

Tailoring an IPM program for Florida Pomegranates

5th Annual Meeting of the Florida Pomegranate Association, Balm, FL
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Pomegranate in Florida



- **A project through UF/IFAS CREC, Lake Alfred began in 2009 to evaluate potential of pomegranate production in Florida**
- **Currently, approx. 25 pomegranate growers with larger acreage (1-15 acre) and 100-200 growers with 1/4 acre or less**
- **The demand of trees increased from 10-100 trees in 2013 to 200-1000 trees in 2014.**

Pomegranate in Florida

- **Production Challenges**
 - Market
 - Cultivar selection
 - Nutrition and water management
 - Physiological disorders
 - Diseases and pests
 - No labeled fungicides
 - Limited information



Pomegranate in Florida

A background image featuring two pomegranates. One is whole and slightly out of focus, while the other is cut open, revealing the dark red, jewel-like seeds (arils) inside. Green leaves are scattered around the fruits.

Advancing commercial fruit production has been severely compromised by various diseases

A large, semi-transparent image of a pomegranate, split open to show its red seeds, serves as the background for the slide. The pomegranate is centered and occupies most of the frame. The text is overlaid on this background.

Florida Specialty Crop Block Grant 2014 - 2016

Objectives

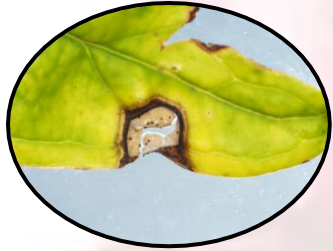
- 1. Conduct a survey of pathogens and pests impacting pomegranate production**
- 2. Develop disease management strategies**

Disease Survey (2014-2015)

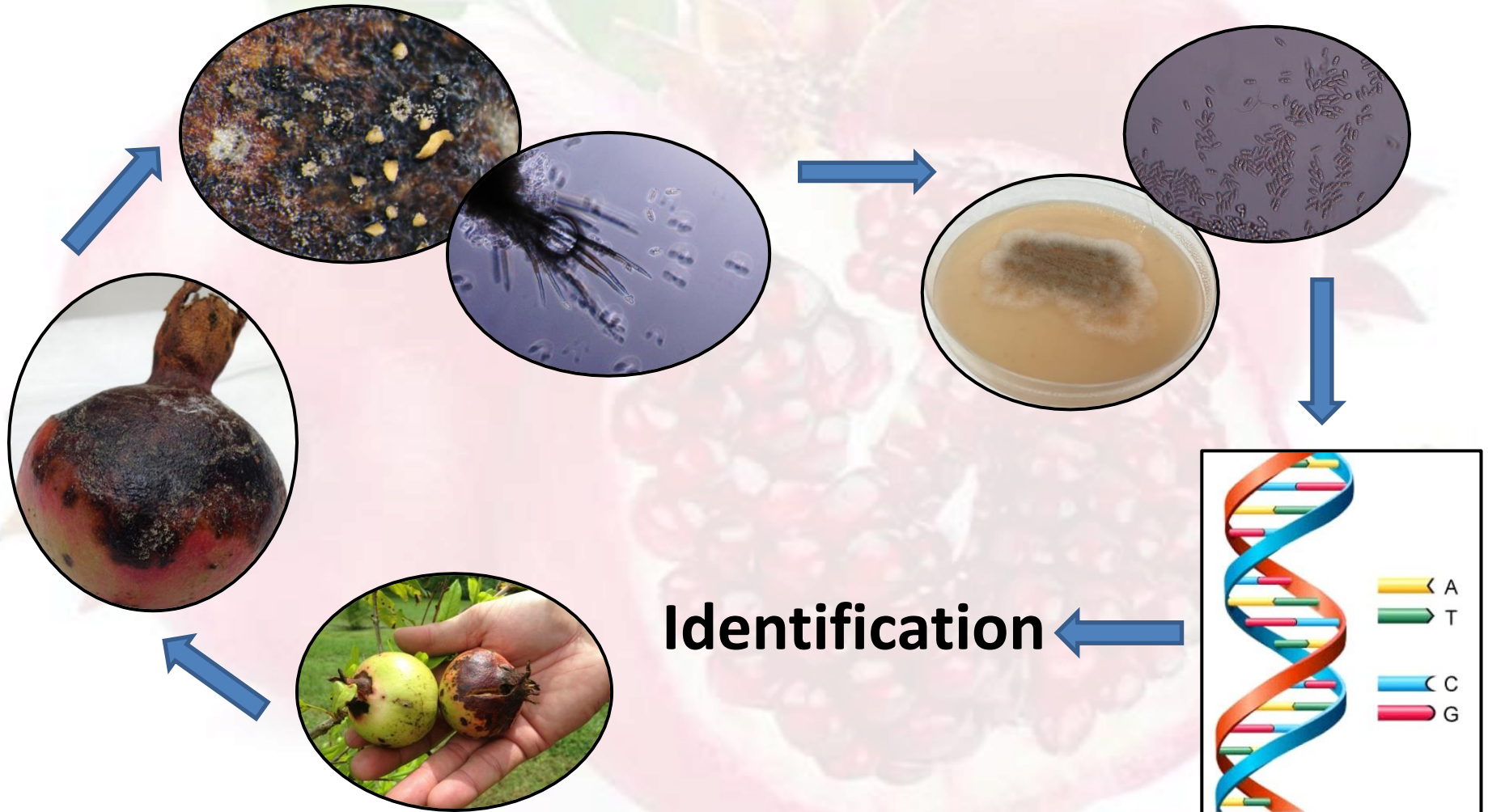


Disease Survey (2014-2015)

Symptoms on leaves, fruits, and stem



Identification



Identification (Results)

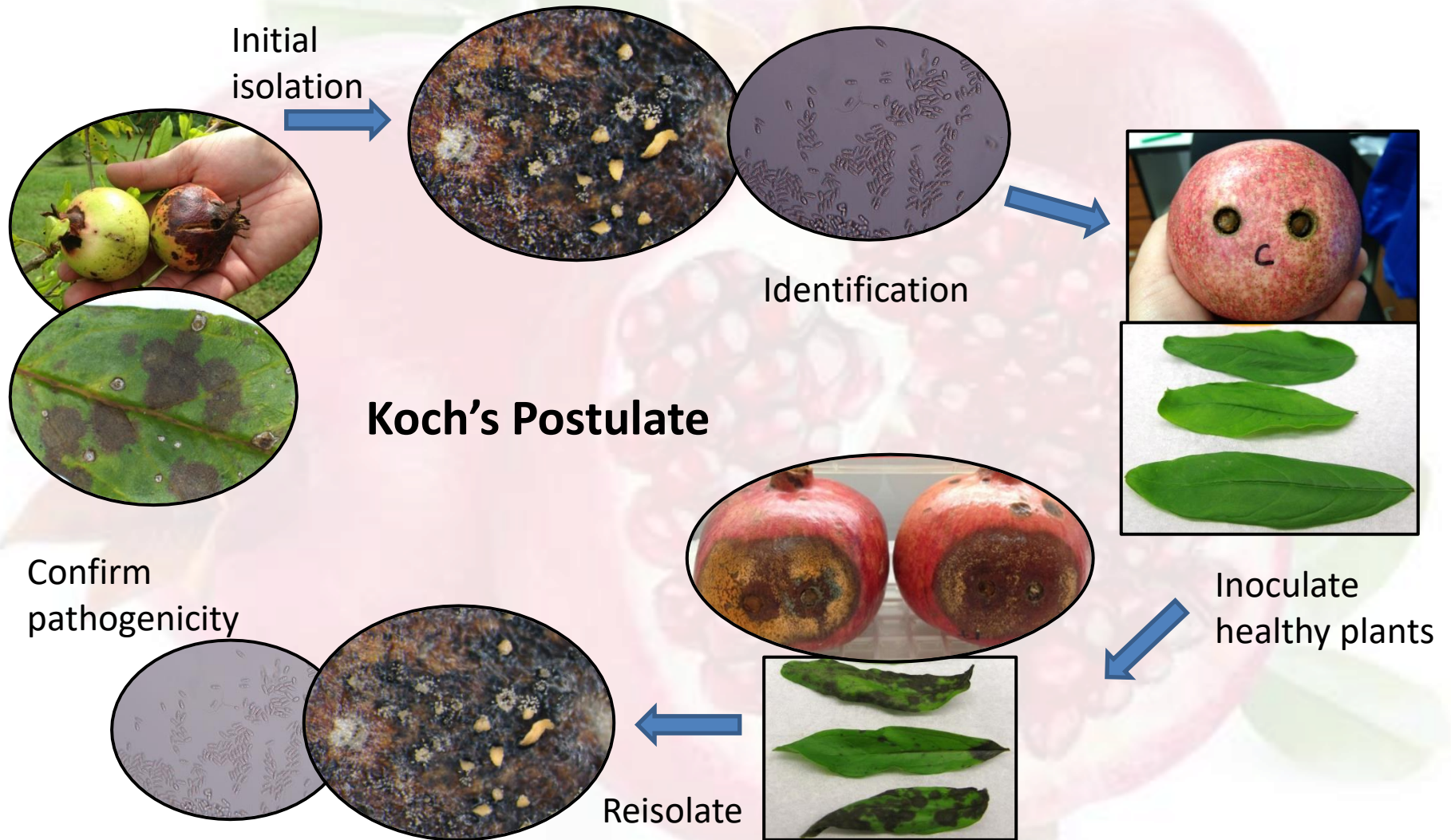
Species	Plant Part	% Isolation (n ≥ 400)
<i>Colletotrichum</i> sp.	Leaf, Stem, Flower, Fruit	29
<i>Neofusicoccum parvum</i>	Leaf, Stem, Pedicel	6
Diaporthales	Leaf, Stem, Flower	6
<i>Pilidiella granati</i>	Stem	3
<i>Lasiodiplodia theobromae</i>	Leaf, Stem, Pedicel, Fruit	9
<i>Alternaria</i> sp.	Leaf	3
<i>Nigrospora sphaerica</i>	Leaf, Fruit	6
<i>Corynespora asiicola</i>	Leaf	3
<i>Epicoccum nigrum</i>	Stem	6
<i>Phyllosticta</i> sp.	Leaf	3
<i>Pestalotiopsis clavispora</i>	Leaf	18
<i>Fusarium</i> sp.	Fruit	6
<i>Nectria mauritiicola</i>	Stem	3

