

Cherry Leaf Spot Management in the Age of Resistance

A photograph of a cherry orchard. The trees are arranged in neat rows, extending from the foreground into the distance. The ground is covered in green grass. In the background, there is a dense line of green trees. The sky is a clear, bright blue.

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Tree Fruit Pathology**

Cherry Leaf Spot

Blumeriella jaapii

- Most important disease affecting tart cherry production in the Great Lakes region
- Causes leaf infections that lead to heavy defoliation
- Early defoliation (prior to harvest)
 - Causes uneven ripening and yield loss
- Defoliation before September
 - Affects the ability of the tree to overwinter
 - Poor fruit set or death the following year



CLS Chemical Management in 2000

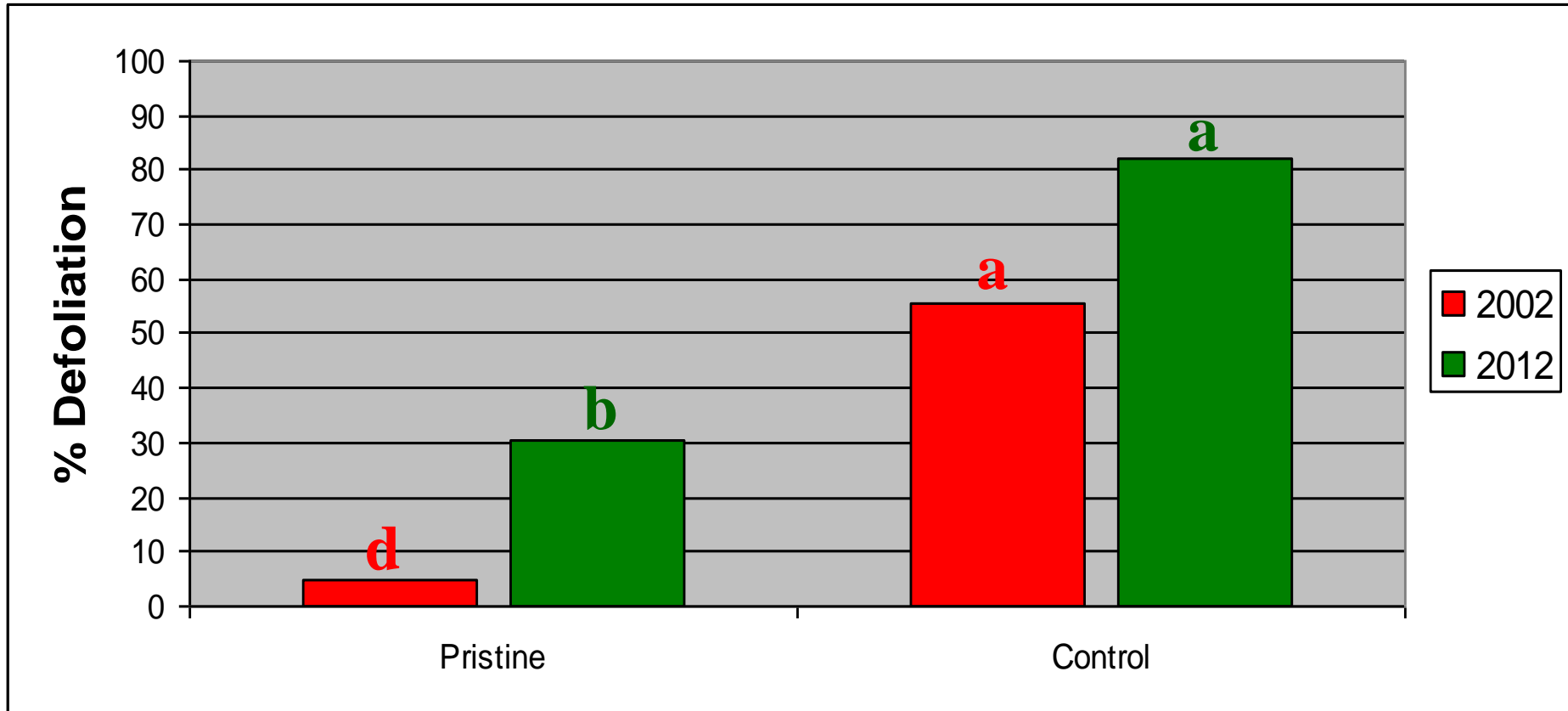
- DMI's first used in Michigan in 1987
- Control failure observed in commercial orchards in 2002
- Associated with over expression of CYP51 gene
- Loss of DMIs as an effective control for cherry leaf spot

Fungicide	Class	Efficacy
Bravo	Chlorothalonil	Excellent
Rally	DMI	Fair
Orbit	DMI	Poor/fair
Elite	DMI	Fair
Rubigan	DMI	Fair
Indar	DMI	Fair
Pristine	SDHI and QoI	Excellent
Gem	QoI	Excellent
Syllit	Dodine	Excellent
Copper	Multi-site	Excellent
Captan	Multi-site	Excellent

Pristine Fungicide (BASF)

- A premix of a succinate dehydrogenase inhibitor (Boscalid) and a QoI/Strobilurin (pyraclostrobin)
- Two unique modes of action
 - **SDHI (Boscalid)**
 - Inhibits respiration at complex II in the mitochondrial respiratory chain
 - Strobilurin
 - Inhibits respiration at complex III in the mitochondrial respiratory chain

