



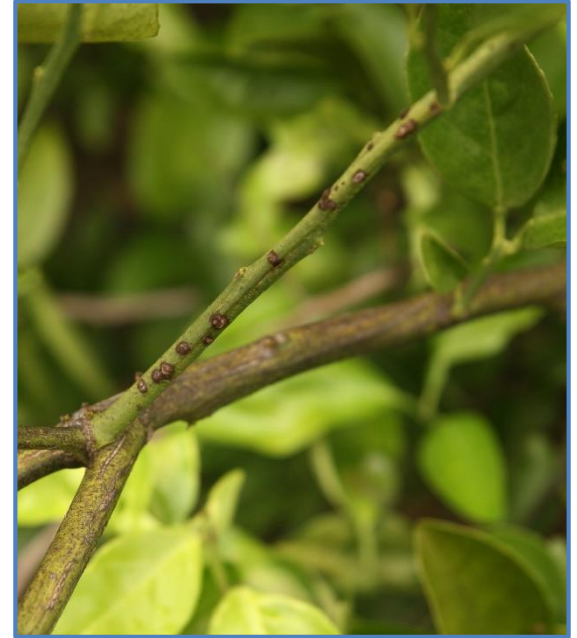
# Citrus Canker, Alternaria and Scab

## Diseases of Citrus

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# CITRUS CANKER



Some slides adapted from E. Johnson

# Fruit size matters!

- Start copper sprays when fruit reach  $\frac{3}{8}$  in
- Need at least a 21 day interval to protect **FRUIT**
- Spray volume and tractor speed important for fruit coverage
  - Slow down!





# Why a 21-day interval?

- Copper residue is significantly reduced by rain washing
- Copper does not move once dried
- Copper residue is cracked by fruit growth
- Copper model is an alternative if do not want to schedule
  - Advise when residue is insufficient for control



*As the fruit grows, copper must be reapplied to continually cover the fruit as it becomes larger*