Pathogenicity tests (Koch's postulate)



- **Attached leaf assays:**
 - cv. Azadi
 - three trees per species
- **Detached leaf assays:**
 - cv. Don Somner North, Desertnyi, and Vietnam
 - four replication, four leaves per cultivar
- **Fruit assays:**
 - Store bought fruit: cv. Wonderful
 - 2 fruit per pathogen, repeated once
- **Whole tree assays:**
 - cv. Wonderful
 - 2 trees per isolate

Pathogen Identification



Pathogen Identification (Results)

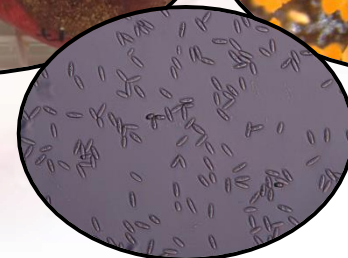
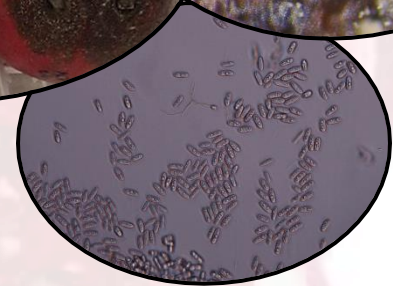
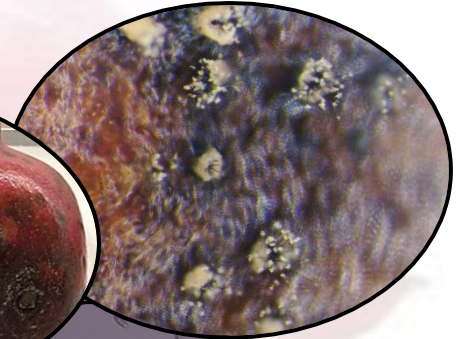
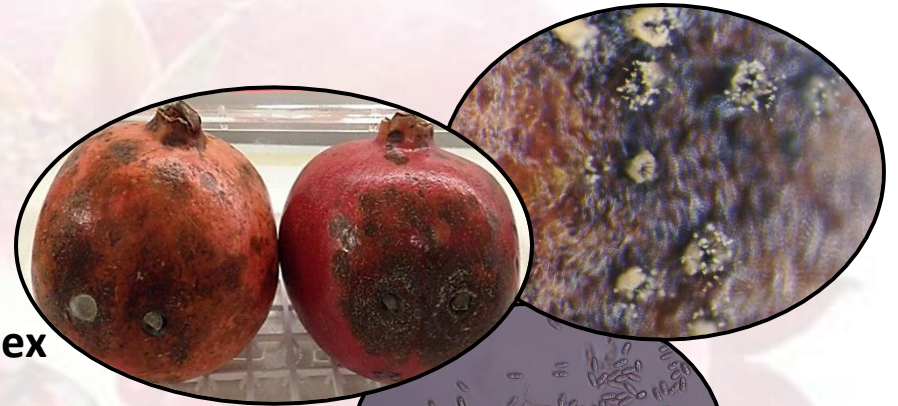
Pathogen	Plant Tissue	Isolation (%)	Pathogenicity:		
			Leaf	Fruit	Virulence
<i>Colletotrichum</i> sp.	Leaf, Stem, Flower, Fruit	29	+	+	**
<i>Neofusicoccum parvum</i>	Leaf, Stem, Pedicel	6	+	+	**
Diaporthales	Leaf, Stem, Flower	6	+	+	**
<i>Pilidiella granati</i>	Stem, Fruit	3	+	+	**
<i>Lasiodiplodia theobromae</i>	Leaf, Stem, Pedicel, Fruit	9	+	+	**
<i>Alternaria</i> sp.	Leaf	3	+	-	*
<i>Nigrospora sphaerica</i>	Leaf, Fruit	6	+	-	*
<i>Corynespora casiicola</i>	Leaf	3	+	-	*
<i>Epicoccum nigrum</i>	Stem	6	-	-	
<i>Phyllosticta</i> sp.	Leaf	3	-	-	
<i>Pestalotiopsis clavispora</i>	Leaf	18	-	-	
<i>Fusarium</i> sp.	Fruit	6	-	-	
<i>Nectria mauritiicola</i>	Stem	3	-	-	

Pathogen Identification (Results)