Pristine Field Trials at NWMHRC



First two applications are Bravo Weather Stik, 4 pts

2010 and 2011 *B. jaapii* Isolates

Non-treated trees in Ohio 2010

44 isolates, 2 orchards

2011

9 isolates, 1 orchard

Grand total of
1,346
isolates

2010

276 isolates, 20 orchards

2011

762 isolates, 18 orchards

2010

47 isolates, 1 orchard

2011

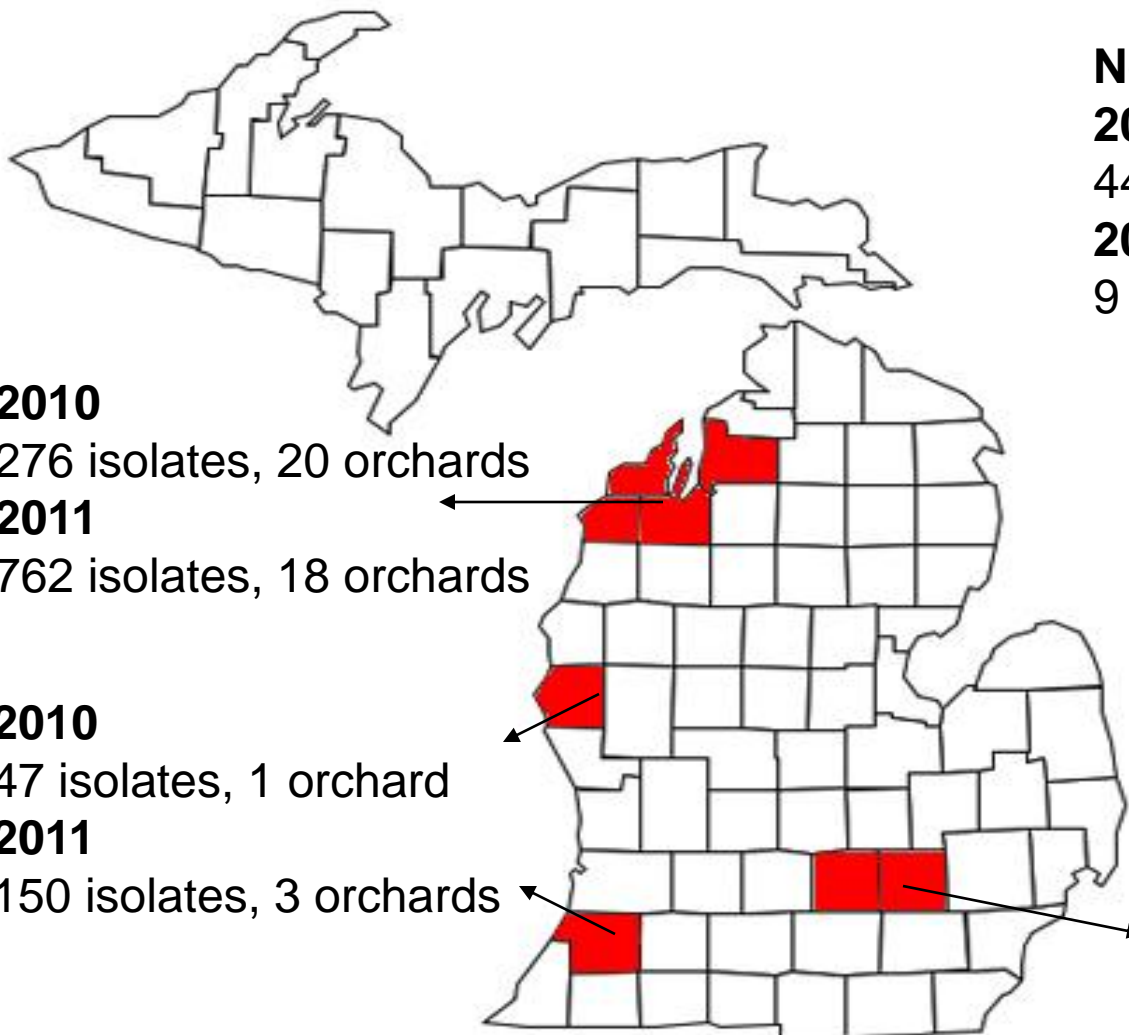
150 isolates, 3 orchards

2010

0 isolates, 0 orchards