# Proper Application of Copper

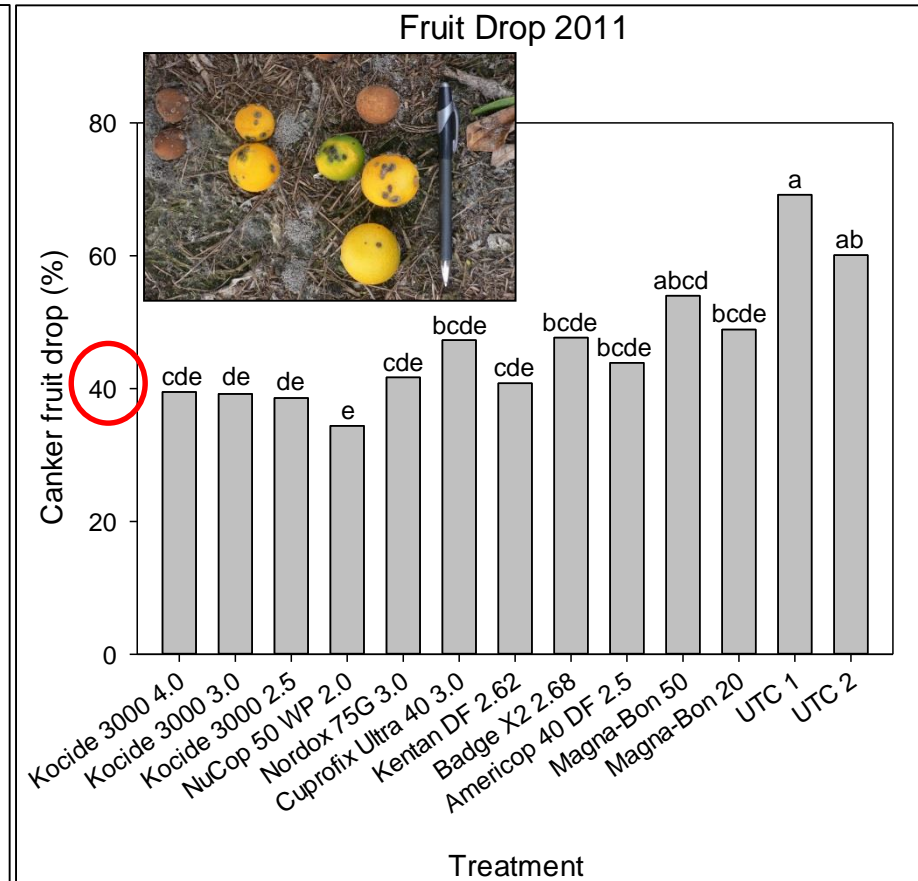
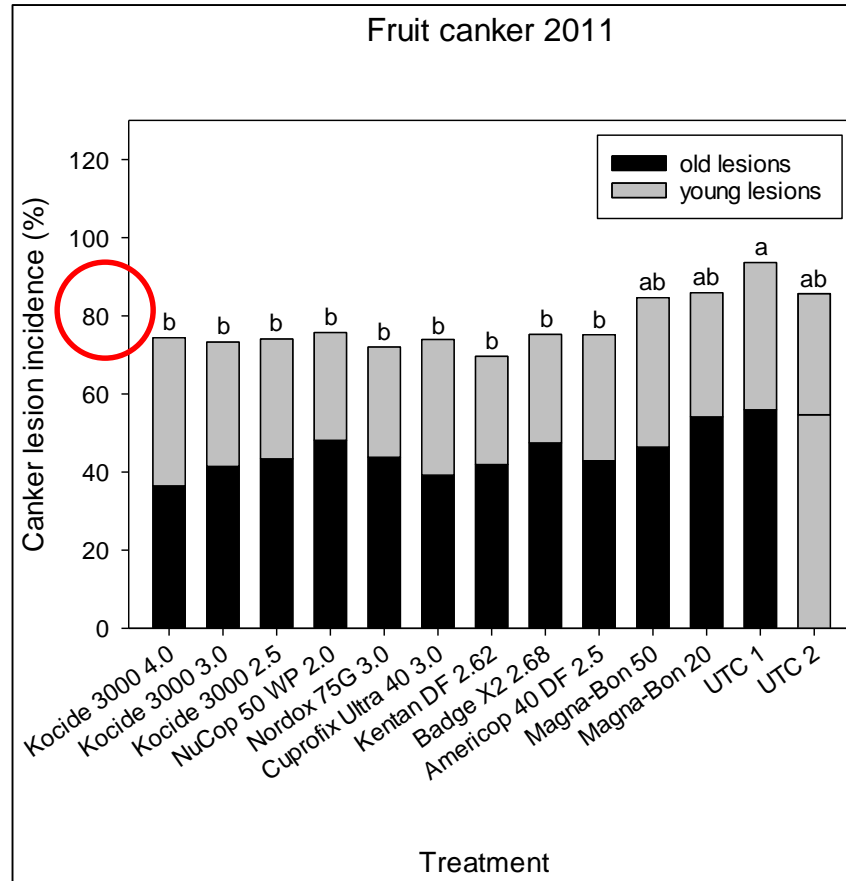
- Use label rate recommended for a disease
- Be cautious in hot weather ( $> 94^{\circ}\text{F}$ ;  $34^{\circ}\text{C}$ )
  - Phytotoxicity can occur more easily in hot weather
- Potential for phytotoxicity can be reduced with greater water volume per acre
- Complex tank mixes, oil applications, and nutritional materials contribute to phytotoxicity
- With aerial applications get inadequate penetration of canopy for control, best method is with an air blast sprayer

# Field trials and the effect of timing

- Evaluate copper sprays in relation to early season rains for control of fruit infection and drop in young fruiting Hamlins
  - In a south central Florida citrus grove
- Compare soluble and fixed copper formulations for efficacy
  - 2011, 2014, and 2015