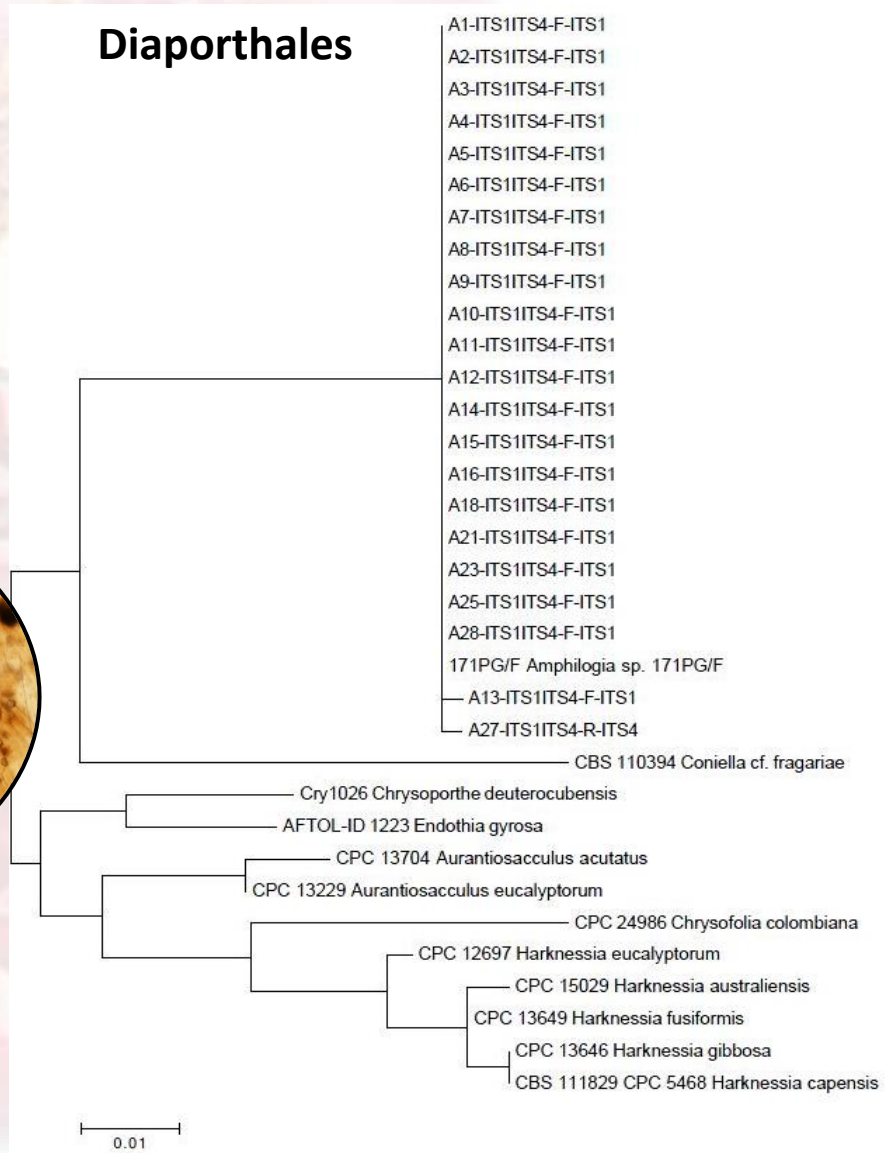
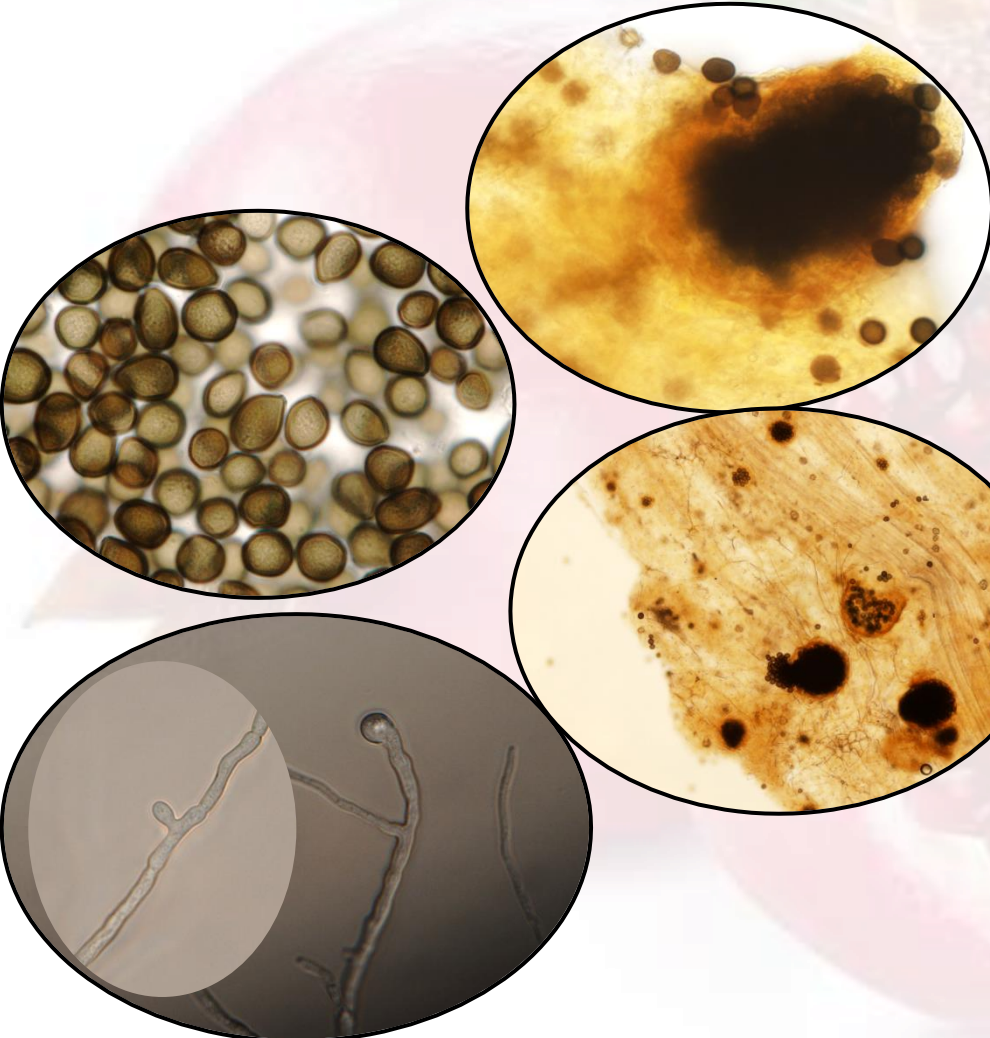
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Diaporthales	Leaf, Stem, Flower	6	+	+	**
<i>Pilidiella granati</i>	Stem, Fruit	3	+	+	**
<i>Lasiodiplodia theobromae</i>	Leaf, Stem, Pedicel, Fruit	9	+	+	**
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<i>Fusarium</i> sp.	Fruit	6	-	-	
<i>Nectria mauritiicola</i>	Stem	3	-	-	

Pathogen Identification (Results)

- **Two species of *Colletotrichum***
 - *Colletotrichum gloeosporioides* species complex
 - *Colletotrichum acutatum* species complex
- **Phylogenetic analysis in progress**
 - 55 isolates from pomegranate field in Florida
 - At least three nuclear gene regions
 - The ribosomal internal transcribed spacer (ITS)
 - B-tubulin 2 (TUB2)
 - Glutamine synthase (GS)



Pathogen Identification (Results)



A large, semi-transparent image of a pomegranate, split open to show its red seeds, serves as the background for the slide. The pomegranate is centered and occupies most of the frame. The text is overlaid on this background.

Florida Specialty Crop Block Grant 2014 - 2016

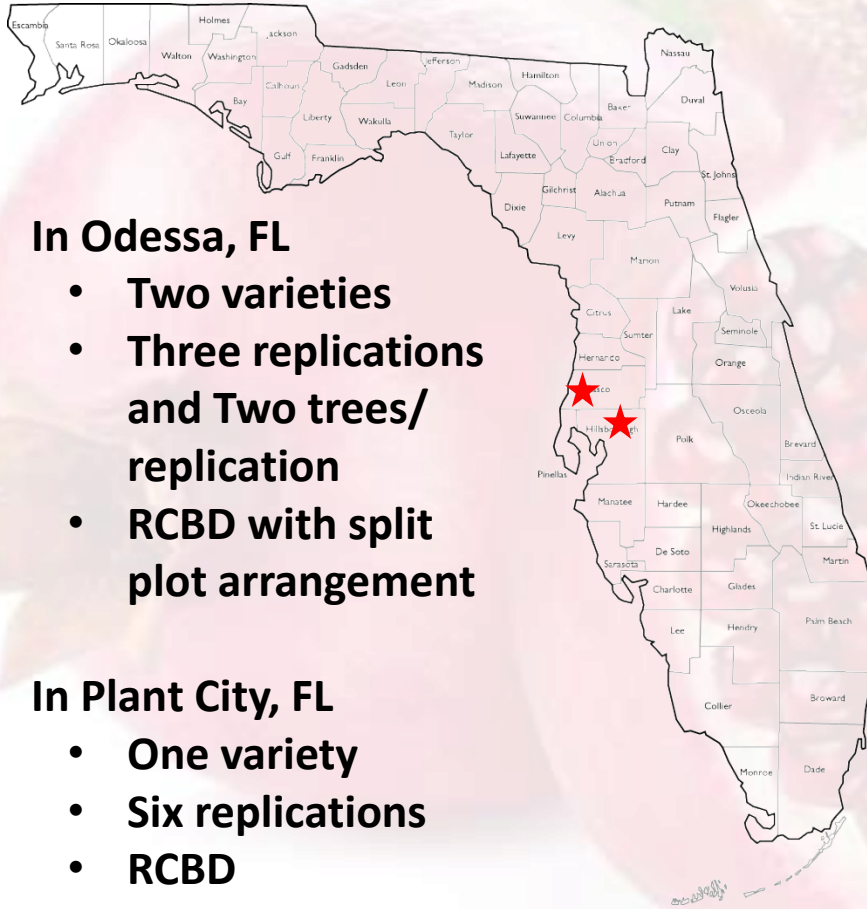
Objectives

- 1. Conduct a survey of pathogens and pests impacting pomegranate production**
- 2. Develop disease management strategies**

Fungicide efficacy trials

Active ingredient (%)	Group name	FRAC code	Product	Manufacturer
Pyraclostrobin (20%)	Quinone outside inhibitors (QoI)	11	Cabrio	BASF
Mancozeb (80%)	Multisite activity	M	Penncozeb	United Phosphorus Inc
Pyrimethanil (54.6%)	Anilino-pyrimidines (AP)	9	Scala	Bayer CropScience
Cyprodinil/Fludioxonil	AP/Phenylpyrrole	9/12	Switch	Syngenta Crop Protection
Fluopyram/Tebuconazole	SDHI/DMI	7/3	Luna Experience	Bayer CropScience