2011

58 isolates, 4 orchards



Sensitive

MMEA Control

0.1 $\mu\text{g/ml}$

0.5 $\mu\text{g/ml}$

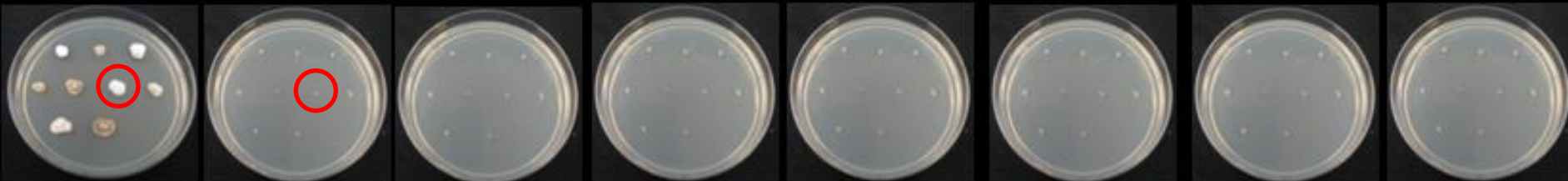
1 $\mu\text{g/ml}$

2.5 $\mu\text{g/ml}$

5 $\mu\text{g/ml}$

10 $\mu\text{g/ml}$

25 $\mu\text{g/ml}$



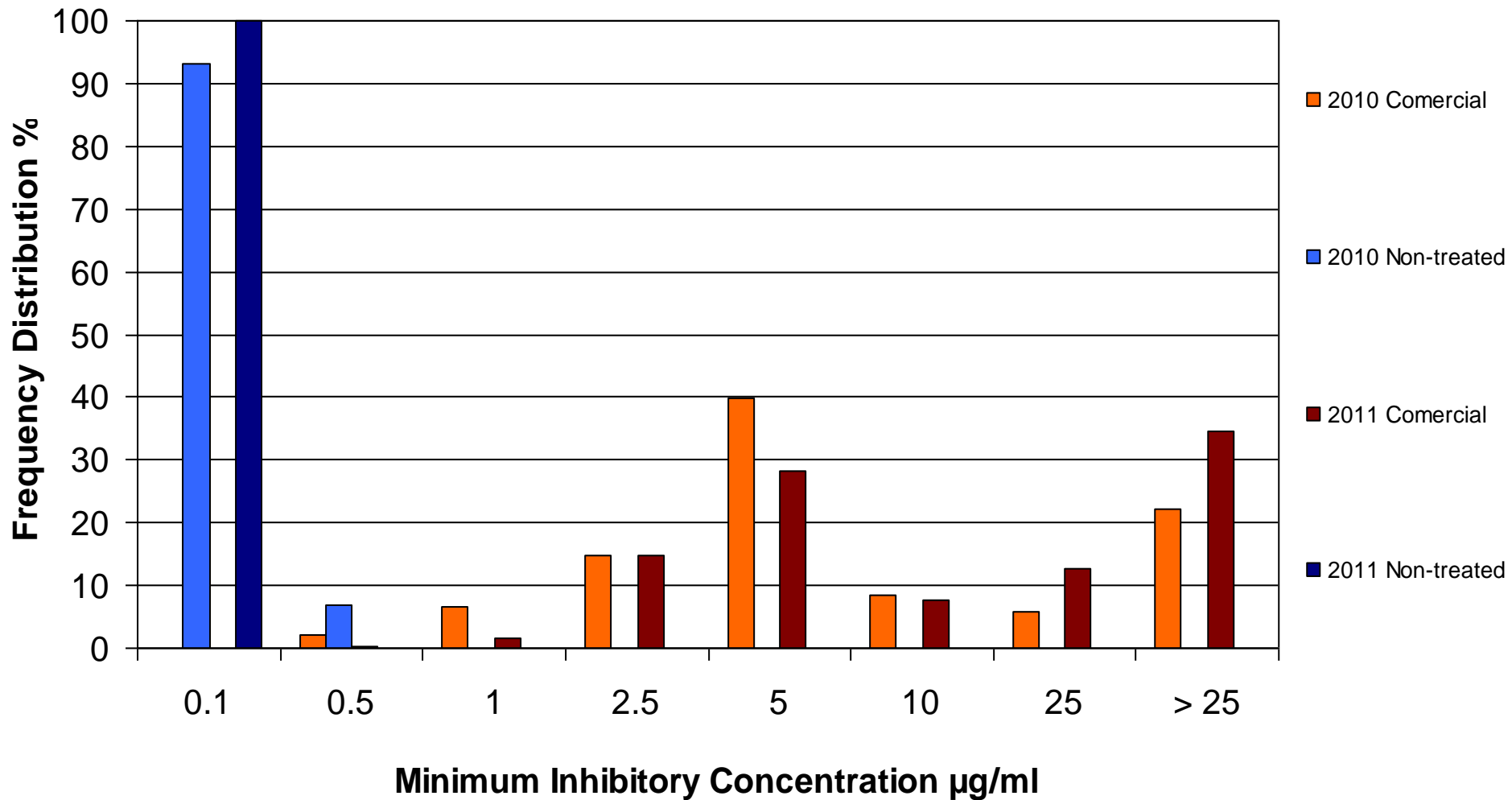
Reduced Sensitivity



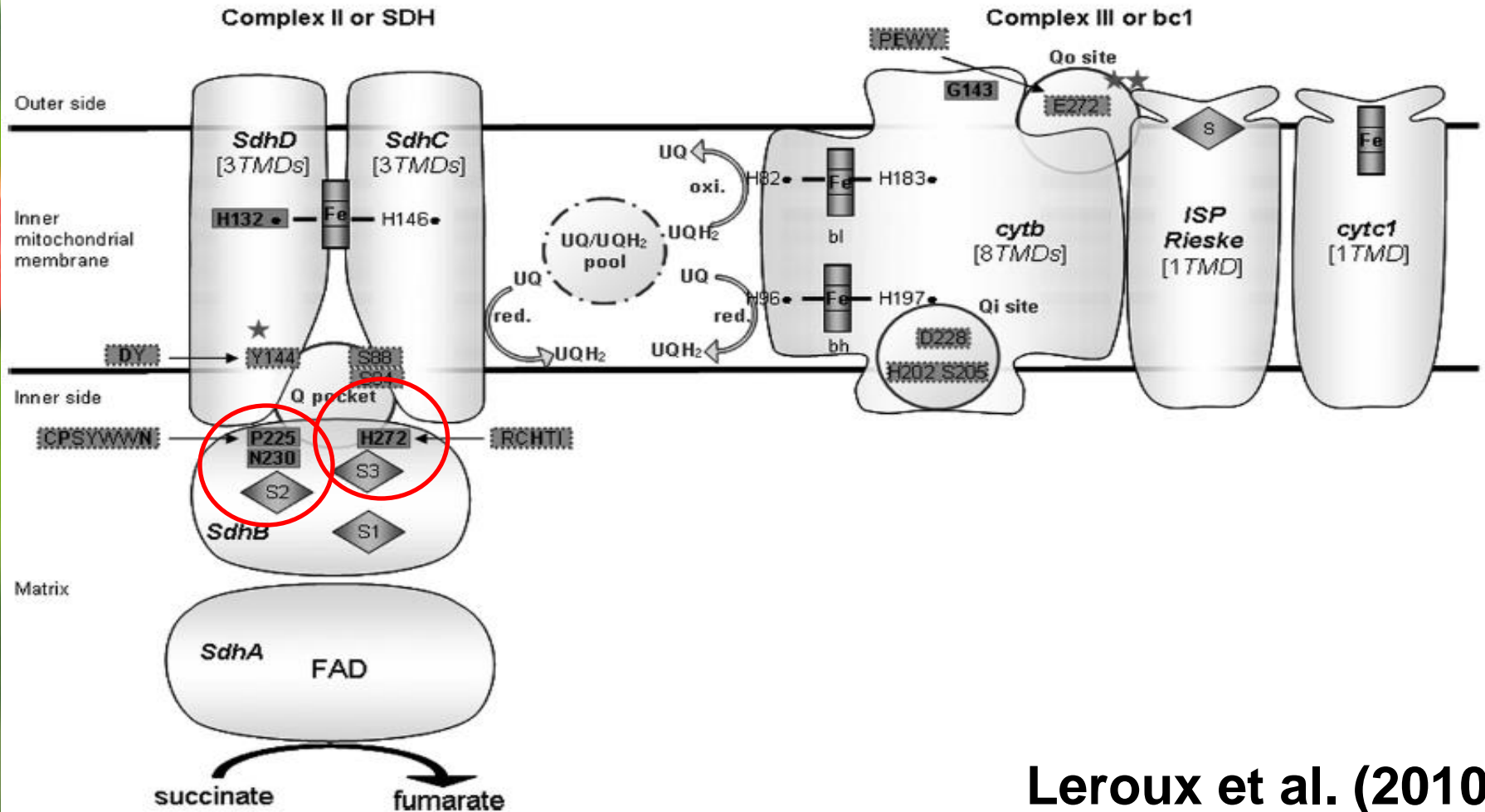
Resistant



Boscalid Sensitivity 2010-2011



SDHI Mode of Action



Leroux et al. (2010)

