CLEMSON
College of AGRICULTURE, FORESTRY AND LIFE SCIENCES

CHEMICAL AND BIOLOGICAL CONTROL OF PEACH BACTERIAL SPOT IN THE SOUTHEAST

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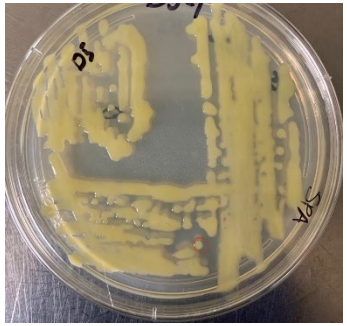
Bacterial spot / Bacteriosis

Xanthomonas arboricola* pv. *pruni



March

May

July

July

Bacterial spot

Chemical burns

Factors contributing to Bacterial spot

- Warm and humid climate, especially wet springs
  - Fruit are most susceptible between "petal fall" to "pit hardening"

Infected **BEFORE** pit-hardening

Infected **AFTER** pit-hardening

Factors contributing to Bacterial spot

- Warm and humid climate, especially wet springs
  - Fruit are most susceptible between "petal fall" to "pit hardening"
- Sandy soil
  - Wounds caused by wind-blown sand facilitates the bacteria infection
- Stressed trees
  - Trees with poor vigor and other disease pressure are more susceptible

Integrated Disease Management

- Dise
  - C
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  - V
- Cultu
  - G
  - P
  - M
  - D
    h
- Cher
  - C
  - Oxytetracycline

se

d

l spot

Integrated Disease Management

- Disease tolerant cultivars
  - Current tolerant cultivars still show symptoms at high disease pressure
  - Waiting for new tolerant varieties with desirable fruit traits
- Cultural practices
  - Ground covers and wind breakers to reduce wind-blown sand
  - Prune off spring cankers
  - Minimize other tree stresses
  - Do not plant susceptible cultivars by trees with bad bacterial spot history
- Chemical control
  - Copper products
  - Oxytetracycline

Copper products

Hydrated Copper
-Synonym Bluestone Copper
-Fast release copper

MASTERCOP

Magna-Bon
AGRICULTURAL CONTROL SOLUTIONS

CUPROFIX™ DISPERSS™
DRY FLOWABLE FUNGICIDE/BACTERICIDE FOR AGRICULTURAL USE

Fixed Copper
-less soluble than hydrated (bluestone) copper
-Slow release copper (less phytotoxicity)
-do not mix with phosphonates (decreases pH and increases phytotoxicity)