2015 Fungicide efficacy trials



In Odessa, FL

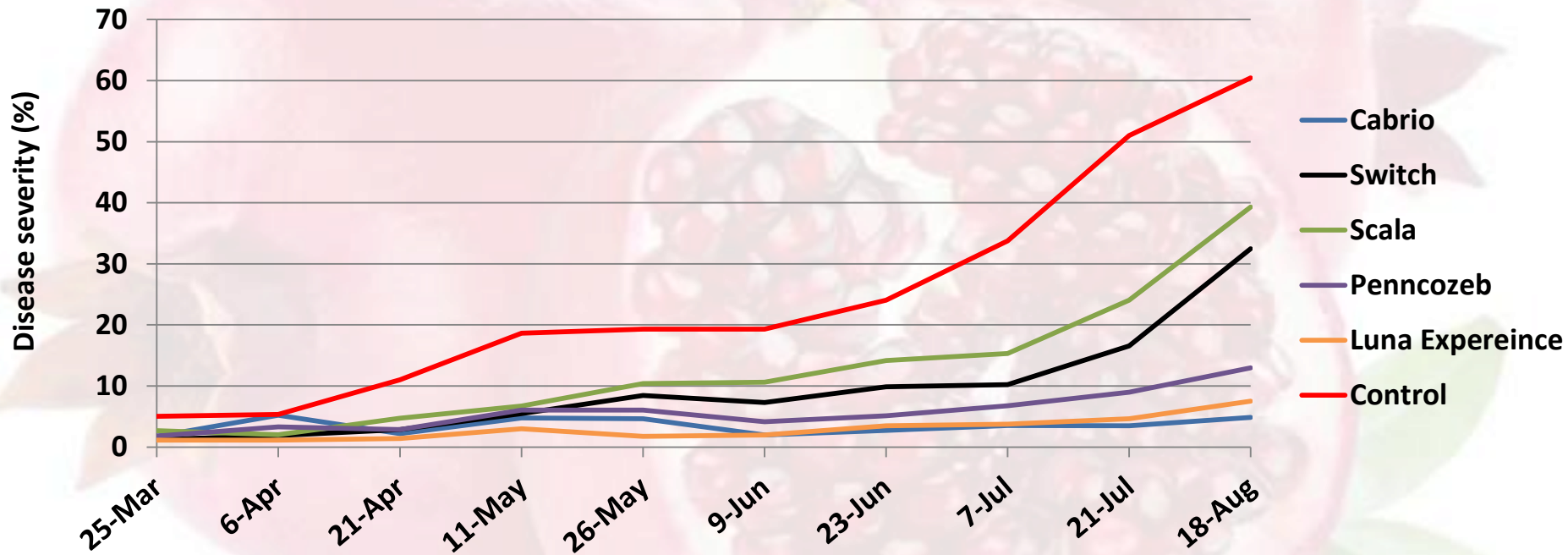
- Two varieties
- Three replications and Two trees/replication
- RCBD with split plot arrangement

In Plant City, FL

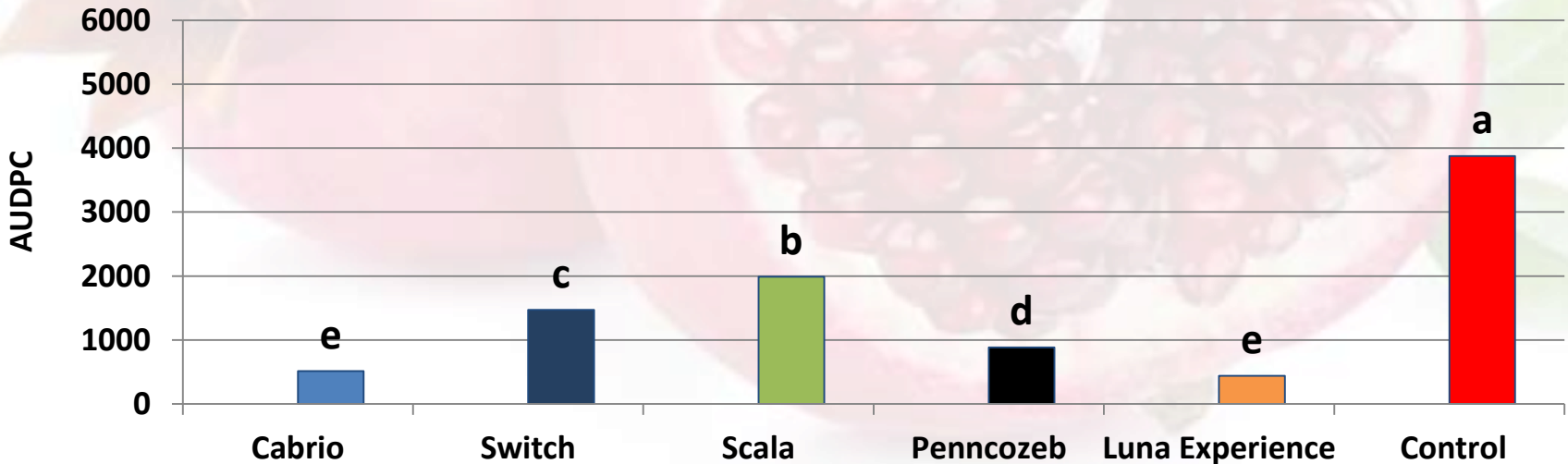
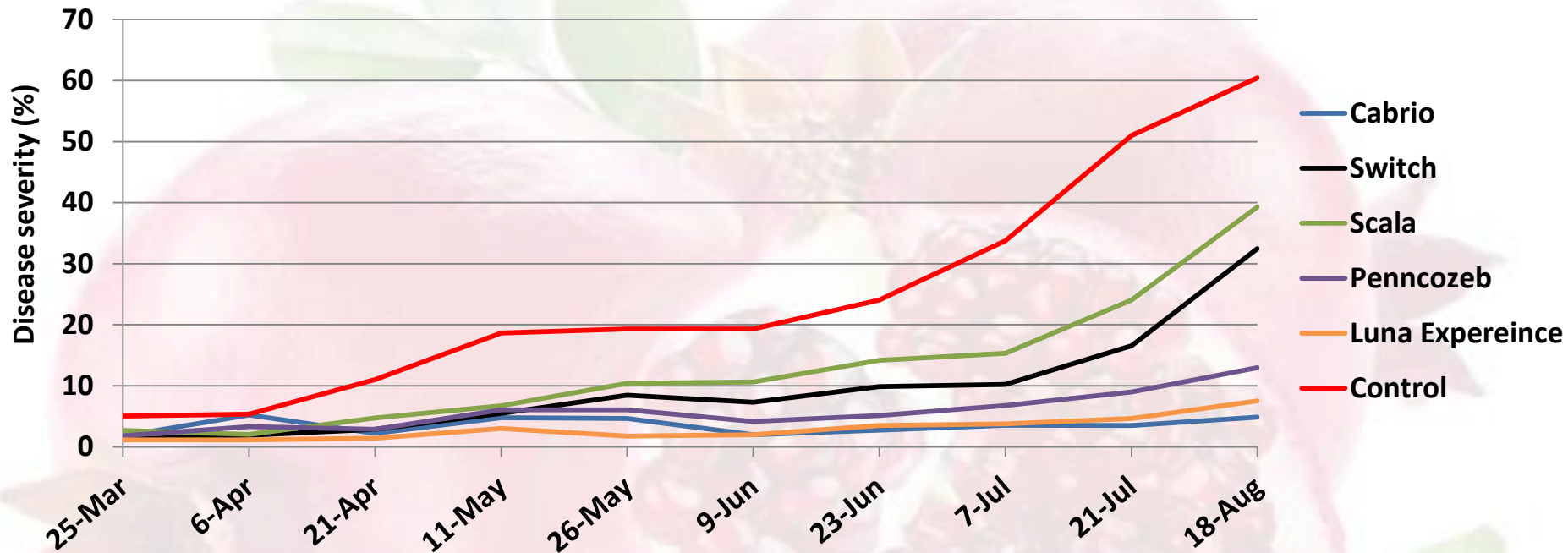
- One variety
- Six replications
- RCBD

- Application from Feb to July 2015
- Sprayed in every three weeks for first three applications and every two weeks there after
- Five fungicides tested for their efficacy to reduce foliar and fruit disease severity
- Data on disease severity using Horsfall-Barrat Scale