Alignment of Deduced Amino Acid Sequences

Second cysteine-rich cluster

Sensitive (ECILCACCSTSC**P**SYWWNSEEYLGPVLMQSYRWLAD)

Reduced Sensitive (ECILCACCSTSC**P**SYWWNSEEYLGPVLMQSYRWLAD)

Resistant (ECILCACCSTSC**P**SYWWNSEEYLGPVLMQSYRWLAD)

Third cysteine-rich cluster

Sensitive (SRDQKKEERKAALDNSMSVYRC**H**TILNCSRTC**P**KGLNP)

Reduced Sensitive (SRDQKKEERKAALDNSMSVYRC**H**TILNCSRTC**P**KGLNP)

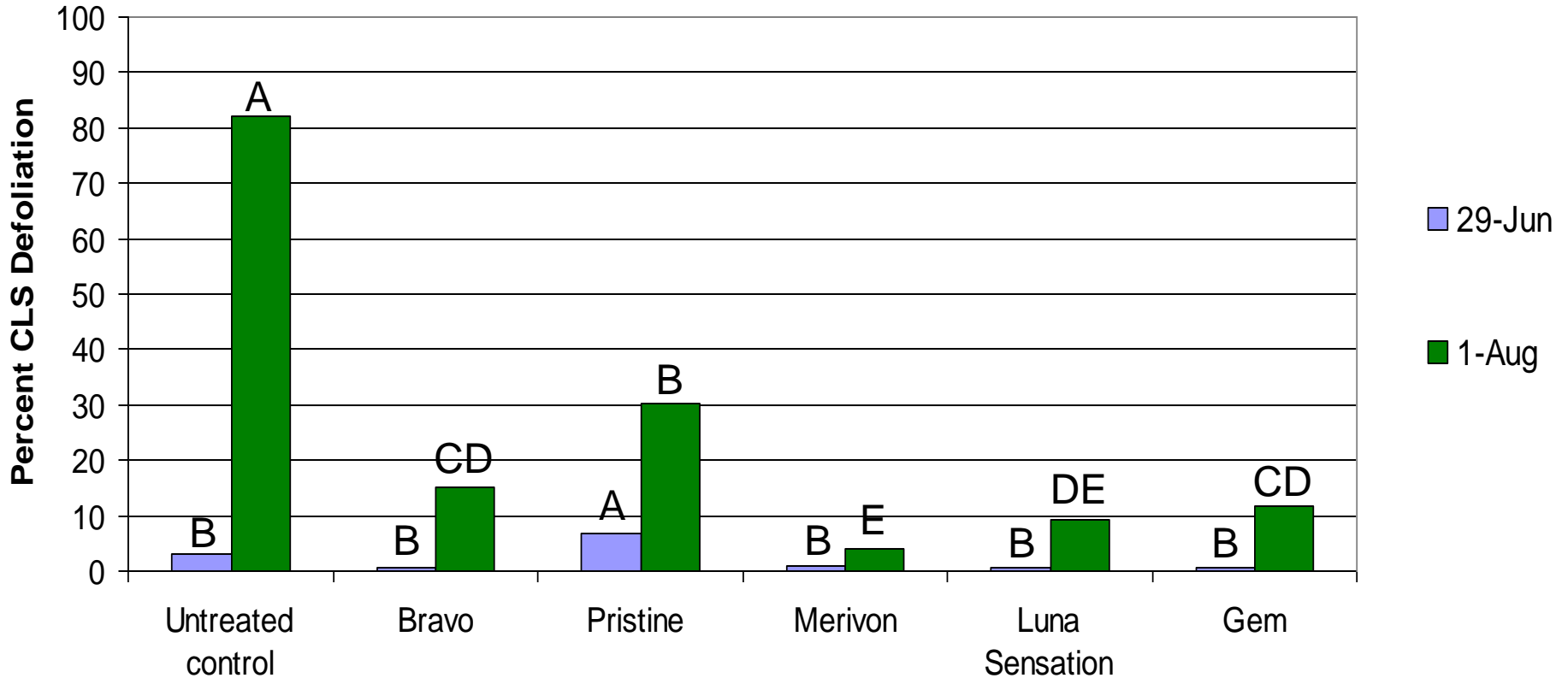
Resistant (SRDQKKEERKAALDNSMSVYRC**R**TILNCSRTC**P**KGLNP)

Isolate	Boscalid Phenotype	Codon in <i>SDHB</i> Sequence	Amino Acid Residue
11PEBJ-1	S	CAC	H (Histidine)
11PEBJ-3	S	CAC	H
11PEBJ-4	S	CAC	H
11PEBJ-9	S	CAC	H
11PEBJ-11	S	CAC	H
11LIBJMR-1	S	CAC	H
11LIBJMR-3	S	CAC	H
11LIBJMR-4	S	CAC	H
11LIBJMR-5	S	CAC	H
11LIBJMR-6	S	CAC	H
11LIBJMR-7	S	CAC	H
11LIBJMR-8	S	CAC	H
11LIBJMR-9	S	CAC	H
10BLGO-2	RS	CAC	H
10BOGW-24	RS	CAC	H
10BOW-1	RS	CAC	H
10BWPB-24	RS	CAC	H
10BWPB-29	RS	CAC	H
10BOW-1	RS	CAC	H
10BOW-3	RS	CAC	H
10BOW-4	RS	CAC	H
10BOW-9	RS	CAC	H
10BOW-12	RS	CAC	H
10BWPB-21	R	CGC	R (Arginine)
10BWPB-22	R	CGC	R
10BWPB-25	R	CGC	R
10BWPB-27	R	CGC	R
10BWPB-30	R	CGC	R
10BOW-5	R	CGC	R
10BOW-14	R	CGC	R
10BOW-15	R	CGC	R
10BOW-16	R	CGC	R
10BOW-17	R	CGC	R