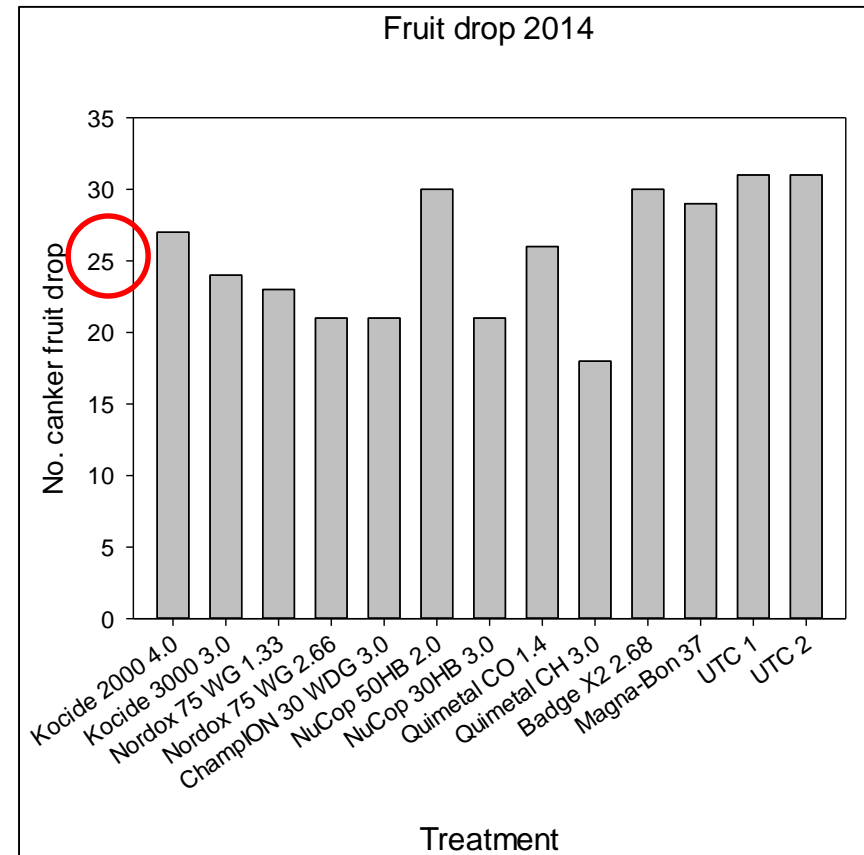
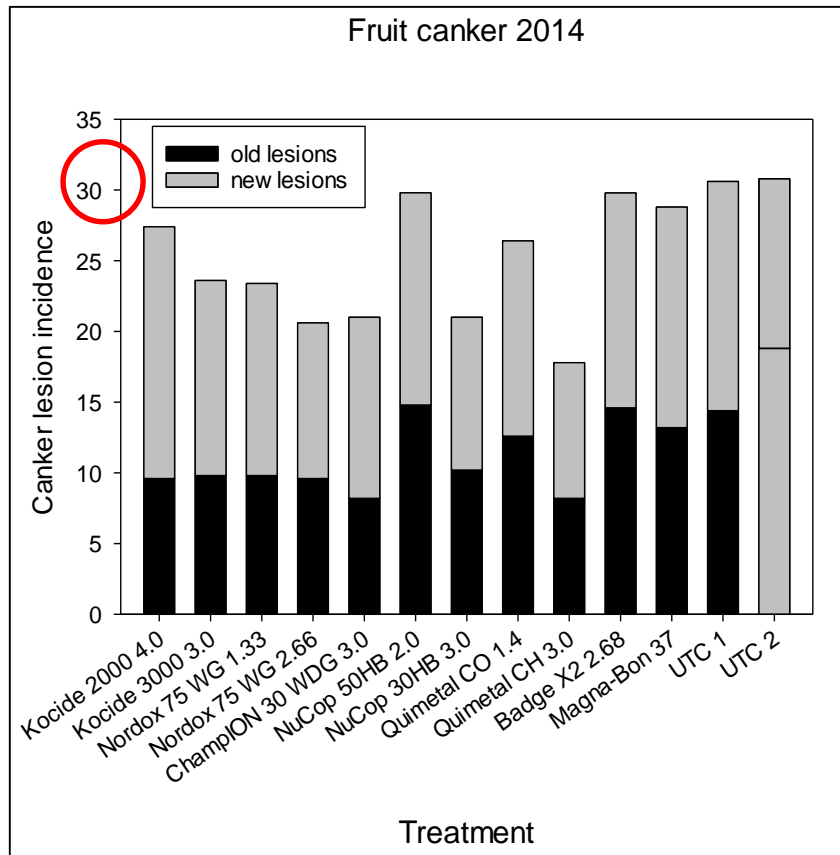
# Timing and weather matters

- Need to watch early season weather forecasts for rain
- Effects of being too late
  - In 2011, 9 sprays began 15 April (too late) to 27 Sept, attempting to reduce impact of early epidemic