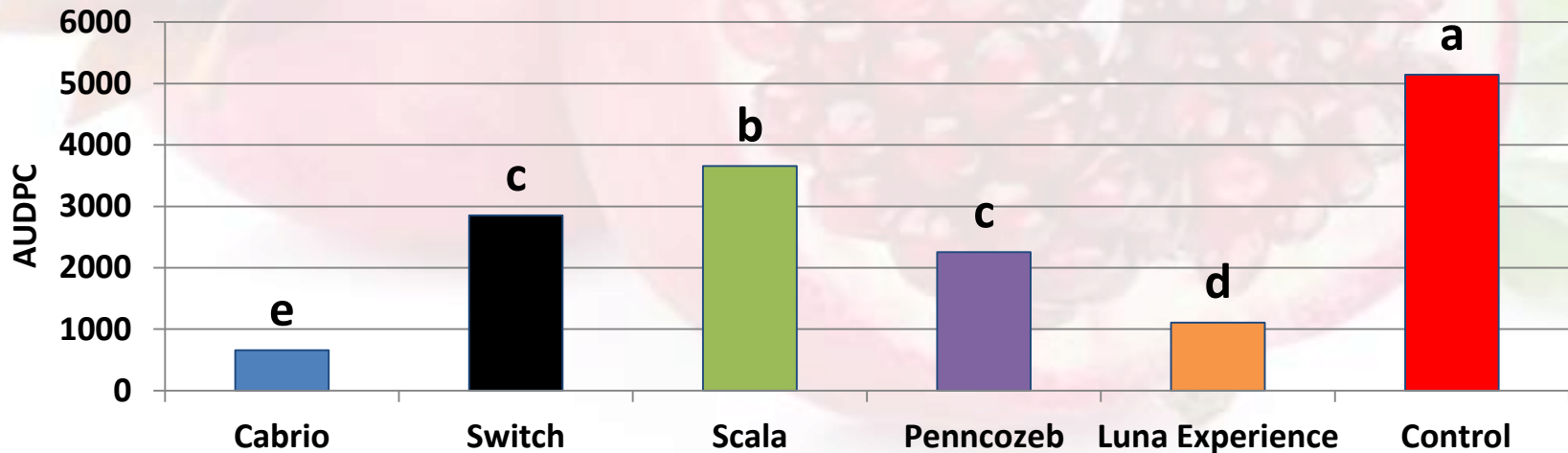
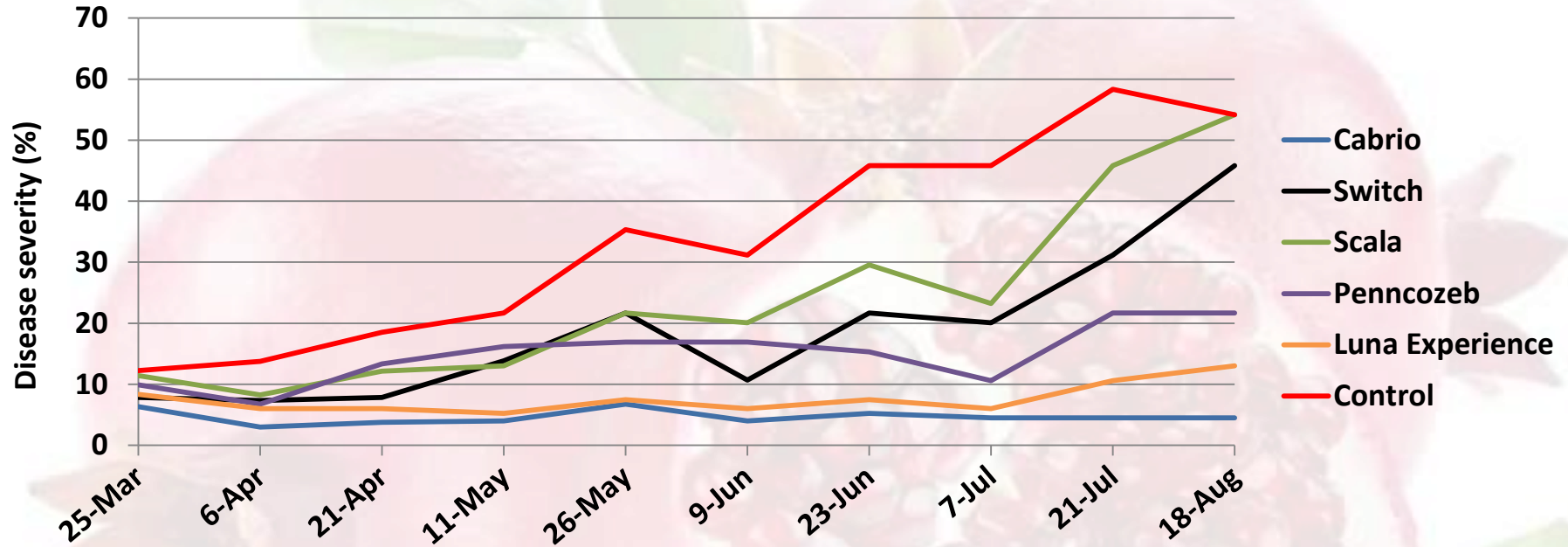
2015 Fungicide trial – Odessa, FL



2015 Fungicide trial – Odessa, FL



2015 Fungicide trial – Plant City, FL



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2015 Fungicide trial – Plant City, FL



2015 Fungicide trial – Plant City, FL



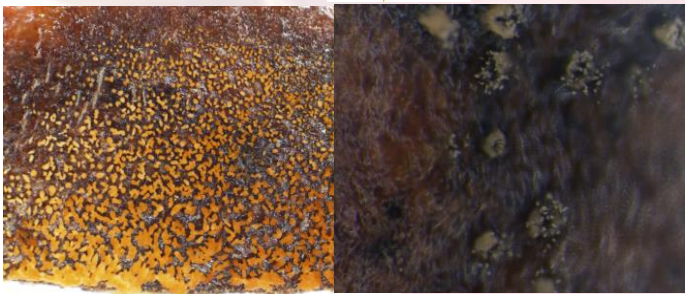
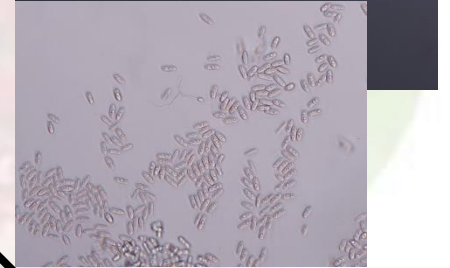
2016 Fungicide efficacy trials

The background of the slide features a soft-focus image of two pomegranates. One pomegranate is whole and positioned to the left, while the other is cut open, revealing its vibrant red, jewel-like seeds. Green leaves are scattered around the fruit, adding a natural, agricultural feel to the presentation.

- Need to address timing and frequency to establish usage patterns.
 - Important for efficacy
 - Important for resistance management
 - Important for labeling (residue = PHI)



Anthracnose disease cycle on pomegranate



Anthracnose of pomegranate

Colletotrichum sp.



Anthracnose of pomegranate

Colletotrichum sp.

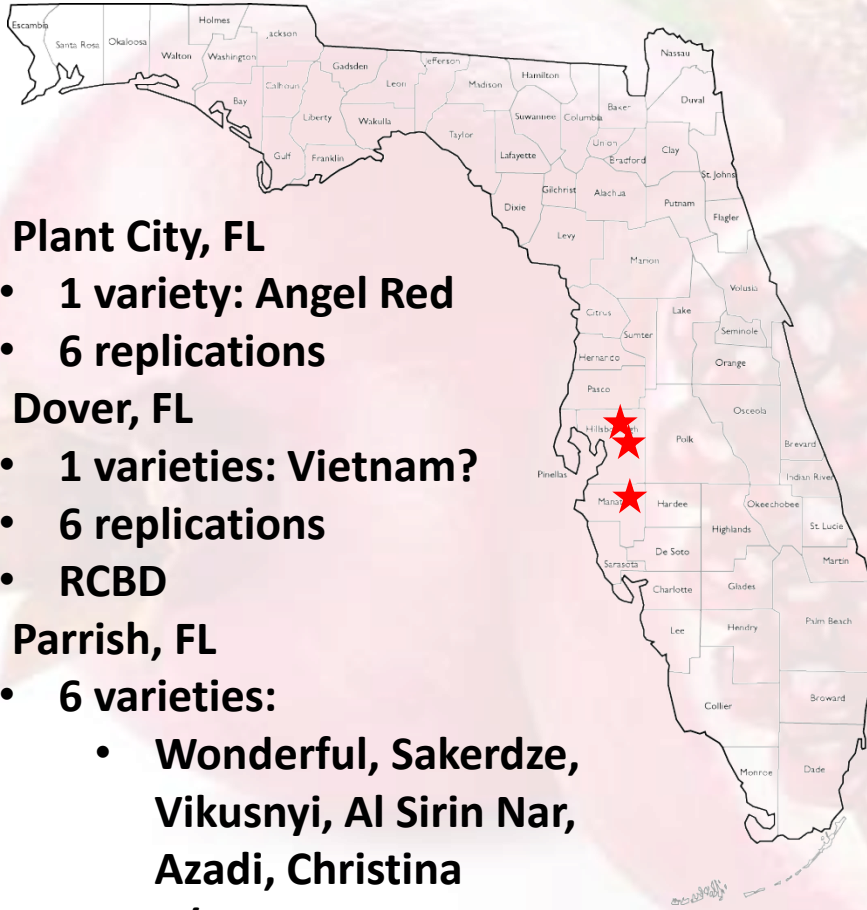


Anthracnose of pomegranate

Colletotrichum sp.



2016 Fungicide efficacy trials



In Plant City, FL

- 1 variety: Angel Red
- 6 replications

In Dover, FL

- 1 varieties: Vietnam?
- 6 replications
- RCBD

In Parrish, FL

- 6 varieties:
 - Wonderful, Sakerdze, Vikusnyi, Al Sirin Nar, Azadi, Christina
- 3 reps/2 var.