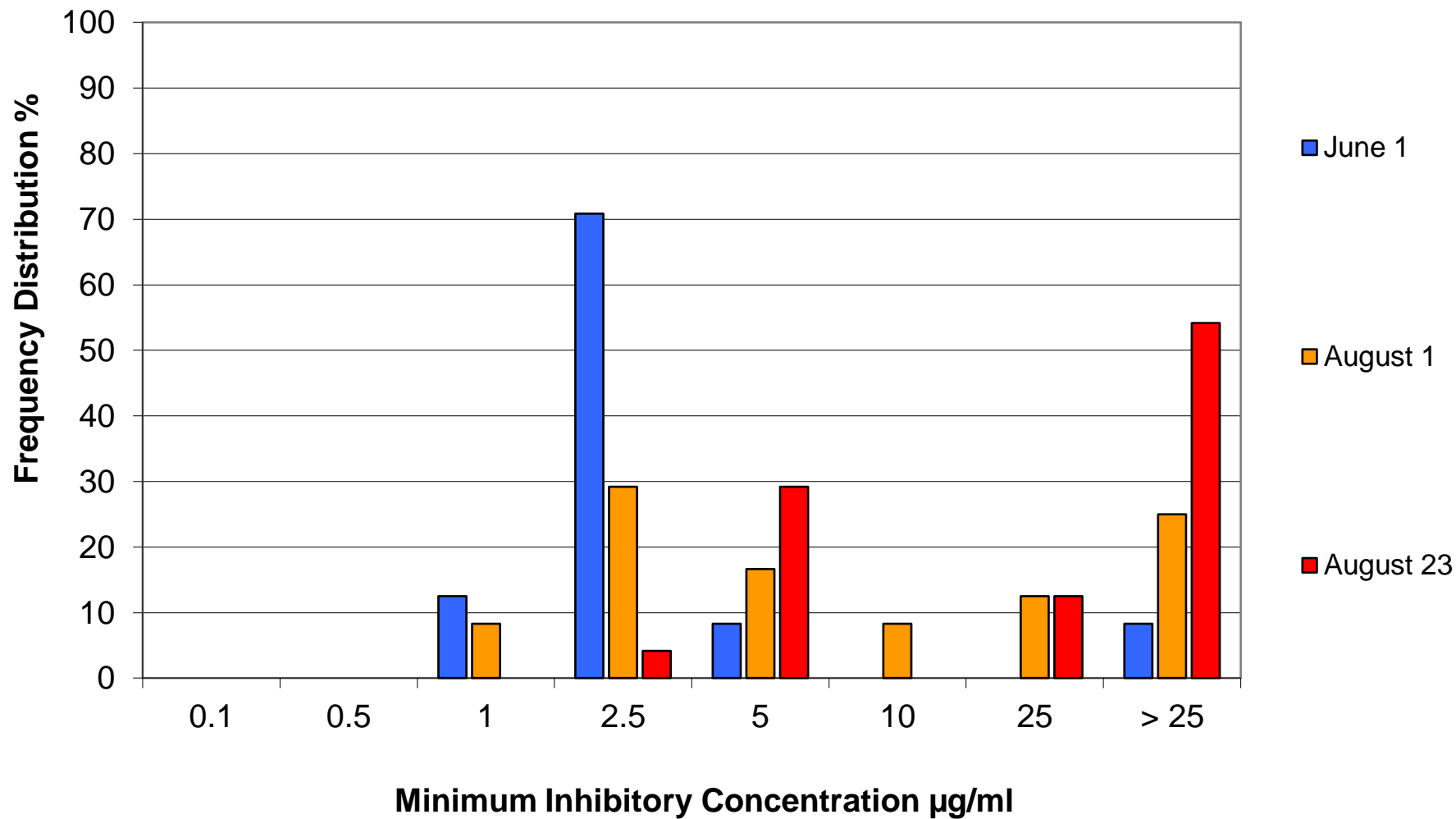
Next Generation SDHIs

- **Introduction of new SDHI fungicides**
 - Fluopyram
 - Fluxapyroxad
- **Have the same mode of action as boscalid**
 - Target complex II of the fungal respiration pathway
- **CLS management utilizing new SDHIs**
 - **Luna Sensation** (Bayer)
 - Premix of fluopyram and trifloxystrobin
 - **Merivon** (BASF)
 - Premix of fluxapyroxad and pyraclostrobin