# Dry spring

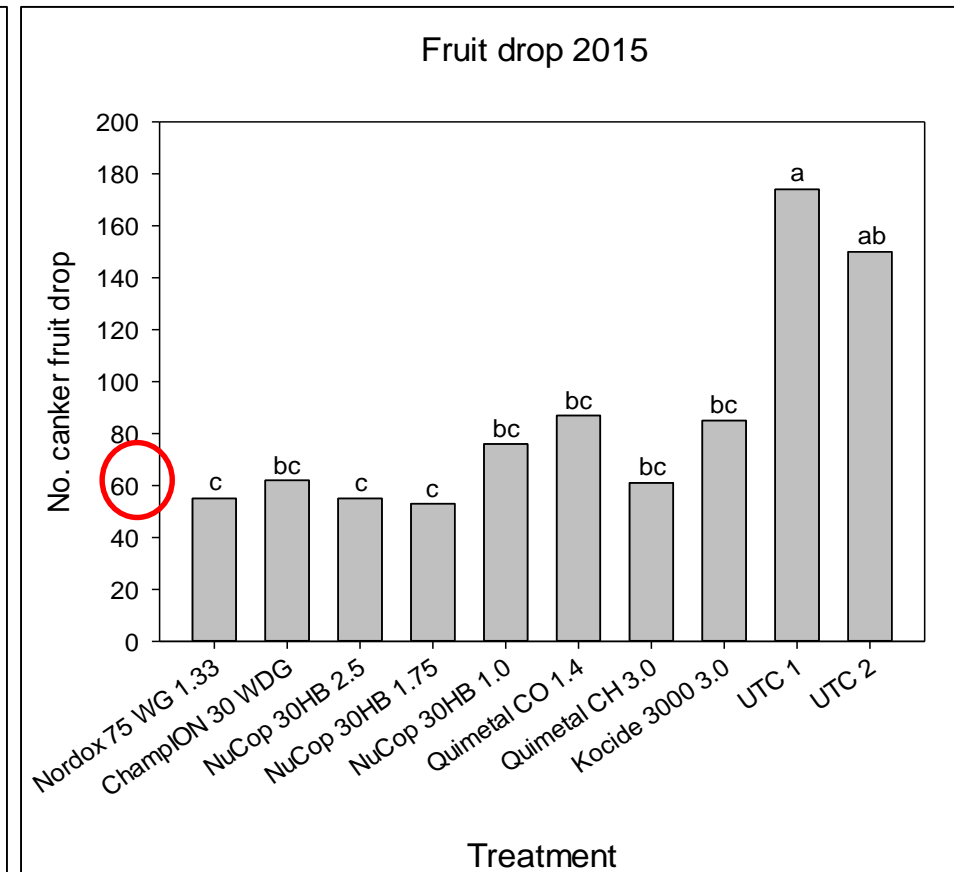
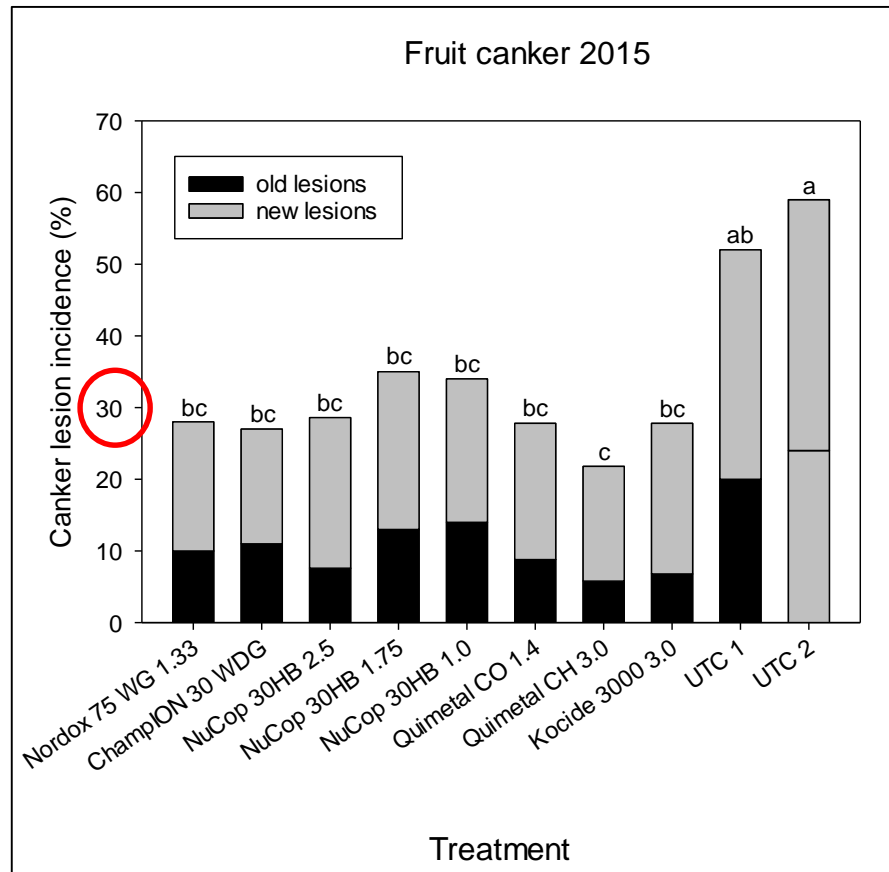
- Limited early season infection
  - In 2014, rain below average when fruit most susceptible size