- Application from Feb to Aug 2016
- Only examined 3 fungicide programs:
 - Merivon
 - Luna Experience
 - Rotation of Penncozeb, Merivon and Luna Experience
 - Residue testing performed at a 4th site by IR-4 Program.
- Examined application timing
 - Addressing usage pattern for labelling.
- Data on disease severity using Horsfall-Barrat Scale

2016 Fungicide efficacy trials

Fungicide	Application interval	rate/A				
Luna Experience	4 apps (6 wk interval) beginning at bloom (low rate)	8.5 oz				
	2 apps at bloom (2 wk interval); 2 post-bloom apps (2 wk interval) (low rate)	8.5 oz				
	2 apps at bloom high rate (2 wk interval)	17 oz				
	1 app at bloom (high rate); 2 post-bloom apps (2 wk interval) (low rate)	17 oz/ 8.5 oz				
	4 post-bloom apps (4 wk interval) (low rate)	8.5 oz				
	Non-treated control	-				
			P > F			
		rate/A				
Merivon	4 apps (6 wk interval) beginning at bloom (low rate)	7 oz				
	2 apps at bloom (2 wk interval); 2 post-bloom apps (2 wk interval) (low rate)	7 oz				
	2 apps at bloom (2 wk interval) (low rate)	7 oz				
	2 apps at bloom (2 wk interval) (high rate)	14 oz				
	2 post-bloom apps (2 wk interval) (low rate)	7 oz				
	2 post-bloom apps (2 wk interval) (high rate)	14 oz				
	Non-treated control	-				
		P > F				

2016 Fungicide efficacy trials

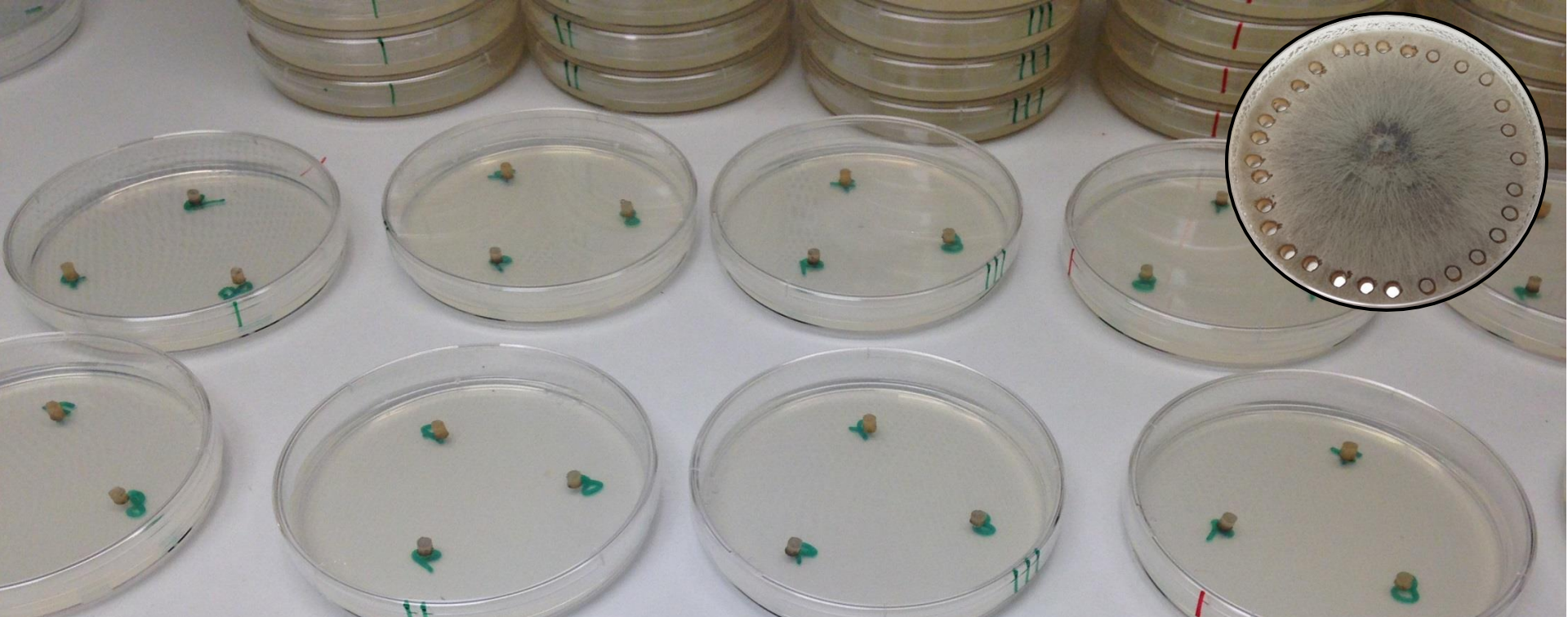
			Plant City		
Fungicide	Application interval	rate/A	AUDPC	Dis. Fruit (%)	
Luna Experience	4 apps (6 wk interval) beginning at bloom (low rate)	8.5 oz	2003 bc	44.8cd	
	2 apps at bloom (2 wk interval); 2 post-bloom apps (2 wk interval) (low rate)	8.5 oz	2151 bc	53.8 bc	
	2 apps at bloom high rate (2 wk interval)	17 oz	1510 c	24.9 d	
	1 app at bloom (high rate); 2 post-bloom apps (2 wk interval) (low rate)	17 oz/ 8.5 oz	2421 bc	52.8 c	
	4 post-bloom apps (4 wk interval) (low rate)	8.5 oz	2637 b	80.5 a	
	Non-treated control	-	3952 a	74.6 ab	
			P > F	0.0111	0.0060
			rate/A	AUDPC	Dis. Fruit (%)
Merivon	4 apps (6 wk interval) beginning at bloom (low rate)	7 oz	487 b	23.3 c	
	2 apps at bloom (2 wk interval); 2 post-bloom apps (2 wk interval) (low rate)	7 oz	525 b	15.0 c	
	2 apps at bloom (2 wk interval) (low rate)	7 oz	490 b	9.0 c	
	2 apps at bloom (2 wk interval) (high rate)	14 oz	431 b	22.6 bc	
	2 post-bloom apps (2 wk interval) (low rate)	7 oz	3338 a	60.1 ab	
	2 post-bloom apps (2 wk interval) (high rate)	14 oz	3501 a	82.0 a	
	Non-treated control	-	3980 a	77.5 a	
		P > F	<0.0001	0.0023	

2016 Fungicide efficacy trials

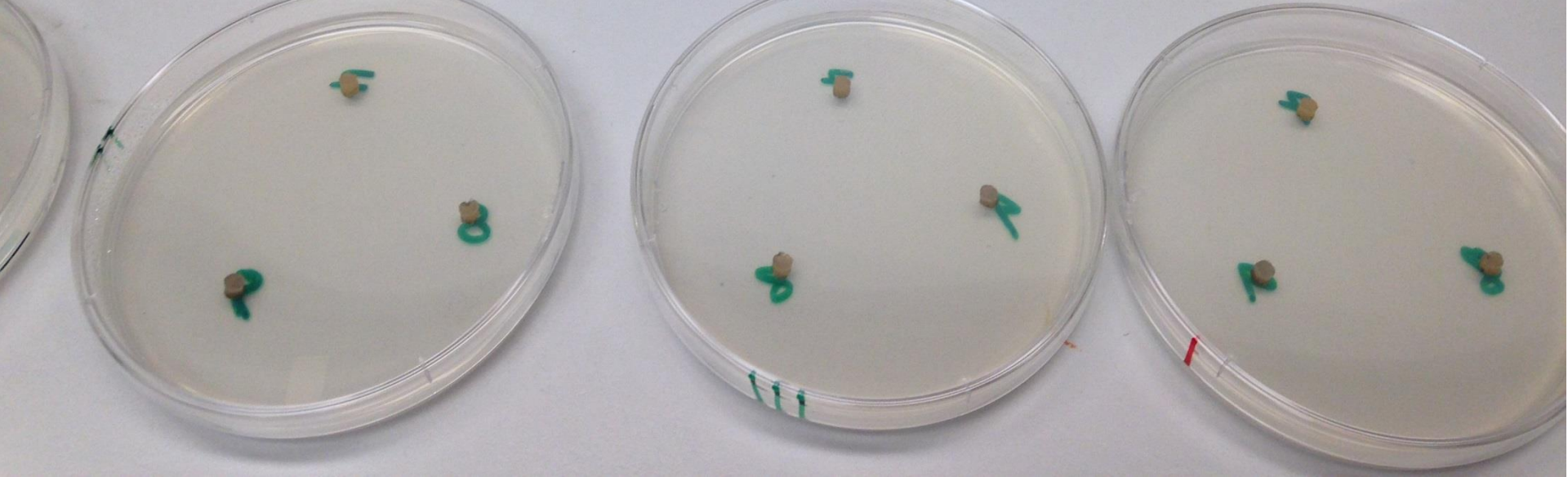
			Parrish	
Fungicide	Application interval	rate/A	AUDPC	Dis. Fruit (%)
Luna Experience	4 apps (6 wk interval) beginning at bloom (low rate)	8.5 oz	770 bc	25.0
	2 apps at bloom (2 wk interval); 2 post-bloom apps (2 wk interval) (low rate)	8.5 oz	777 bc	7.2
	2 apps at bloom high rate (2 wk interval)	17 oz	595 c	0.0
	1 app at bloom (high rate); 2 post-bloom apps (2 wk interval) (low rate)	17 oz/ 8.5 oz	760 bc	3.3
	4 post-bloom apps (4 wk interval) (low rate)	8.5 oz	982 b	10.0
	Non-treated control	-	1688 a	19.4
			P > F	<0.0001
			AUDPC	Dis. Fruit (%)
		rate/A	AUDPC	Dis. Fruit (%)
Merivon	4 apps (6 wk interval) beginning at bloom (low rate)	7 oz	637 d	0.0 b
	2 apps at bloom (2 wk interval); 2 post-bloom apps (2 wk interval) (low rate)	7 oz	--	--
	2 apps at bloom (2 wk interval) (low rate)	7 oz	950 c	0.0 b
	2 apps at bloom (2 wk interval) (high rate)	14 oz	606 d	0.0 b
	2 post-bloom apps (2 wk interval) (low rate)	7 oz	1026 c	14.6 a
	2 post-bloom apps (2 wk interval) (high rate)	14 oz	1350 b	5.1 ab
	Non-treated control	-	1647 a	5.1 ab
		P > F	<0.0001	0.0292