2012 CLS Fungicide Efficacy Field Trial Data



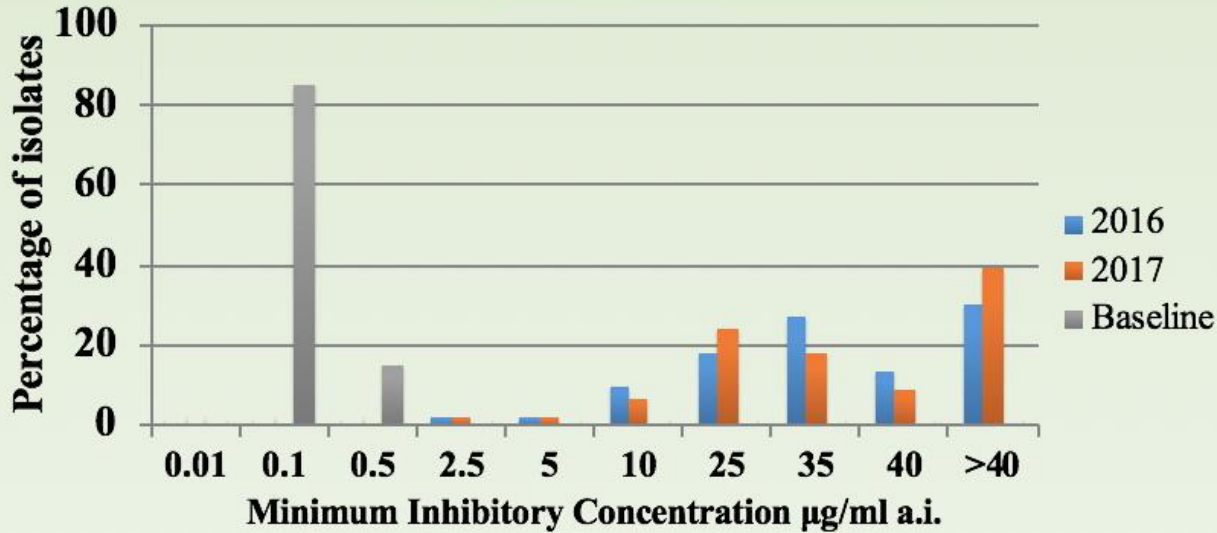
Boscalid Sensitivity for Pristine Treatments



Fast forward four years

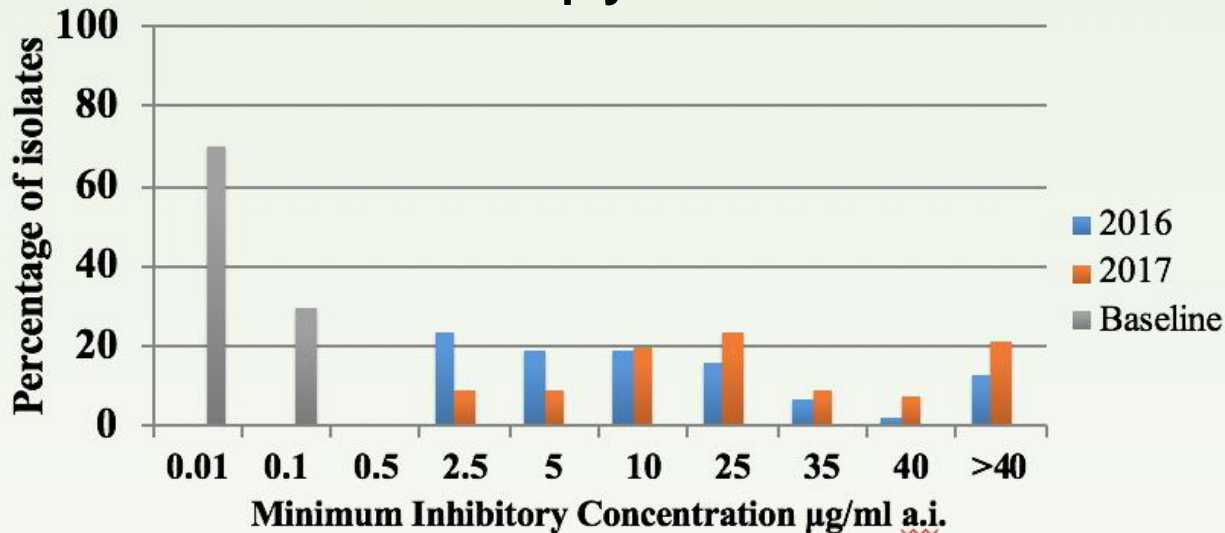
- Merivon and Luna Sensation are widely used by growers for CLS and brown rot control
- Control failures have been reported by numerous growers
- Statewide sensitivity survey was conducted during 2016-2017

Fluopyram



~ 65% resistance, both years
Increasing top end

Fluxapyroxad



~ 17% resistance, 2016
~ 30% resistance, 2017

2018 SDHI Sensitivity Screening

- **32 orchards sampled from new locations**
 - Sampled from sites not in the vicinity of previously sampled orchards
- ***B. jaapii* isolates screened for sensitivity to fluopyram and fluxapyroxad**
 - 2.5 and 35 ppm fungicide concentrations
- **Sensitive** – no growth at 2.5 ppm
- **Shifted** – growth at 2.5 but not at 35 ppm
- **Resistant** – growth at 35 ppm