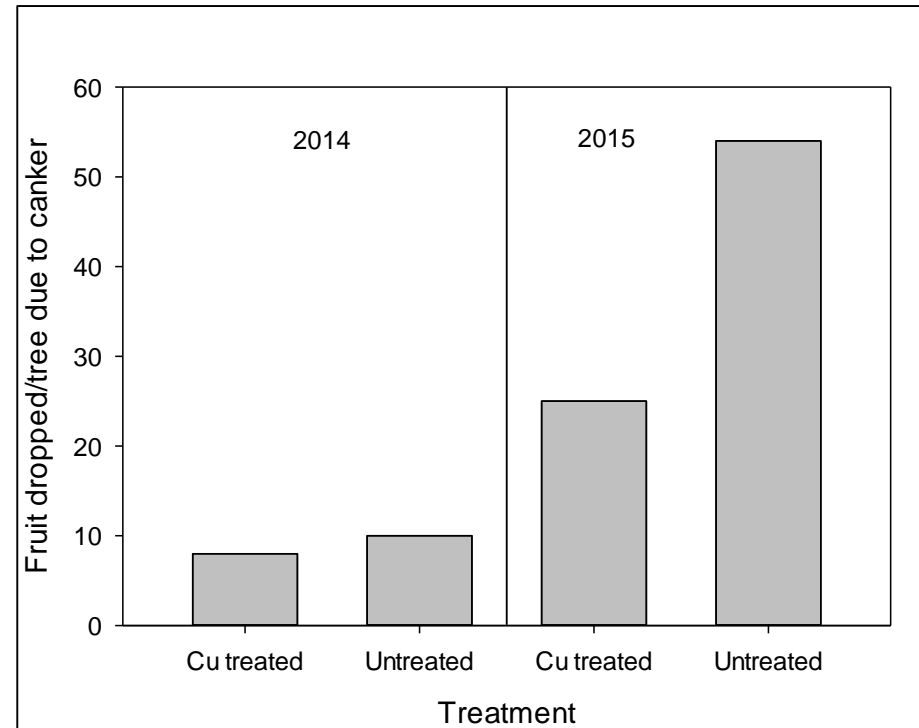
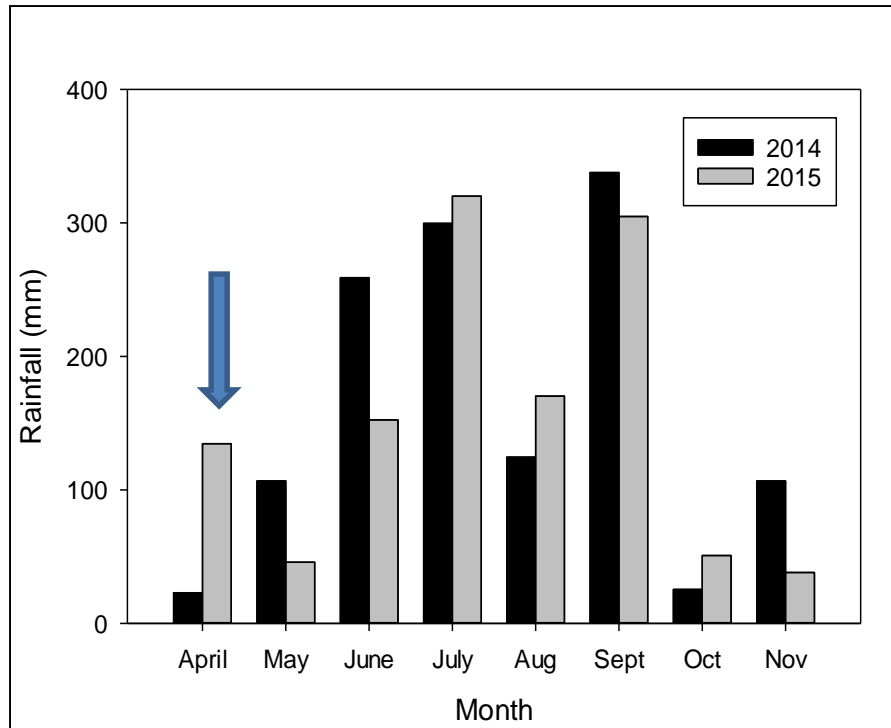
# Well timed application

- Well timed applications can mitigate unfavorable rainfall patterns
  - 2015, April rain greater than average when fruit at most susceptible stage



# Effect of inoculum carry over

- April rains induced early season fruit drop
  - Not canker inoculum carry over from previous season
- Early bloom this season
  - Initiate program once fruit reach 3/8 in. dia.
  - May be in mid- to late-March