Dover

Fungicide	Application interval	rate/A	AUDPC	Dis. Fruit (%)
Luna Experience	4 apps (6 wk interval) beginning at bloom (low rate)	8.5 oz	949 c	7.1 b
	2 apps at bloom (2 wk interval); 2 post-bloom apps (2 wk interval) (low rate)	8.5 oz	1247 bc	3.9 b
	2 apps at bloom high rate (2 wk interval)	17 oz	1006 bc	5.0 b
	1 app at bloom (high rate); 2 post-bloom apps (2 wk interval) (low rate)	17 oz/ 8.5 oz	1402 bc	9.4 b
	4 post-bloom apps (4 wk interval) (low rate)	8.5 oz	1502 b	37.3 a
	Non-treated control	-	2137 a	13.8 b
			P > F	0.0055
		rate/A	AUDPC	Dis. Fruit (%)
Merivon	4 apps (6 wk interval) beginning at bloom (low rate)	7 oz	805 b	3.1
	2 apps at bloom (2 wk interval); 2 post-bloom apps (2 wk interval) (low rate)	7 oz	1084 b	11.2
	2 apps at bloom (2 wk interval) (low rate)	7 oz	1030 b	23.4
	2 apps at bloom (2 wk interval) (high rate)	14 oz	842 b	7.6
	2 post-bloom apps (2 wk interval) (low rate)	7 oz	2224 a	13.3
	2 post-bloom apps (2 wk interval) (high rate)	14 oz	2090 a	3.7
	Non-treated control	-	2330 a	13.8
		P > F	0.0024	0.1723



In vitro assessment of sensitivity to different fungicides



Fungicide sensitivity tests



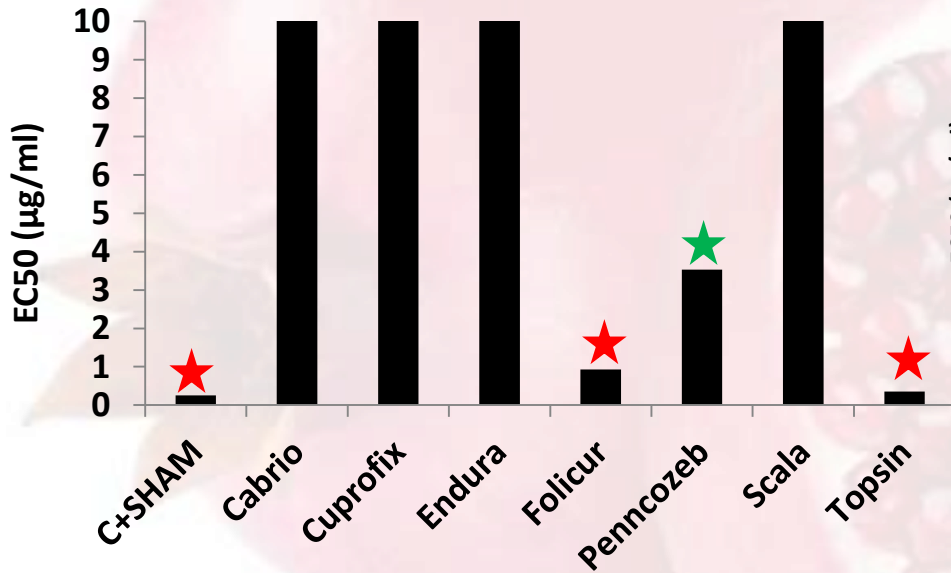
- **Three pathogens were tested for sensitivity**
 - *Lasiodiplodia theobromae*.
 - *Neofusicoccum parvum*
 - *Colletotrichum* sp.
- **Six isolates of each replicated three times**
- **Entire experiment repeated once**
- **Sensitivity to seven fungicides were tested**
 - 5 concentrations (100, 10, 1, 0.1, 0.01 $\mu\text{g/ml}$) of AI vs control
 - Colony diameter was measured after three to five days
 - EC_{50} for each fungicide was calculated

Fungicides tested in plate assays

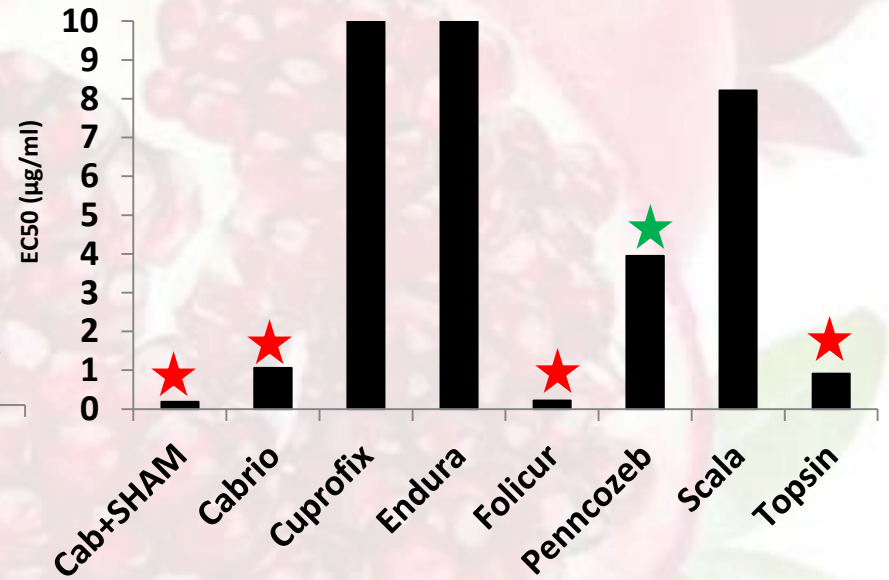
Active ingredient (%)	Group name	FRAC code	Product	Manufacturer
Copper Sulfate (71.1%)	Multisite activity	M	Cuprofix	United Phosphorus Inc
Boscalid (70%)	Succinate dehydrogenase inhibitors (SDHI)	7	Endura	BASF
Tebuconazole (38.7%)	Demethylation inhibitors (DMI)	3	Folicur	Bayer CropScience
Thiophanate-Methyl (45%)	Methyl benzimidazole carbamates (MBC)	1	Topsin	United Phosphorus Inc
Pyraclostrobin (20%)	Quinone outside inhibitors (QoI)	11	Cabrio	BASF
Mancozeb (80%)	Multisite activity	M	Penncozeb	United Phosphorus Inc
Pyrimethanil (54.6%)	Anilino-pyrimidines (AP)	9	Scala	Bayer CropScience

Results - Plate Assay

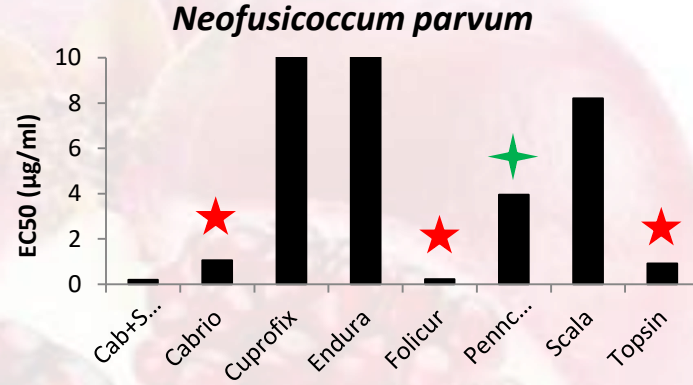
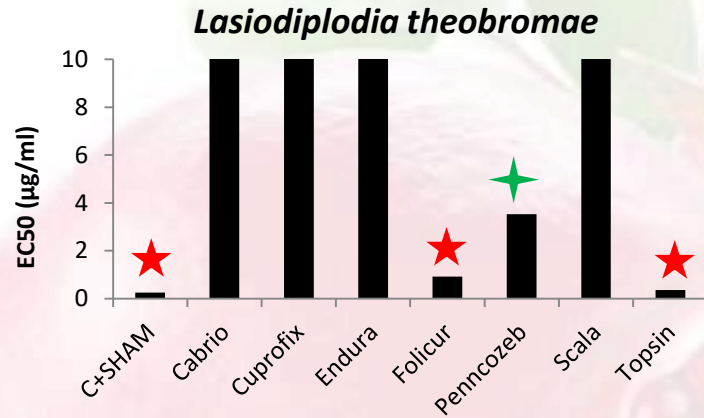
Lasiodiplodia theobromae