Copper Oxychloride
Basic Copper Sulfate

Copper diammonia
Diacetate Complex

Copper-Count®-N
Liquid Fungicide Spray

Copper Hydroxide

Kocide® 2000
FUNGICIDE/BACTERICIDE
Kocide® 3000
FUNGICIDE/BACTERICIDE

Copper Octanoate

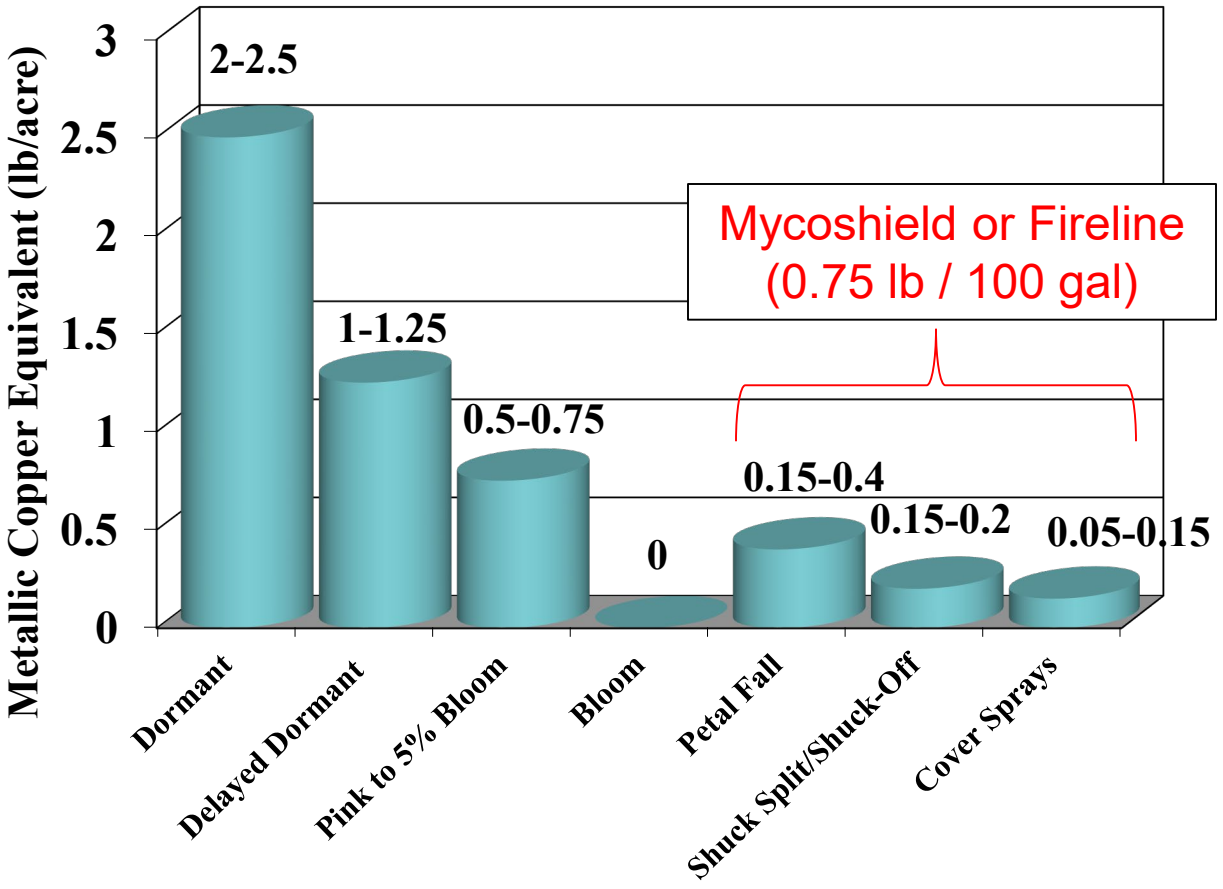
Cueva
FLOWABLE LIQUID COPPER FUNGICIDE

Cuprous Oxide

Copper Oxychloride
Copper Hydroxide

Badge SC

2021 SE Peach Spray Guide



https://secure.caes.uga.edu/extension/publications/files/pdf/B%201171_14.PDF

