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Plant Pathology Update
Fungicide Resistance

2024 FBGA Summer Grower Meetings

UF UNIVERSITY of FLORIDA
IFAS Extension

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Overview

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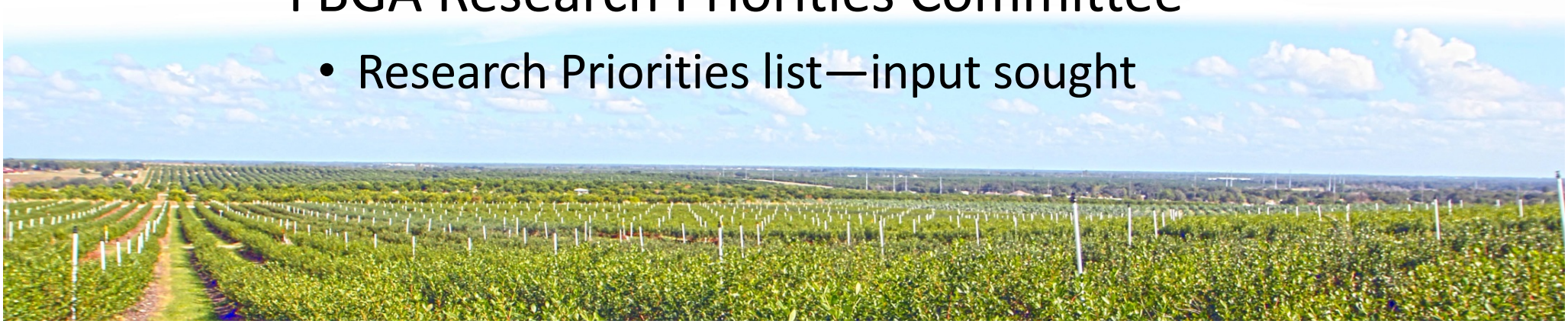
Today's topics to review

- Common blueberry diseases in Florida
  - Plant disease sample report
- Emerging disease issues
  - *Gloeocercospora* leaf spot
  - Fungicide resistance in anthracnose
- Fungicide resistance review
- FBGA Research Priorities Committee
  - Research Priorities list—input sought



PDC Blueberry Data

Variety	No.	Variety	No.	Variety	No.
311	2	GeorgiaDawn	10	Patricia	4
12-279	7	Indigocrisp	6	Preston	10
17-142	20	Jewels	1	Rabbiteye	3
Abundance	5	KeeCrisp	24	SanJoaquin	3
Albus	3	Kestrel	10	Sentinel	31
Arcadia	59	Kira	2	Stellar	13
Avanti	48	Legacy	15	Suziblue	16
Chickadee	4	Mageia	3	SweetCrisp	5
Collosus	8	Meadowlark	6	Vireo	8
Emerald	17	Oneal	7	Winterbelle	7
Farthing	78	Optimus	24	WinterSweet	4

PDC Blueberry Data

33 samples through 7/12/24

County, State	No.	County, State	No.
ALACHUA, FL	126	Hardin, TX	13
PASCO, FL	39	ORANGE, FL	12
HIGHLANDS, FL	36	Pender, NC	7
DESOTO, FL	36	Bacon, GA	6
POLK, FL	29	Clinch, GA	4
LAKE, FL	21	GLADES, FL	3
HARDEE, FL	21	HILLSBOROUGH, FL	3
MARION, FL	19	LEE, FL	2
CLAY, FL	17		
Ware, GA	16		

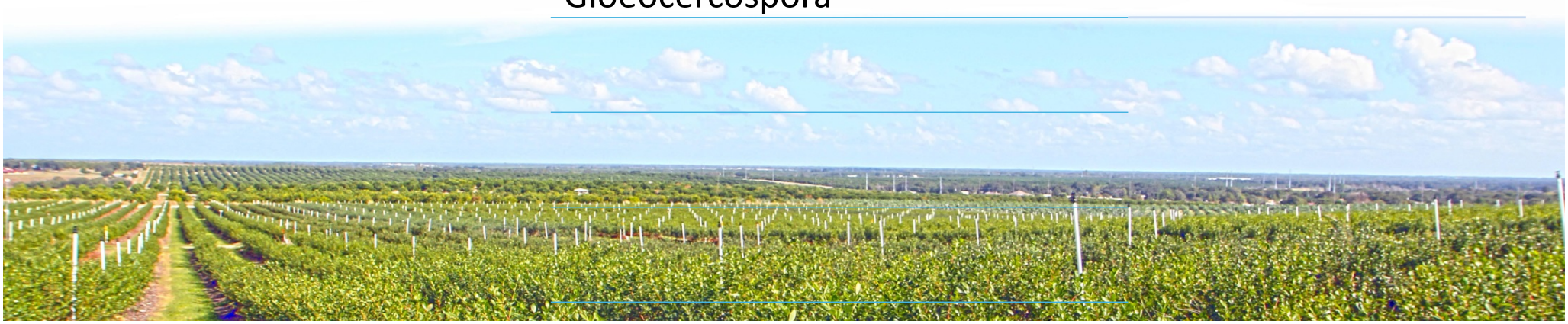
2023-2024 PDC Blueberry Data

2024 through **7/12/2024** (33 samples)