# How has Michael changed things?

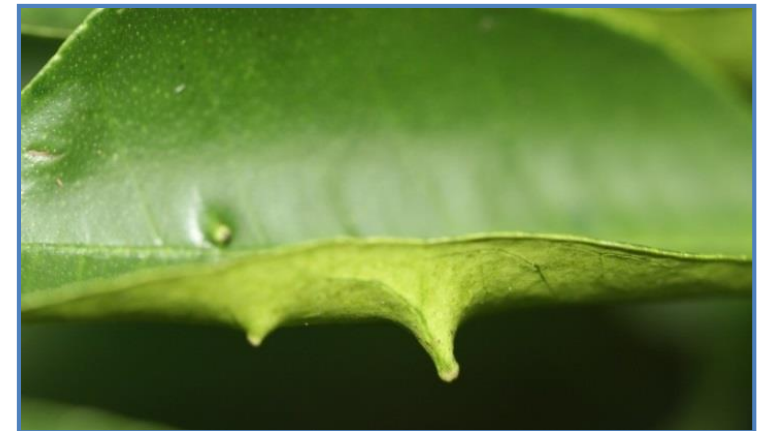
- On all trees, hurricane force winds push bacteria past any barriers
  - Where inoculum present, considerable mature leaf infection and stem lesions
  - Particularly bad in young blocks, especially if high canker in surrounding blocks
- Stem lesions found on twigs
  - Will contribute years of inoculum;
  - Leaves only supply significant inoculum for a few months post-infection
- For non-bearing and young blocks, Blockade recommended
  - Copper does not control stem or leaf lesions
  - Will help to suppress inoculum

# Conclusions on Application Timing

- Spray timing before spring rains critical for fruit protection once 3/8 in. dia
- Inoculum from infected leaves and stems from previous season always present in spring
  - Stem lesions more problematic
  - Michael has amplified and spread inoculum in the area
- Early fruit infection leading to fruit drop depends on spring rains coinciding with most susceptible fruit stage
- In June-July, infections of fruit > 1.5 in. result in smaller lesions that do not induce premature drop



# CITRUS SCAB





# Citrus Scab

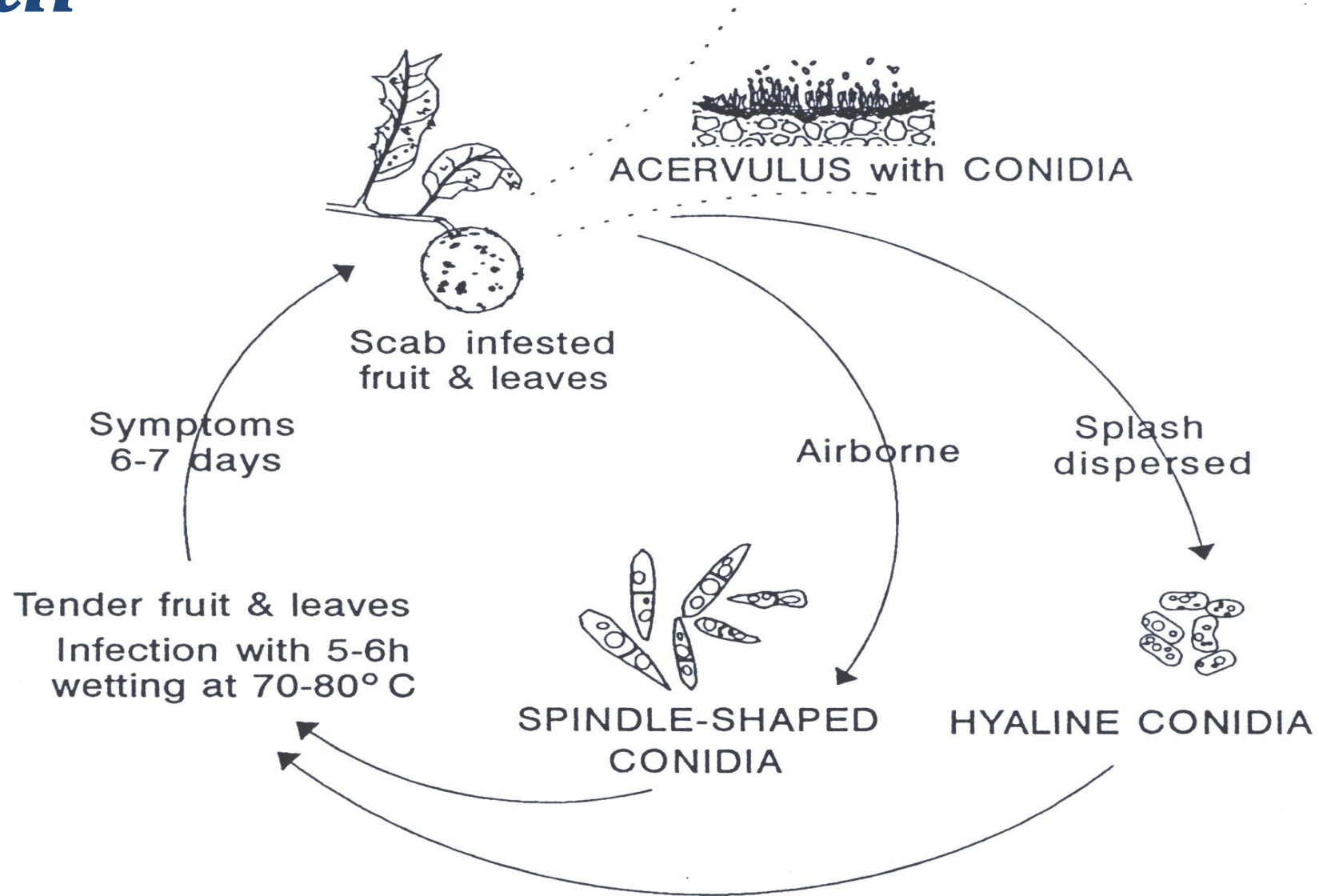
- Causal fungus: *Elsinoë fawcettii*
- Found in most humid citrus production regions
- Important for fresh fruit production
  - Economic damage restricted to peel
- Infects young leaves, twigs, and fruit