Limitations of chemical controls

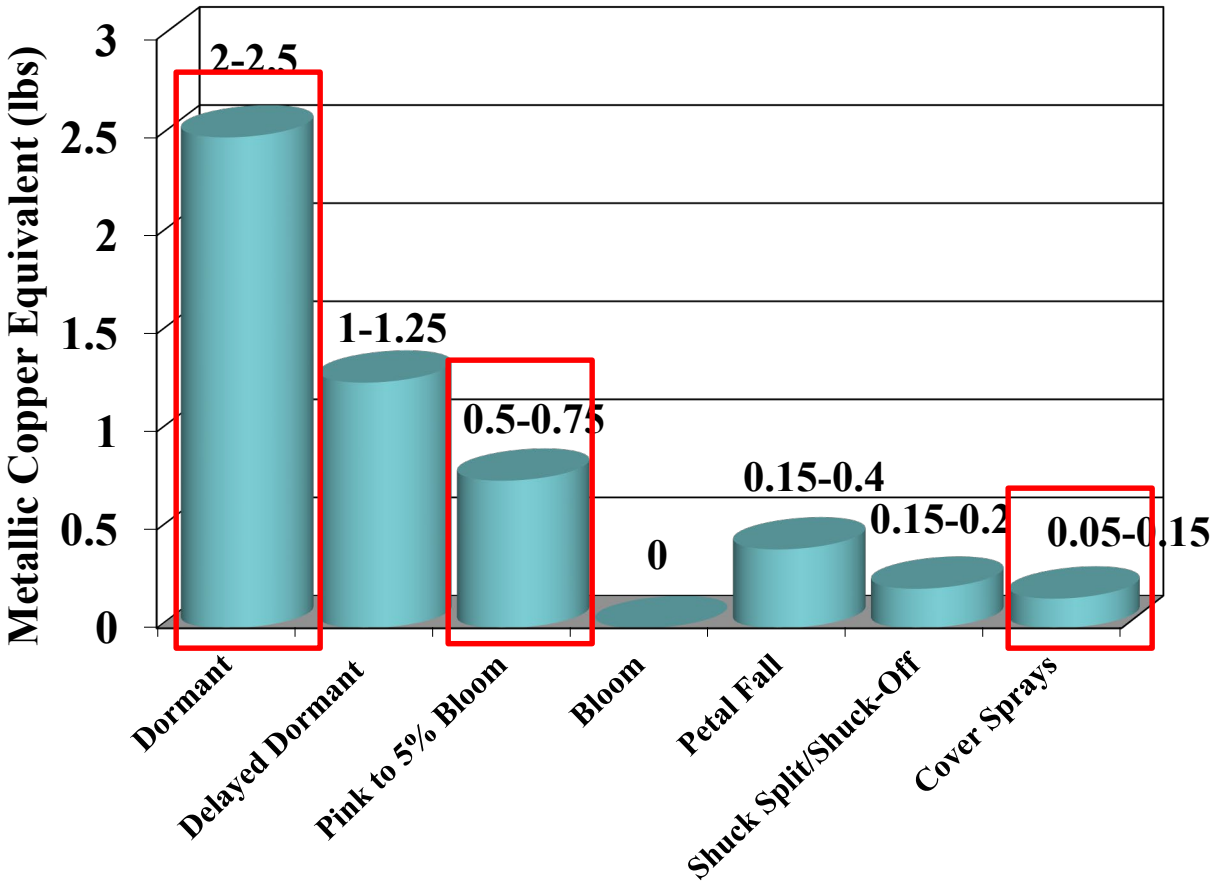
- Can not stop disease
  - Can only serve as protectant to prevent or postpone infection
- Copper phytotoxicity
  - Could cause defoliation and reduce tree performance
- Oxytetracycline has short control window
  - Degraded in 2 sunny days
  - Best to spray within 24 h before rain
  - Do not use within 21 days of harvest.
- Chemical resistance/tolerance

