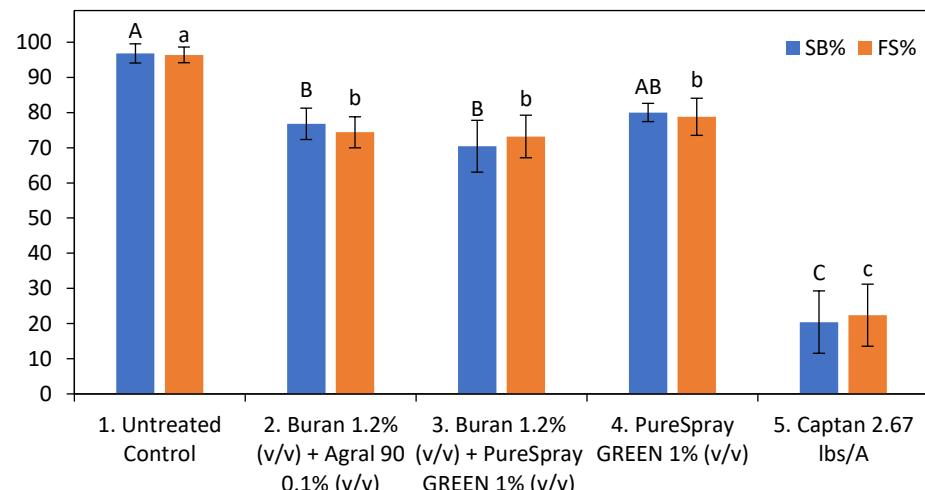
SBFS Trial 2020

- Ginger Gold -

Ginger Gold SB&FS Incidence % Harvest 2020 (LSD, $P<0.05$)



Ginger Gold SB&FS Incidence % Two Weeks After Harvest in 2020 (LSD, $P<0.05$)



Harvest: 9/1/2020



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Crist Bros Orchards

• EST 1883 •



This work was supported by the NY Apple Research and Development Program



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Thank you for attention . . .

Questions?

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