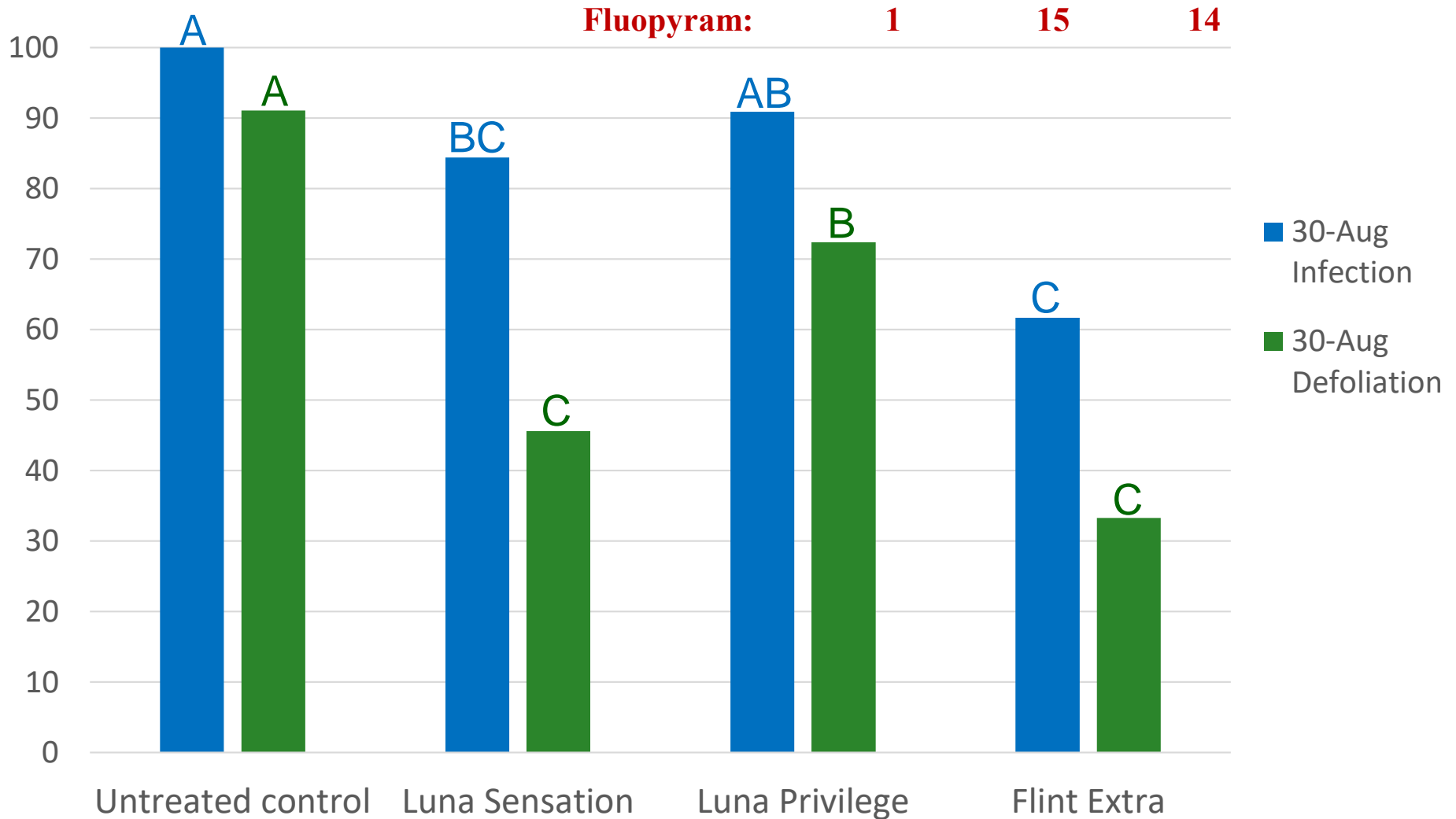
2018 population at the NWMHRC fungicide efficacy test site

- 30 isolates – obtained from unsprayed control trees

	Number of isolates		
	Sensitive	Shifted	Resistant
<u>Fluopyram</u>	1	15	14
<u>Fluxapyroxad</u>	5	25	0

2018 NWMHRC fungicide efficacy trial

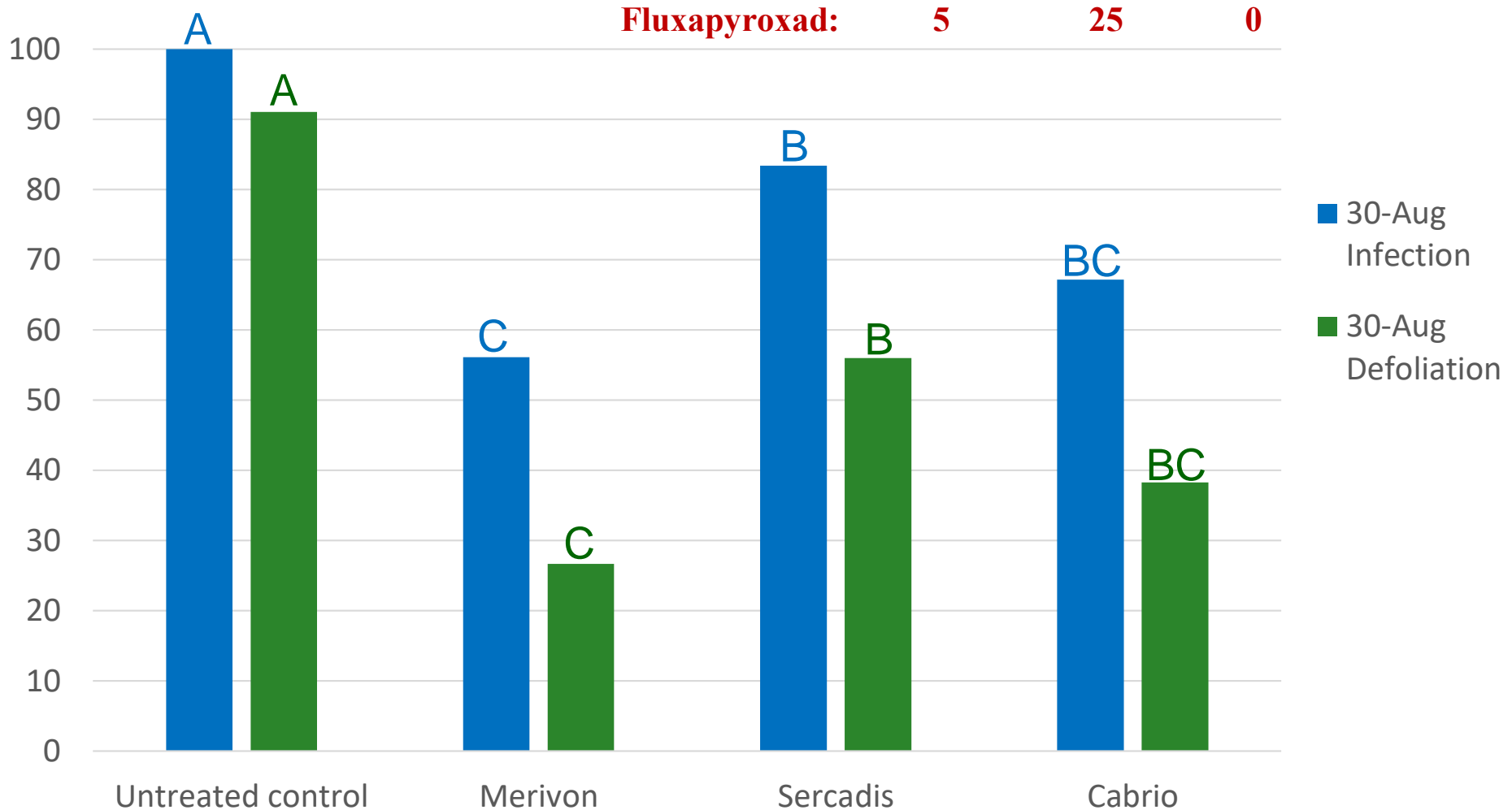
Luna Sensation (fluopyram)