Neofusicoccum parvum



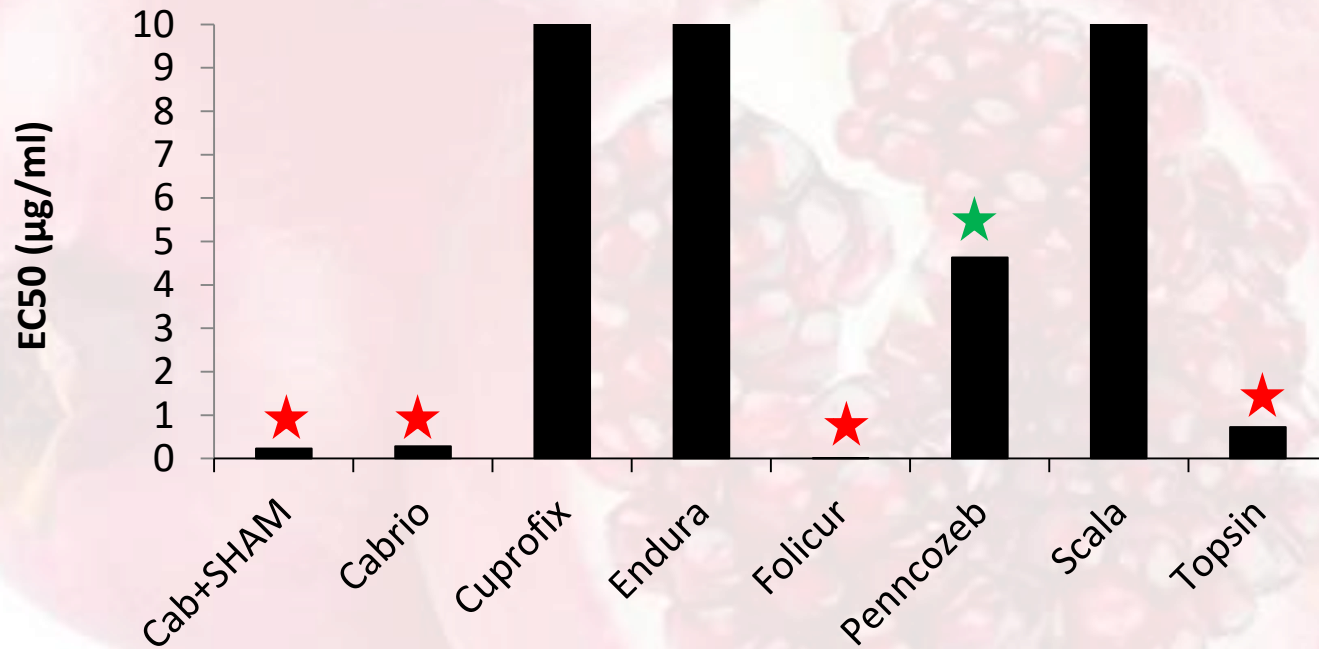
Results - Plate Assay



Fungicides	Range (EC ₅₀)	
	<i>L. theobromae</i>	<i>N. Parvum</i>
Cabrio	0.01 – 0.8	0.01 – 0.2
Folicur	0.6 – 1.4	0.1 – 0.4
Topsin	0.2- 0.6	0.7 – 1.0
Penncozeb	2.6 – 4.1	2.7 – 5.0
Scala	6.2 – >10	4.1 – 9.8
Endura	9.0 - >10	>100
Cuprofix	>100	>100

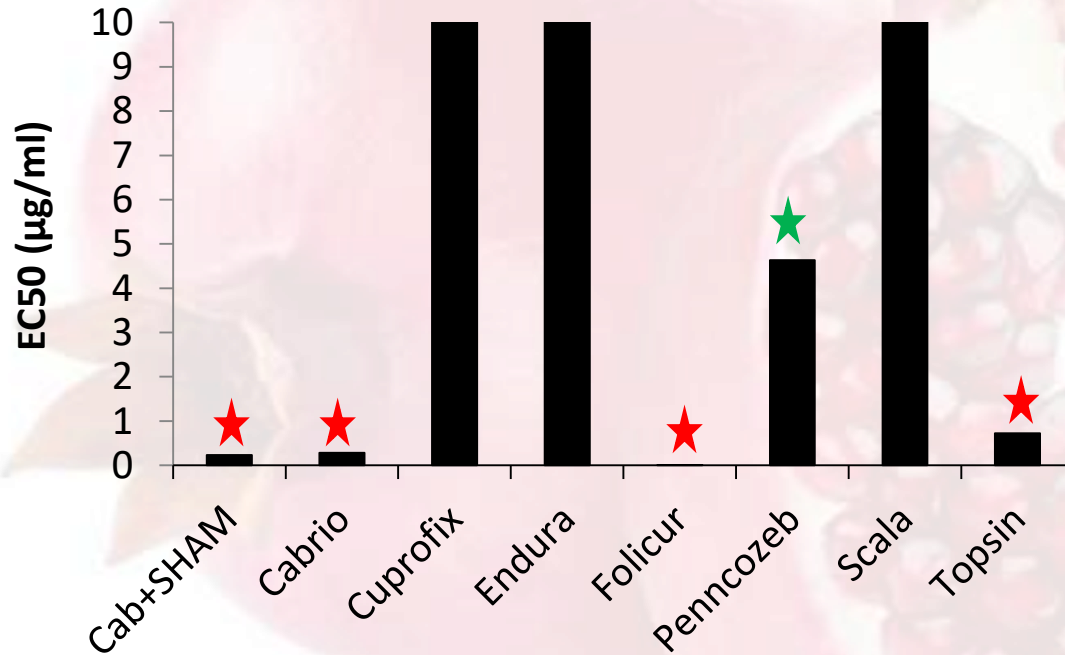
Results - Plate Assay

Colletotrichum sp.



Results - Plate Assay

Colletotrichum sp.



Fungicides	Range (EC ₅₀) <i>Colletotrichum sp.</i>
Cabrio	0.06 - 0.5
Folicur	< 0.01
Topsin	0.4 - 0.6
Penncozeb	3.5 - 18.9
Scala	6.5 - >100
Endura	0.1 - 100
Cuprofix	>100

Conclusion

- Among thirteen fungal species isolated from symptomatic tissues, six fungal species were pathogenic to pomegranates
- *Colletotrichum* sp., *Lasiodiplodia theobromae*, and *Neofusicoccum parvum* were sensitive to Cabrio, Folicur, and Topsin and moderately sensitive to Penncozeb in laboratory assays
- In field trials, Cabrio and Luna Experience were highly effective and Penncozeb was moderately effective in reducing foliar and fruit diseases
- Integrated disease management will be critical to pomegranate production in Florida
 - At bloom applications critical for effective disease management.
 - Additional fungicides are needed to establish an appropriate rotation.
 - Field sanitation is critical to manage pathogen levels = reduce disease pressure

Disease control is CRITICAL to Pom production!



Plant City, FL

Disease control is CRITICAL to Pom production!



Diseased fruit collected from treated plots



Not out of the woods yet !

Future plans



- **New Specialty Crop Block Grant**
 - Continuation of disease management & breeding
 - Sources of inoculum
 - Host range
 - Pathogens biology/disease cycle
 - Epidemiology of disease development
 - Integrated disease management
- **Specialty Crop Research Initiative (SCRI)**
 - Multidisciplinary
 - Multistate

Acknowledgement

- **UF Pomegranate Team**
 - Dr. Bill Castle
 - Dr. Zhanao Deng
 - Dr. Zhengfei Guan
 - Dr. Hugh Smith
 - Dr. Shinsuke Agehara
- **Cindy Weinstein**
- **Pacific Tomato Growers – Parrish, FL**
- **Mc Teer Farms - Haines City, FL**
- **Cee Bee's Citrus - Odessa, FL**
- **Sutherland's Pomegranate Field - Plant City, FL**
- **Rodney Faulkner – Dover, FL**
- **Florida Pomegranate Association**
- **Florida Specialty Crop Foundation**
- **FDACS Specialty Crop Block Grant Program**
- **GCREC Staff**



Acknowledgement