Row Labels	Count
No Path Found	**6**
Insect Damage	**1**
Insects	
Girdling Roots	**3**
Chili thrips	**1**
Insuficient sample	**1**

Row Labels	Count
Root rot	**8**
Phytophthora	
Anthracnose	**7**
Colletotrichum	
Phyllosticta leaf spot	**5**
Phyllosticta	
Stem blight	**4**
Botryosphaeria	
Leaf rust	**3**
Thekospora	
Angular leaf spot	**4**
Gloeocercospora	

Row Labels	#
Gray mold/blight	**1**
botrytis	
Crown gall	**1**
Agrobacterium	
Twig blight	**1**
Phomopsis	
Mushroom root rot	**1**
Armillaria	



Gloeocercospora leaf spot

- Described in 1947
- Found on the Sentinel variety in 2022

2023 Grower Survey

Top 5 Disease problems/causal agent

Disease	Pathogen	Top5
anthracnose ripe rot	*Colletotrichum gloeosporioides*	28
leaf rust	*Thekopsora mimimum*	27
algal stem blotch	*Cephaleuros virescens*	17
root rot	*Phytophthora cinnamomi*	16
stem blight	*Botryosphaeria spp.*	12
bacterial wilt	*Ralstonia solanacearum*	9
target spot	*Corynespora cassiicola*	5
Alternaria fruit rot	*Alternaria spp.*	2
gray mold	*Botrytis cinerea*	1
Septoria leaf spot	*Septoria albopunctata*	1

“Anthracnose”