First two applications are Bravo Weather Stik, 4 pts

2018 NWMHRC fungicide efficacy trial

Merivon (fluxapyroxad)



First two applications are Bravo Weather Stik, 4 pts

2018 SDHI Resistance Screening NW MI

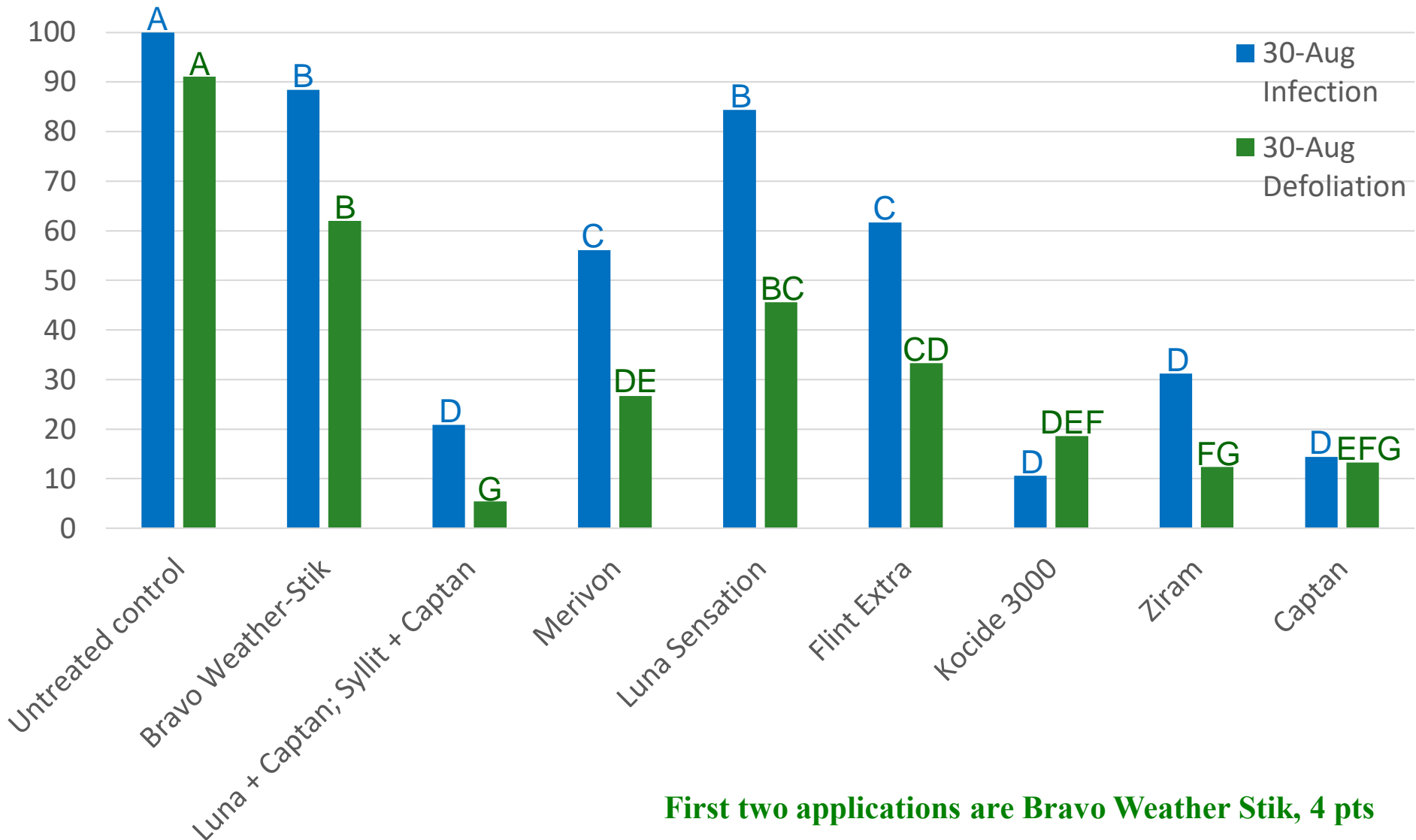
	FLUOPYRAM (# isol.)			FLUXAPYROXAD (# isol.)		
	Sensitive	Shifted	Resistant	Sensitive	Shifted	Resistant
1	0	15	5	9	11	0
2	0	13	7	9	11	0
3	6	14	0	18	2	0
4	0	9	11	7	13	0
5	0	5	19	4	20	0
6	0	13	7	11	8	1
7	0	17	3	13	6	1
8	0	8	12	3	17	0
9	4	13	3	11	7	2
10	10	7	3	7	11	2
11	0	14	6	14	6	0
NWMHRC	1	15	14	5	25	0

2018 SDHI Resistance Screening West Central MI

	FLUOPYRAM (# isol.)			FLUXAPYROXAD (# isol.)		
	Sensitive	Shifted	Resistant	Sensitive	Shifted	Resistant
1	10	7	5	9	11	1
2	0	17	0	4	13	0
3	0	15	5	3	17	0
4	0	8	12	0	19	1
5	0	16	4	0	19	1
6	0	11	9	6	14	0
7	0	7	19	0	25	1
8	0	14	13	5	21	1
9	0	1	27	0	25	3
10	0	7	23	4	12	14
NWMHRC	1	15	14	5	25	0

Strategies for CLS management

2018 NWMHRC efficacy trial



SDHI fungicides and *B. jaapii* in Michigan

- Fluopyram
 - Resistance appears to be developing quicker
 - ~40 to 60% of MI isolates are resistant
- Fluxapyroxad
 - ~10 to 30% of MI isolates are resistant
 - Merivon should still be effective in most orchards
- Tank mixing with **Captan** for both fungicides is essential
- Use of protectants such as **Bravo**, **Ziram** and **copper** as primary control may have to play a bigger role

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AgBioResearch


Project GREEN