# Symptoms



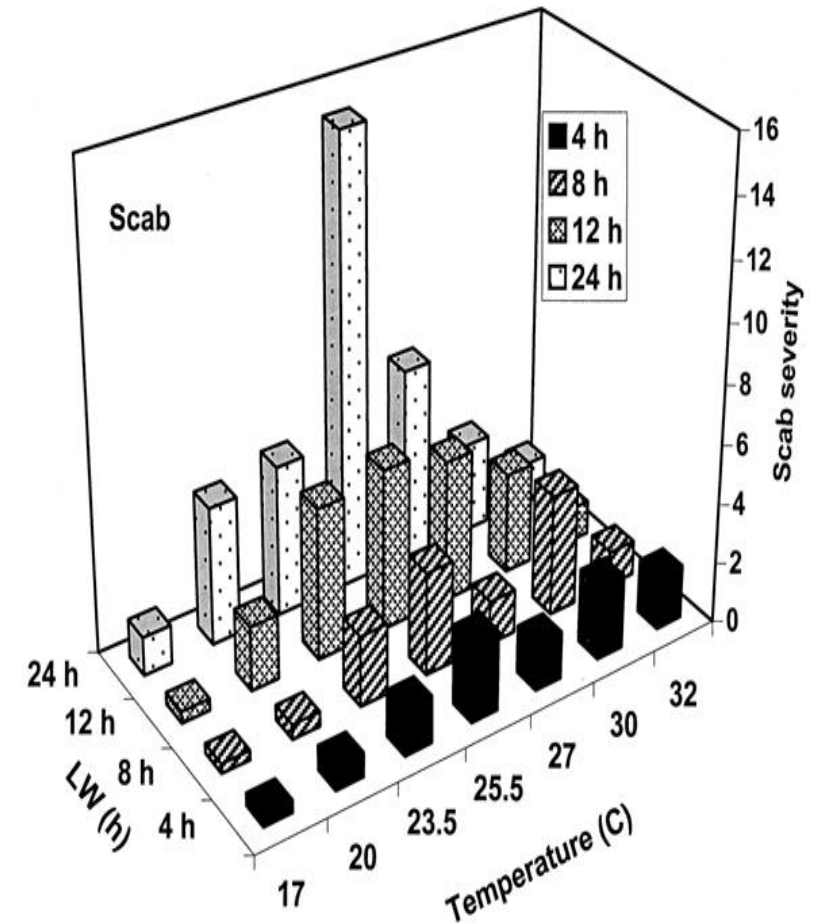
# Citrus Scab Disease Cycle Caused by *Elsinoë fawcettii*





# Infection

- Optimal temperature range
  - 74.3 to 80.6°F (23.5 to 27°C)
- Optimal leaf wetness
  - Between 12 and 24 hrs
  - Can infect in as little as 4 hrs
- Tend to see more disease with low lying areas where there is more dew and longer dew periods



# Host Range and Tissue Susceptibility

- Young leaves and fruit are susceptible
  - Leaves immune to infection until half expanded
  - Fruit remain susceptible up to two months post petal-fall
- Summer flush can be especially badly affected
- The host range of *E. fawcettii* is complicated
- Matter of considerable phylogenetic research



# Host Range

Disease	Pathogen	Pathotype	Hosts
Citrus scab	<i>Elsinoë fawcettii</i>	FBHR	Lemon, grapefruit, Temples, sour orange, sweet orange, Satsuma, many tangerines
		FNHR	Lemon, grapefruit, Satsuma
		Tyron's	Lemon, Cleopatra
		Lemon	Lemon
		SRCG	Satsuma, Rough lemon, Clementine, grapefruit

# Cultural Controls

- Disease-free nursery trees
  - Start clean and problems are unlikely
- Hedge and top badly-affected plantings
  - Does not move far into canopy
- No vigorous rootstocks
- No overhead irrigation