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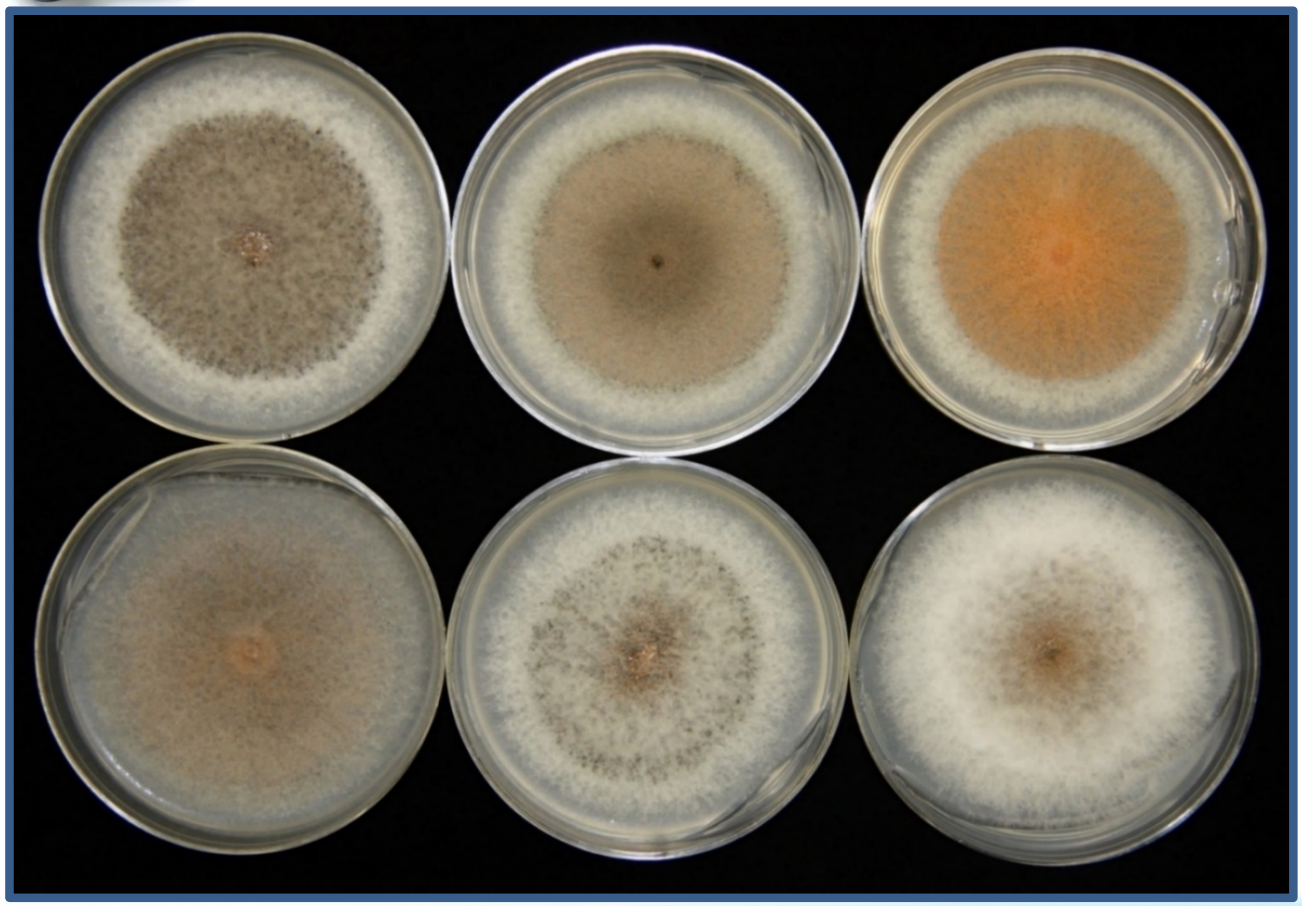
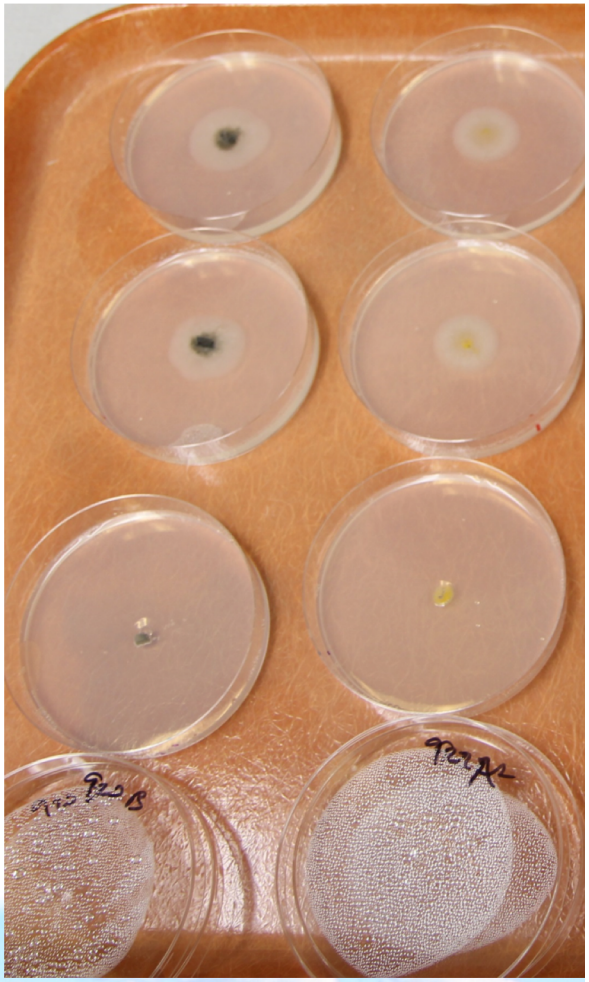
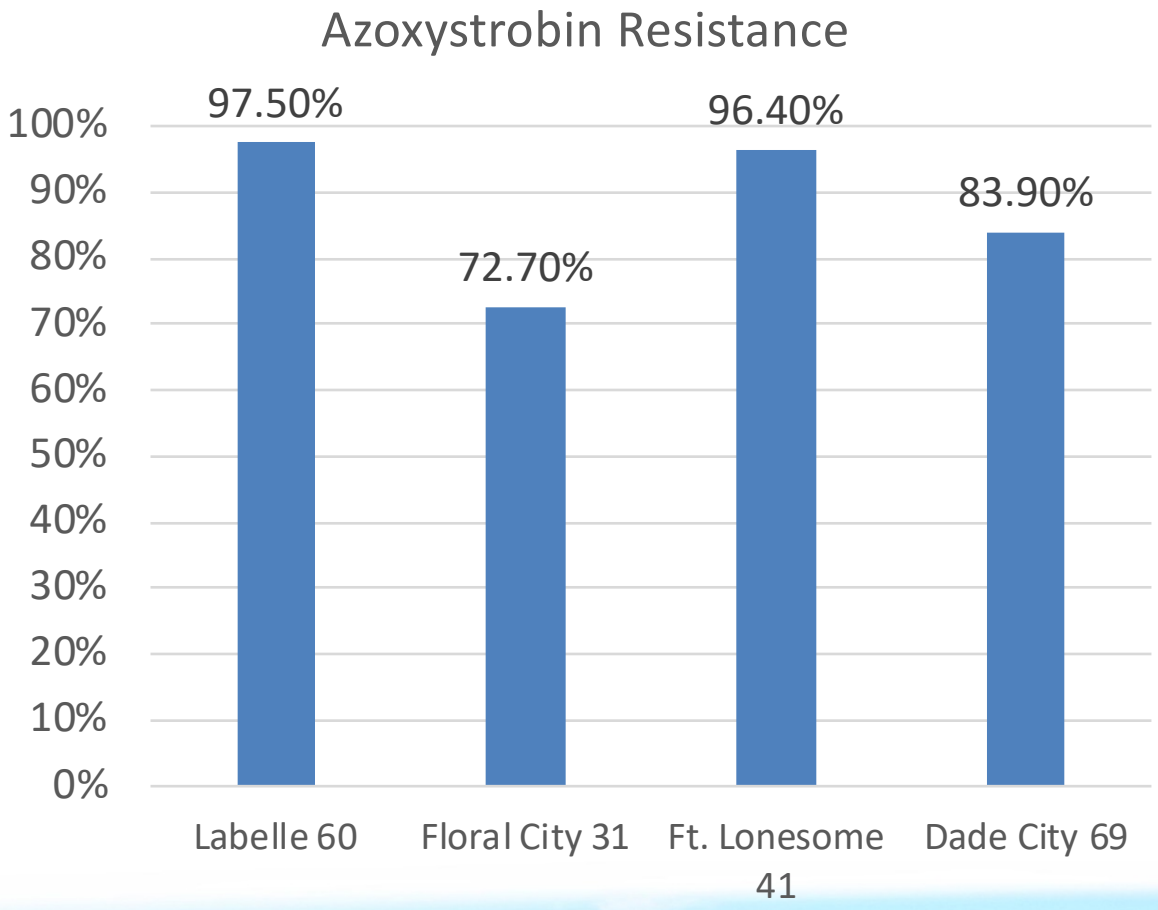