Chemical resistance in SC peach orchards

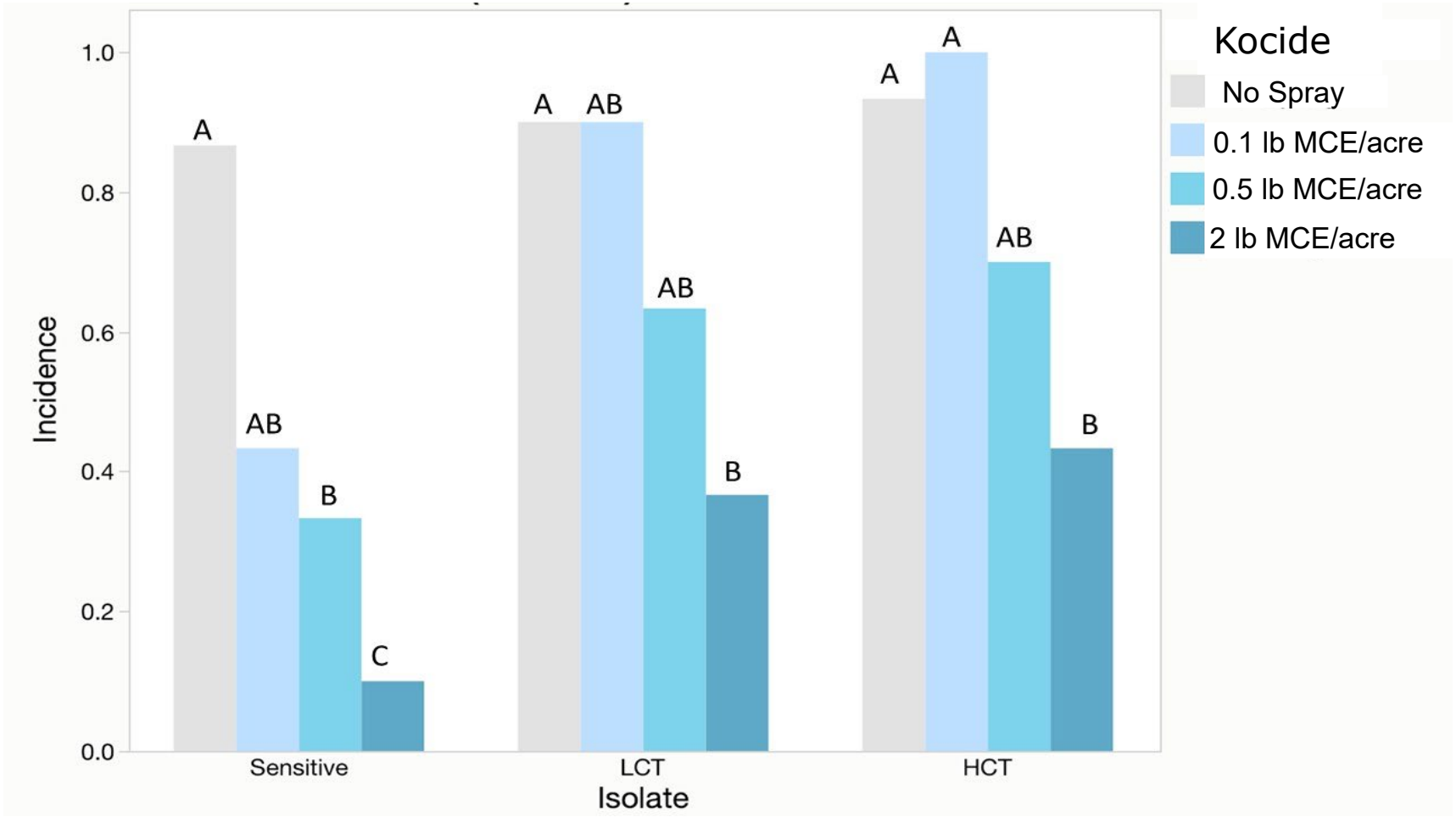
- **OxyR**: growth on media with 25-100 ppm of oxytetracycline
- **High Copper Tolerant (HCT):** growth on media with up to 200 ppm of CuSO4·5H2O
- **Low Copper Tolerant (LCT):** growth on media with up to 150 ppm of CuSO4·5H2O
- **Sensitive:** no growth on media with 150 ppm of CuSO4·5H2O or 25 ppm of oxytetracycline