Overlapping colony morphology from berry, stem, and leaf.
Fungicide resistance to our best products

Anthracnose fruit rot

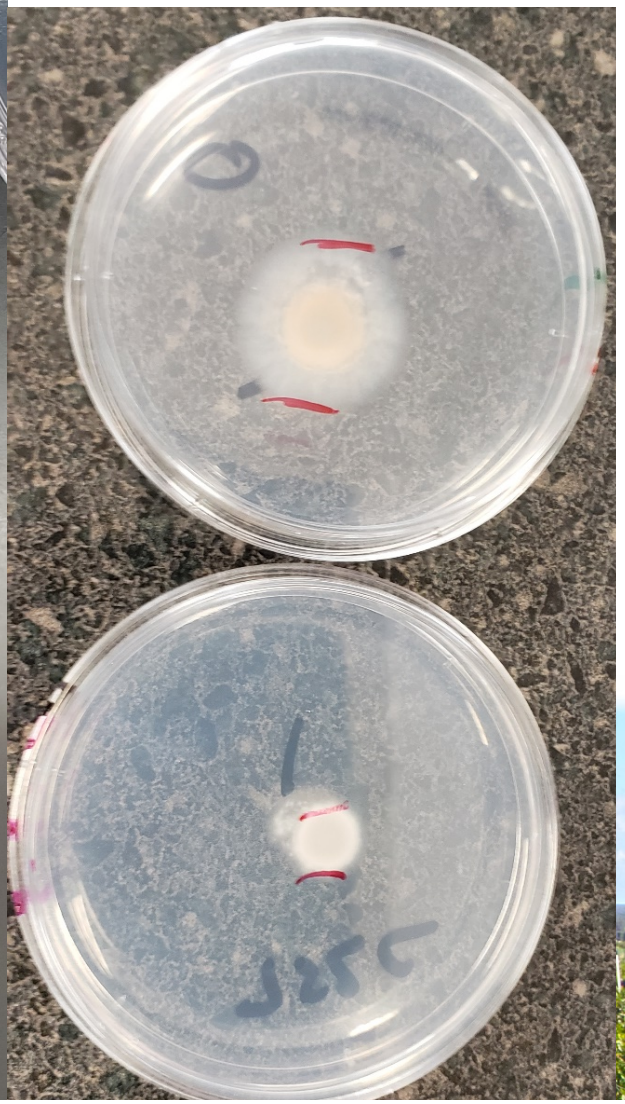
Known Resistance



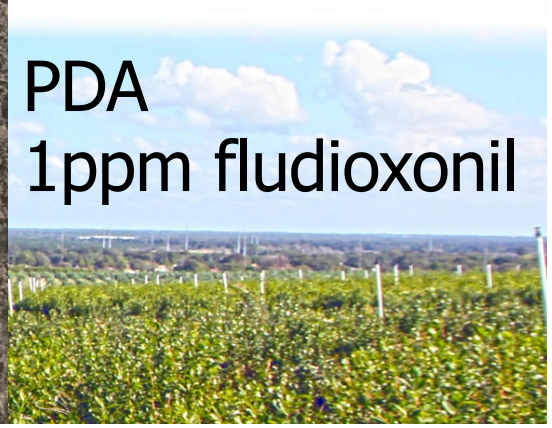
- Resistance
  - Abound (azoxy)
  - Miravis (pydiflum)
  - Pristine (boscalid)
- Sensitive
  - Switch (fludioxonil)
  - Omega (fluazinam)
  - Fontelis (penthiopy
  - Aprovia (benzovindi (lowbush only)

Resistance to fludioxonil (Switch)?

Isolate *Colletotrichum*

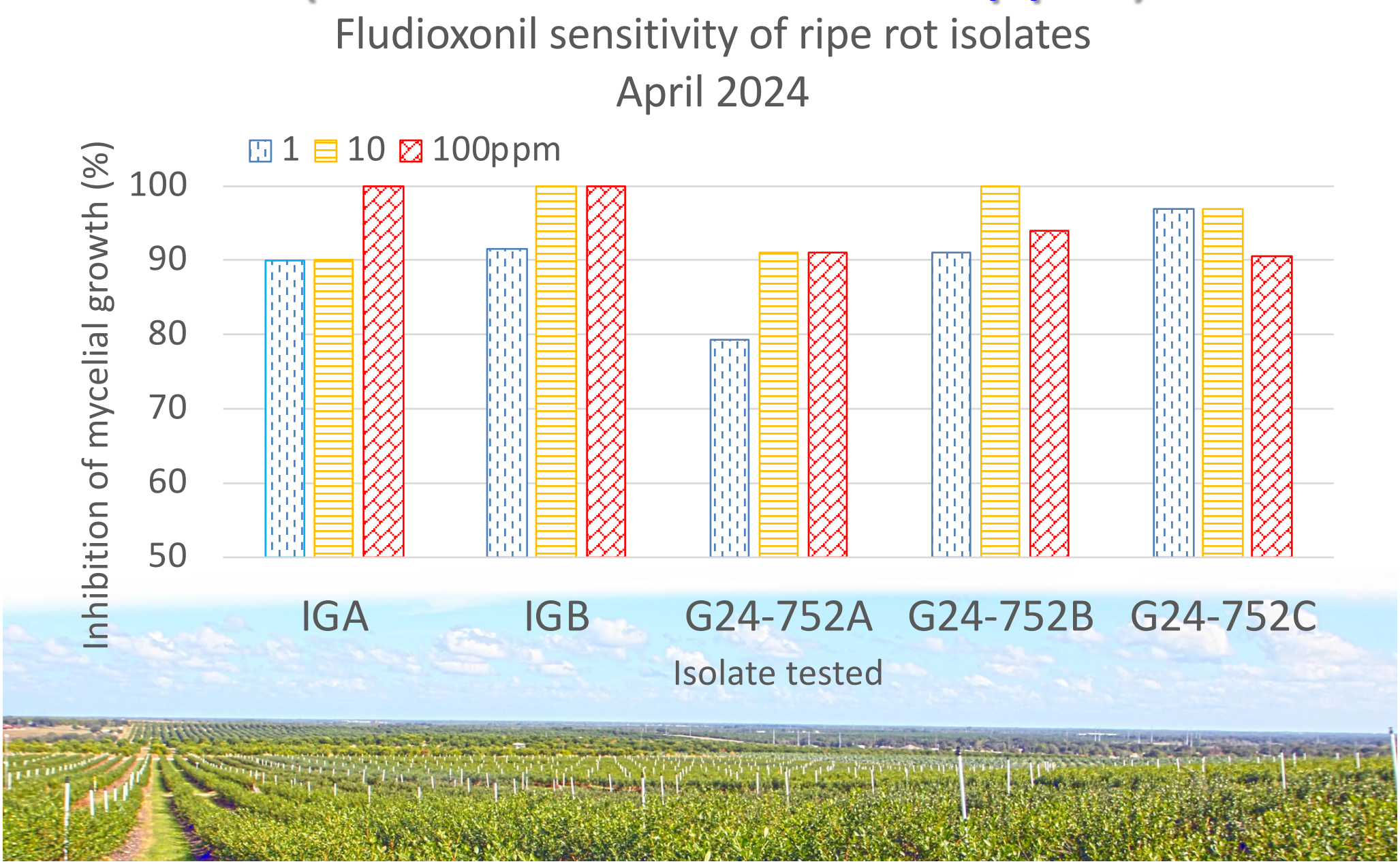


PDA



PDA
1ppm fludioxonil

Isolates were sensitive (>90% inhibition at 10ppm)



Resistance is a major concern!

Follow label instructions, do not overuse fludioxonil.