Phenotypes	% of bacteria isolates	
	2017-2019	2020
OxyR	2.0	3.3
HCT	4.4	1.6
LCT	25.3	88.5
Sensitive	70.3	9.8
# of isolates	344	61

2021 SE Peach Spray Guide



Impact of copper tolerance on disease control



Cox et al. 2020

Copper tolerant bacteria could impact our ability to control bacterial spot

Trial 1

Phenotype	Average Incidence	Significance
HCT	71%	A
LCT	63%	A
Sensitive	28%	B

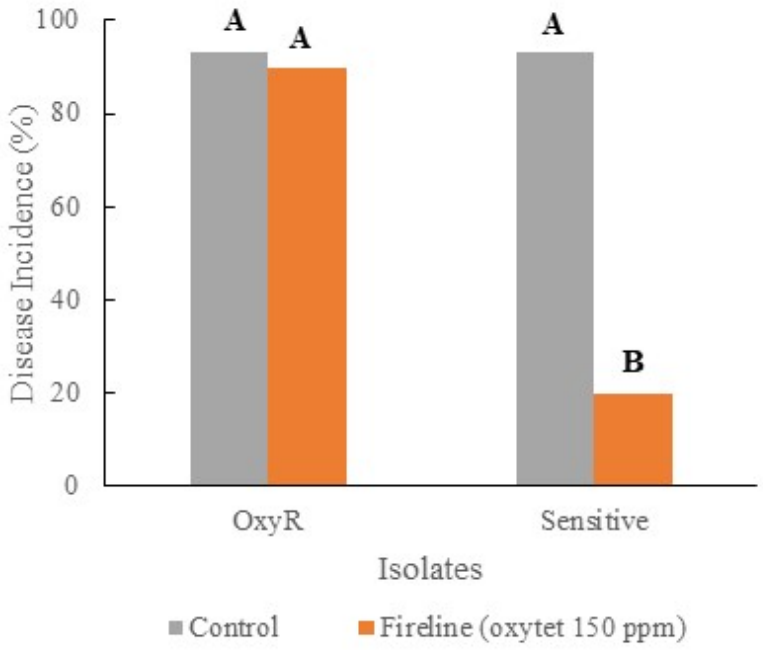
Trial 2

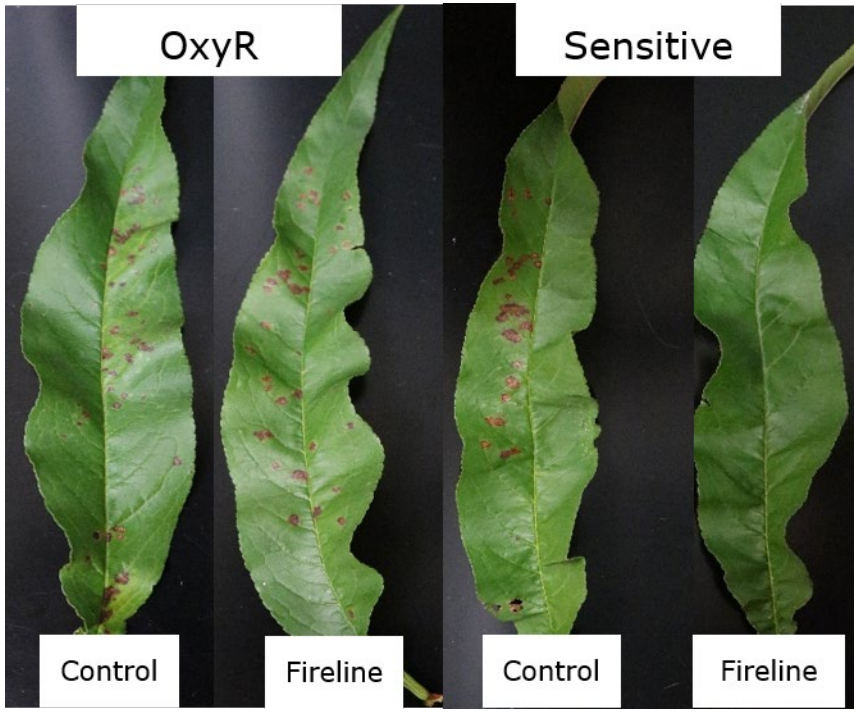
Phenotype	Average Incidence	Significance
HCT	82%	A
LCT	73%	A
Sensitive	32%	B

Cox et al. 2020

Oxytetracycline resistance

- Oxytetracycline resistance significantly reduced the efficacy of Fireline in controlling bacterial spot
- All the OxyR bacteria are also resistant to Streptomycin