Fungicide resistance modes

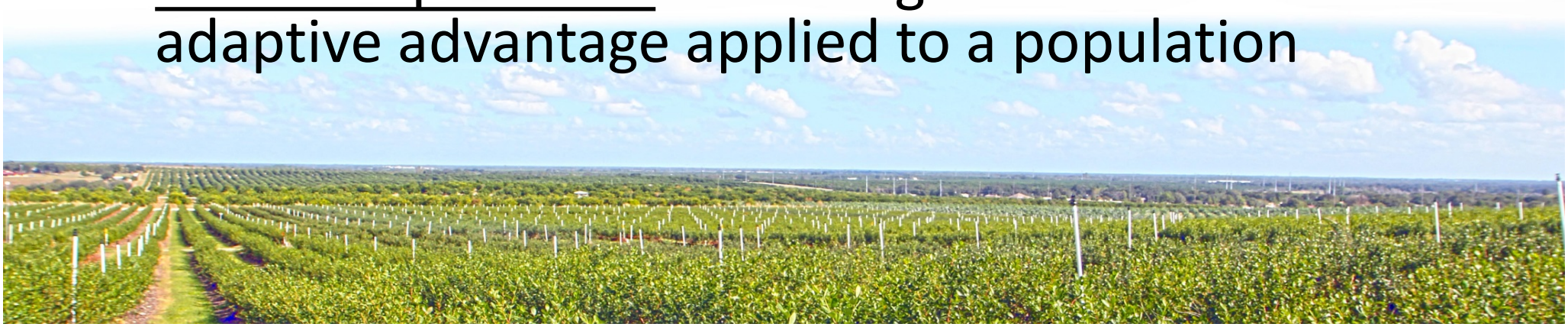
- modification of sensitive site
- exclusion of fungicide
- detoxifying the fungicide

Resistance Review

- **Risk factors for fungicide resistance**
  - # of site(s) of action in the targeted microbe
  - fitness of resistant mutants
  - use of repetitive or sustained fungicide treatments
  - extensive areas of use
  - population size and reproductive rate of target pathogen
  - lack of other types of fungicides or cultural controls
  - cross-resistance with existing fungicides (resistance to two or more fungicides mediated by the same genetic factor)

What is resistance?

- Fungicide no longer provides acceptable levels of disease control, because individuals in the pathogen population are not sensitive to the active ingredient
- Sensitivity is the quantifiable toxicity of an active ingredient on a fungus
- Selection is the increase in ratio of individuals in a population with an adaptive advantage to those without it
- Selection pressure is the magnitude of the adaptive advantage applied to a population



How does it occur?

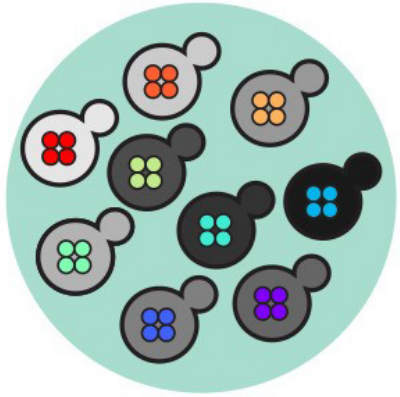
- Mutation is the ultimate source of variation in a population
  - Single site fungicides potentially affect one protein at one binding site defined by one codon
  - Mutation rates are low, but populations can be large
    - *Neurospora crassa* inositol requirement $8x10^{-8}$, Adenine requirement $4x10^{-8}$ per asexual spore
    - 6 out of every 100 million spores
- Resistance does not represent a pathogen's deliberate response to exposure to a fungicide
  - Fungicides do not cause changes in DNA sequence

When does it occur?

- Fungi differ in their likelihood of developing resistance
  - Large populations—prolific spore producers
  - Lower mutation rates? Higher resilience to mutation?
  - Few other sources of genetic variation—transposable elements, sex, etc.
- Persistent, strong, selection pressure applied to large diverse populations are more likely to result in resistance in a given amount of time

What types of resistance?

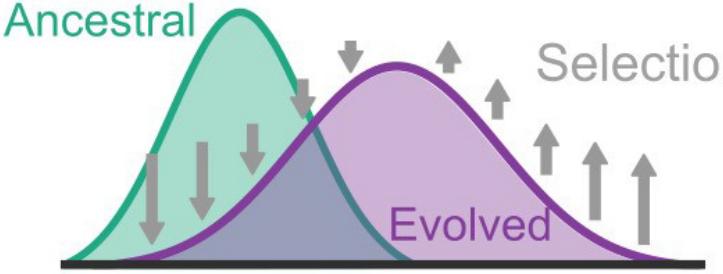
- Monogenic
  - Qualitative sensitivity distribution likely
  - Changes in the target site of the fungicide
- Polygenic
  - Quantitative sensitivity distribution likely
  - Changes in the ability of the fungus to limit accumulation of the active ingredient in fungal cells
    - Reduced uptake (polyoxin D)
    - Secretion (DMI)
    - Detoxification
    - Alternative pathways (alternative oxidase, QoI)

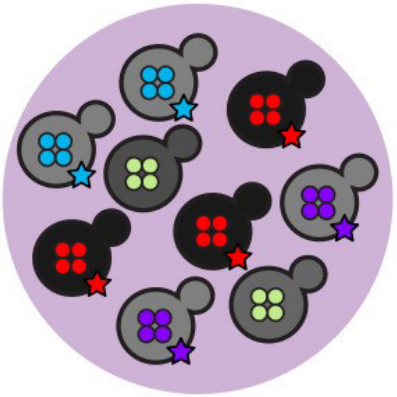


S. cerevisiae

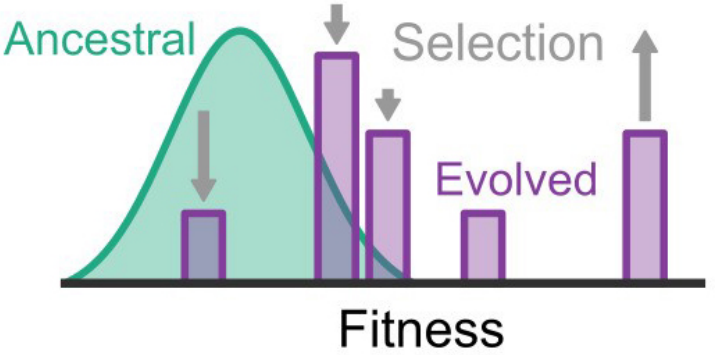
Antimicrobial drugs

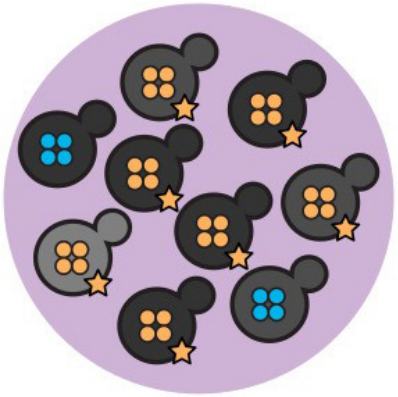
Many mutations of similar effect





Few strong-effect mutations





Fitness

low high

☆ Driver mutation

○ Passenger mutation

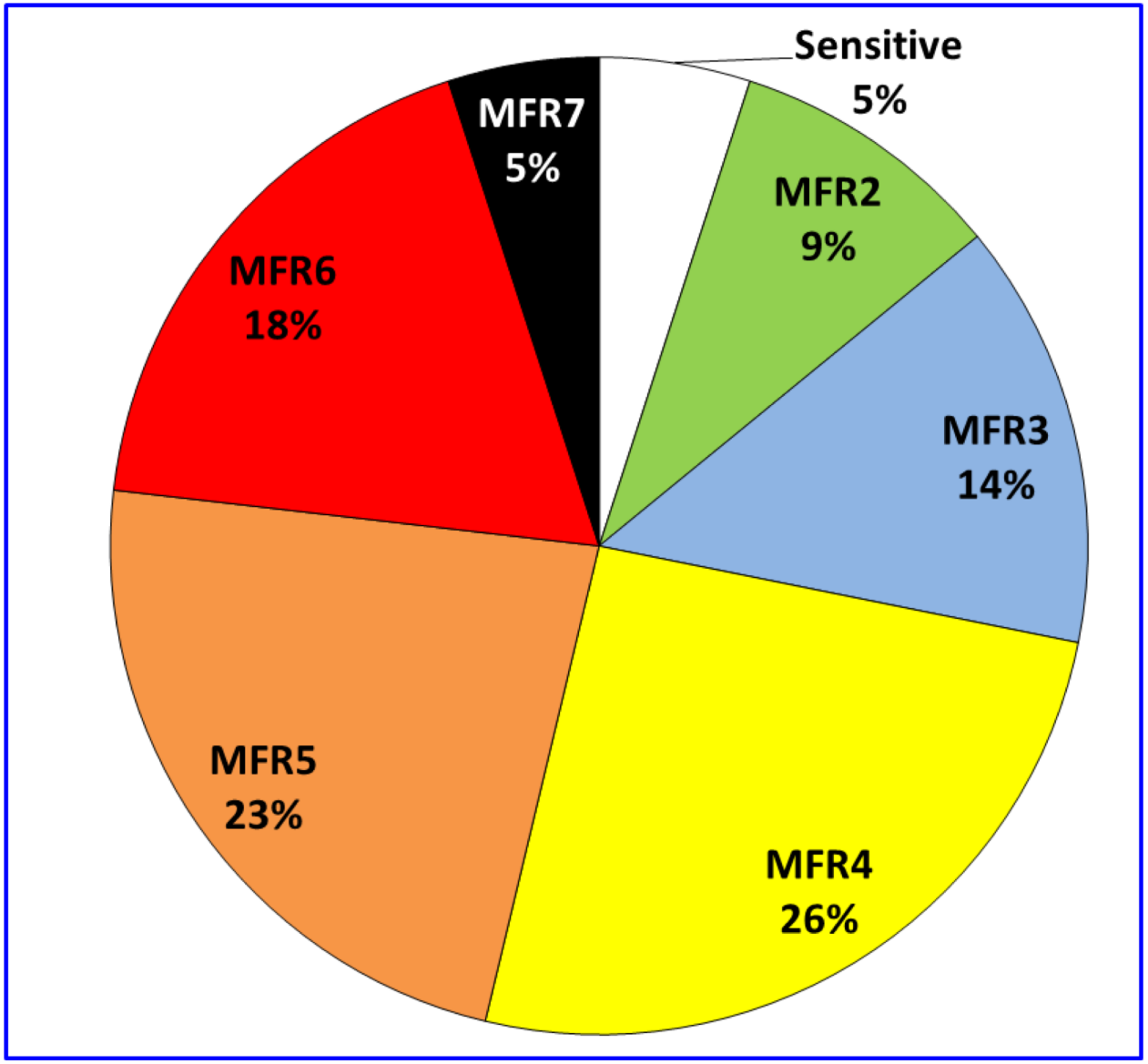
Multiple resistance

- Cross resistance
  - Resistance to multiple active ingredients in a MOA
- Multiple resistance
  - Resistance to multiple MOA groups

- Gray mold caused by *Botrytis*
  - Examples of isolates that are resistant to DMI, benzimadazoles, and 5 other MOA's exist!
- Ripe rot anthracnose caused by *Colletotrichum*


Botrytis blossom blight

Management at risk because of multiple resistance



Phenotype	Resistant to
MFR2	2 fungicides
MFR3	3 "
MFR4	4 "
MFR5	5 "
MFR6	6 "
MFR7	7 "

MFR = The same botrytis isolate may be resistant to 2, 3, 4 or more fungicides, simultaneously.

From Amiri, Harmon, & Peres. Winter BGA meeting, Plant City, FL, 02/20/14

Managing resistance

- Two strategies or goals for preventing resistant populations from becoming predominate
  - Keep population sizes small
  - Reduce selection pressure
- Recommendations
  - Employ nonchemical options of disease control
  - Apply fungicides preventatively
  - Use multi-site compounds as the first line of defense
  - Limit the use of site-specific actives
  - Use multi-site tank mix partners
  - Rotate or tank mix site-specific classes
  - Use the recommended rate

FBGA Research Priorities

- Committee of FBGA Board Members
  - Charge is to formalize a list of prioritized research needs for the Florida Blueberry Industry
  - A draft list of topics has been put together with Board of Directors' input
  - We'd like to get your input!
  - What are the most important research needs for your farm?

FBGA Research Priorities

- Breeding-Cultivar development, improvement
  - Increase yield, firmness, pest and disease resistance, flavor, machine harvestability