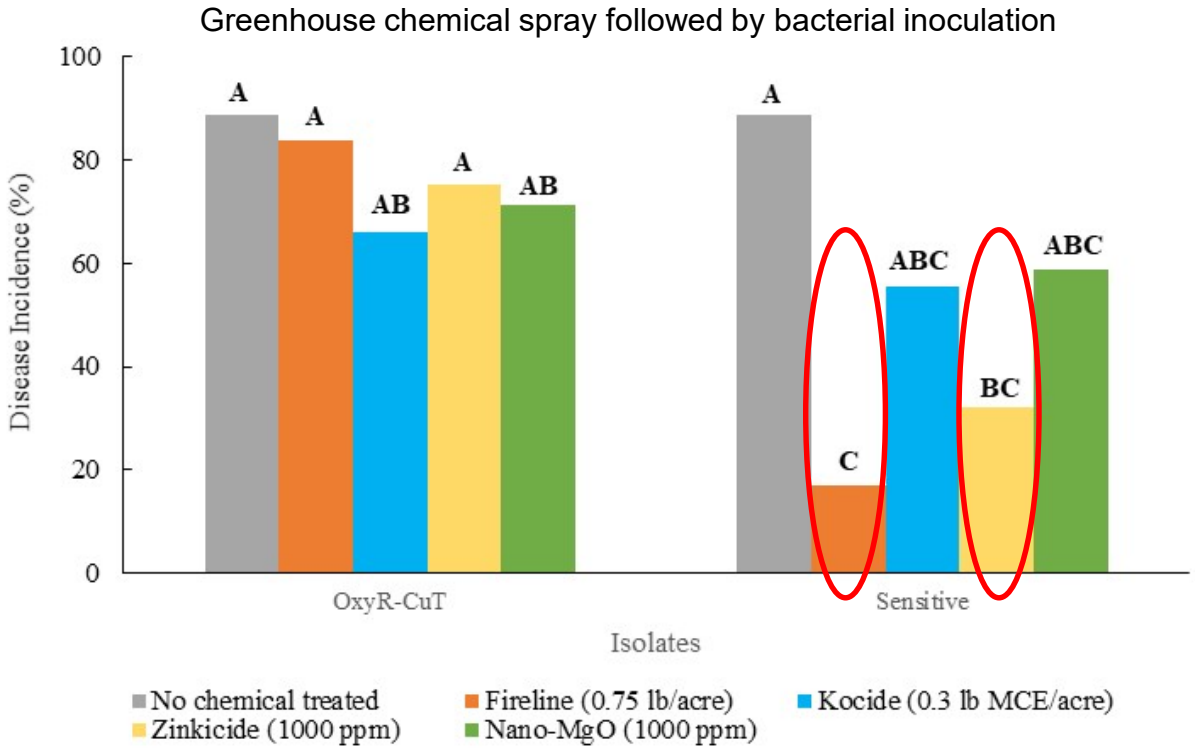


Evaluation of new chemical control options

- Zinkicide (nano-ZnO): new chemical with success controlling the *Xanthomonas* pathogen on citrus
  - Totally inhibited *Xap* growth in our lab assays
- Nano-MgO: new chemical with success controlling the copper-tolerant *Xanthomonas* pathogen on tomato
  - Did not control *Xap* well in our lab assays
- Amino thiadiazole: new chemical with success controlling the *Xanthomonas* pathogen on strawberry
  - Did not provide *Xap* control in our lab assays
- Mancozeb/Penncozeb: combination with copper showed the best control effect of *Xap* on almonds
  - Totally inhibited *Xap* growth in our lab assays

Evaluation of new chemicals

- Zinkicide and Fireline significantly reduced disease with sensitive bacterial strain with little phytotoxicity



Phytotoxicity

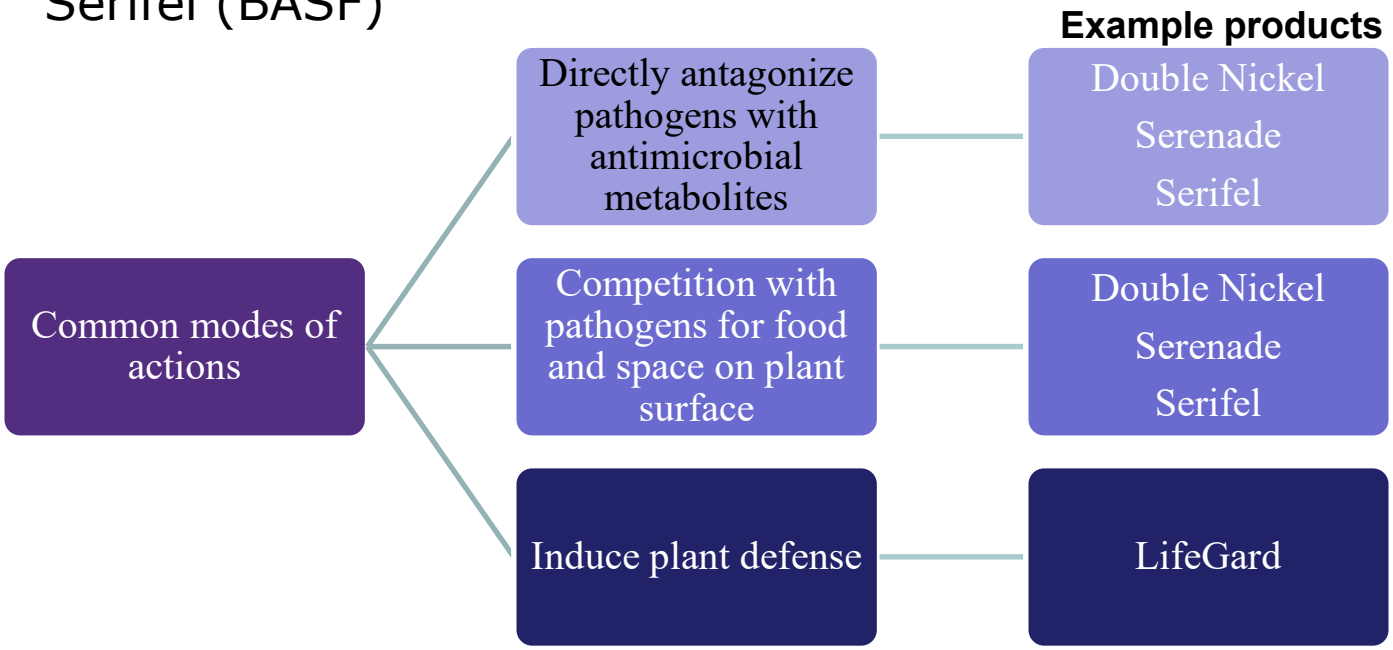
Zinkicide Copper

NIFA-AFRI project on peach bacterial spot

1. Monitor oxytetracycline-resistance and copper-tolerance in SC and GA peach orchards and evaluate the impact on current chemical control programs;
2. Identify the mechanisms of oxytetracycline resistance and copper tolerance;
3. Evaluate more novel chemicals for improved control of bacterial spot;
4. Compare the overwintering capability of resistant/tolerant and sensitive *Xap* strains and develop a model based on environmental factors during the dormant season to predict the inoculum levels for the subsequent growing season.

Biological control

- Biocontrol: use of living organisms to suppress pests
  - E.g. Double Nickel (Certis), LifeGard (Certis), Serenade (Bayer), Serifel (BASF)



  - Biocontrol products (no phytotoxicity) can be used as more sustainable options to rotate with copper under <u>low to moderate disease pressure</u>

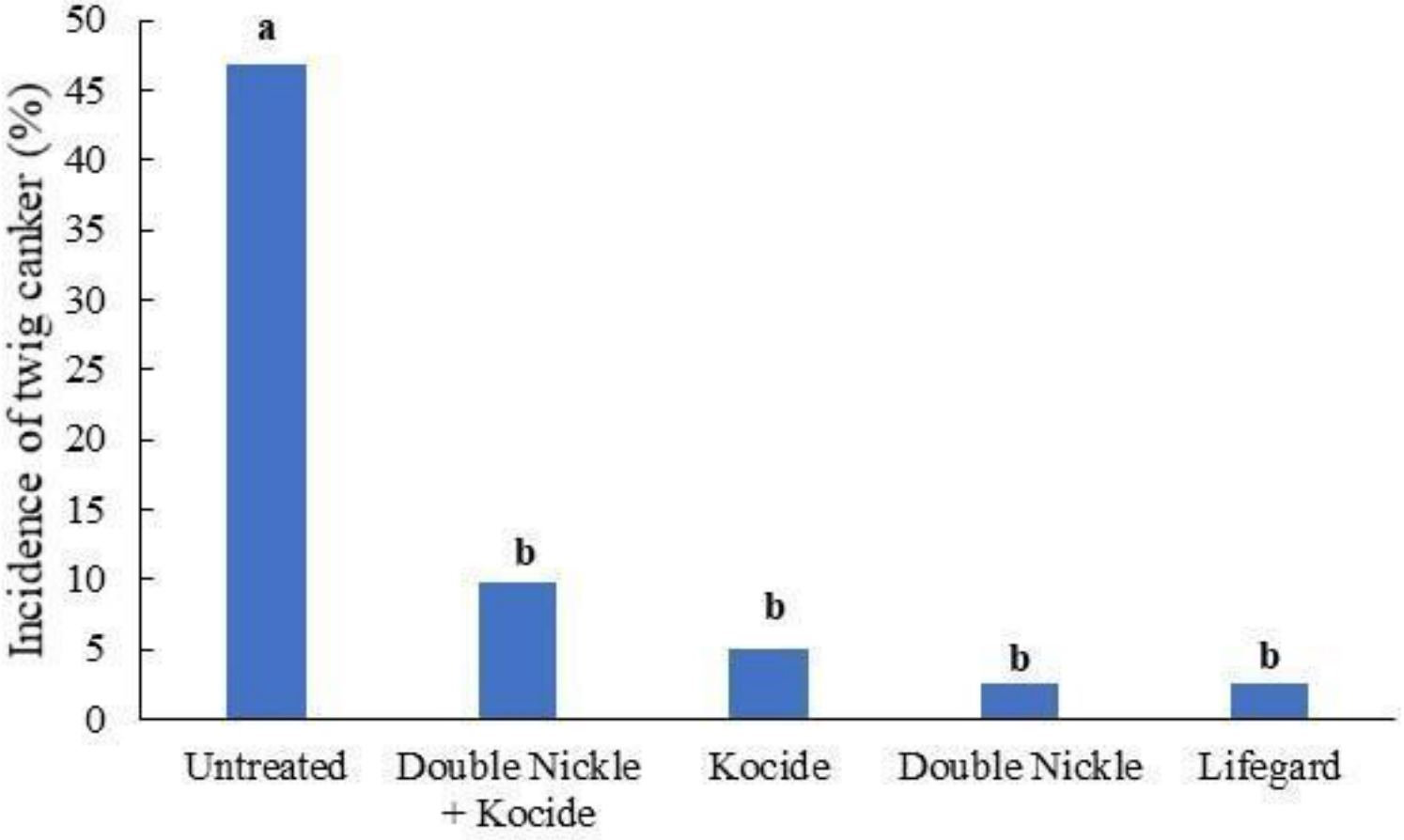
Fall applications of Biocontrol

- Target to reduce inoculum for the next growing season
  - Bacteria infect leaf scars, twigs, and buds during fall and overwinter as inoculum sources for the next season
  - Dormant applications with copper or copper-mancozeb significantly reduced bacterial spot in almond (exact same pathogen) in seasons with high rainfall in California (= normal seasons in the southeast)

- Hypothesis: biocontrol agents may work better in fall than in growing seasons
  - Bacterial pathogen levels in late fall are lower than in the growing seasons
  - Mild fall temperatures with high humidity in the southeast and the absence of other pesticide applications could favor the survival of the living biocontrol agents on peach trees, increasing their chance of success to fight pathogens

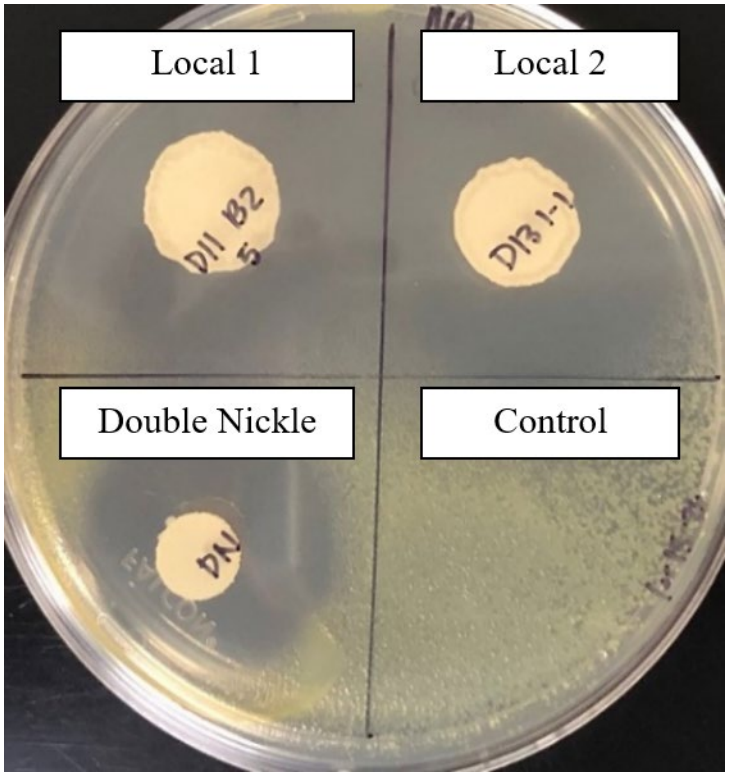
Biocontrol fall sprays could reduce spring cankers

- 2019 field trial



Local biocontrol strains

- 14 local biocontrol strains showed comparable or higher degree of antagonism against the bacterial pathogen than Double Nickle and Serenade in the lab assays
  - May work better in local environment
  - Will be evaluated in spray trials



Summary from our research

- Biocontrol sprays during late fall have shown promise in reducing inoculum for the subsequent growing season
  - a potential option for both organic and conventional growers
- Low copper tolerance is becoming more prevalent in SC, which could impact the efficacy of low copper dosages
  - We will evaluate the alternation of copper with other products (e.g. biocontrol agents, zinc, and antibiotics) after petal fall in our field trials
- Oxytetracycline-streptomycin resistance occurred in low frequency so far
- We will keep monitoring the chemical resistance/tolerance in southeastern peach orchards, evaluating their impact, and developing new strategies for improved disease control

Suggestions on current spray programs

- Spray before symptoms appear
  - Start early (late dormancy or bud break) in orchards with bacterial spot history
  - Petal fall to pit hardening is the most critical infection window for fruit
- Rotate copper with oxytetracycline or biocontrol products to reduce phytotoxicity and resistance
- Monitor weather and spray before rain events
- Do not quit spraying early when environmental conditions are conducive for inoculum build up in the orchard
  - Defoliation from bacterial spot could weaken the tree for the next season

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Watsonia Farms
Big Smile Peaches
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