- Entomology-Control measure development for:
  - Chili thrips, mites, gall midge, diaprepes
  - Rankings of varieties for tolerance to pests
  - Spray timing, rotations, rates, economic returns
- Nematology-investigate replant disorder
  - Survey, fumigation work
- Weeds-Additional control options for:
  - Sedge, perennial grasses, QuinStar safety for FL
  - Plant safety, specifically when carrying fruit
  - Evaluate combinations, reduce PHI's for glufosinate, organic options
- Pathology-Control options for:
  - Rust, root rot, stem blight, anthracnose, bacterial wilt
  - Refine effectiveness ratings, economic return studies
  - Overhead vs drip irrigation impacts on disease
  - Methods to limit spread of pathogns to limit risk, sanitation efforts
  - Root girdling, sucker removal, stem blight

FBGA Research Priorities

Continued

- Horticultural practices-
  - Variety specific pruning practice effects on yield for machine harvesting
  - Renewal pruning practices vs renovation, economic thresholds for evergreen and deciduous
  - Plant spacing and density multi-year multi variety research
  - Precocious varieties recommendations to maximize yr1 yield, crop insurance implications
  - Phosphorous and other nutrient management impact on fruit quality and yield
  - Nitrogen needs for crop production leading to and through harvest, crop load impacts, slow release tech
  - Fruit drop, red cap, pollination, fert impacts on fruit abortion (Sentinel, Meadowlark, Optimus)
  - Mechanization, fruit toughening practices, new harvest tech
  - Pine bark alternatives, coco,
  - Low temp impact and damage studies at different floral and fruit development stages (water conservation)
- Pollination
  - Flower visitation studies with yield prediction by AI to promote market stability
  - Cross pollination partners, interplant density requirements

Any Questions?

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