# Citrus Scab Control

- Common control products
  - Enable
  - Strobilurin fungicides (Abound, Gem, Headline)
    - Good for first application because kills fungus in last year's lesions
  - Ferbam
  - Copper - All formulations
    - Use later in the season as it is not as effective as other products

- If infestation is light, disease can be pruned out

Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
Tangerines								
Grapefruit								

# Spray Timing

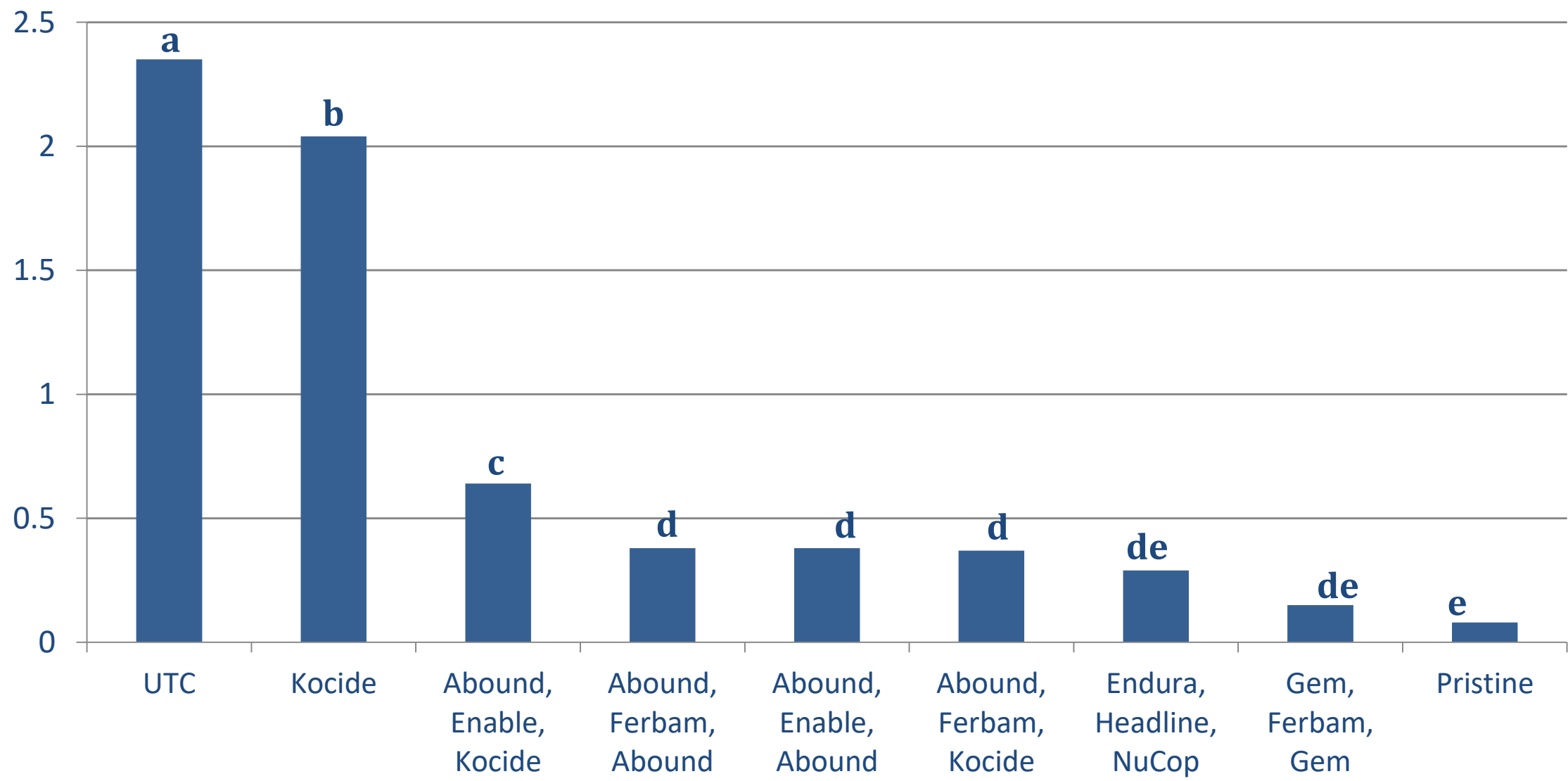
- Sprays are mainly for groves with a recent history of scab
- Key to good scab control is timing
- 1<sup>st</sup> application at  $\frac{1}{4}$  flush expansion
  - Enable, ferbam or strobilurin fungicide
- 2<sup>nd</sup> application at petal fall
  - Different chemistry from 1<sup>st</sup> application
- 3<sup>rd</sup> application 3 weeks post-petal fall
  - Copper can fit well in this application

# Grapefruit Spray Trial 2004

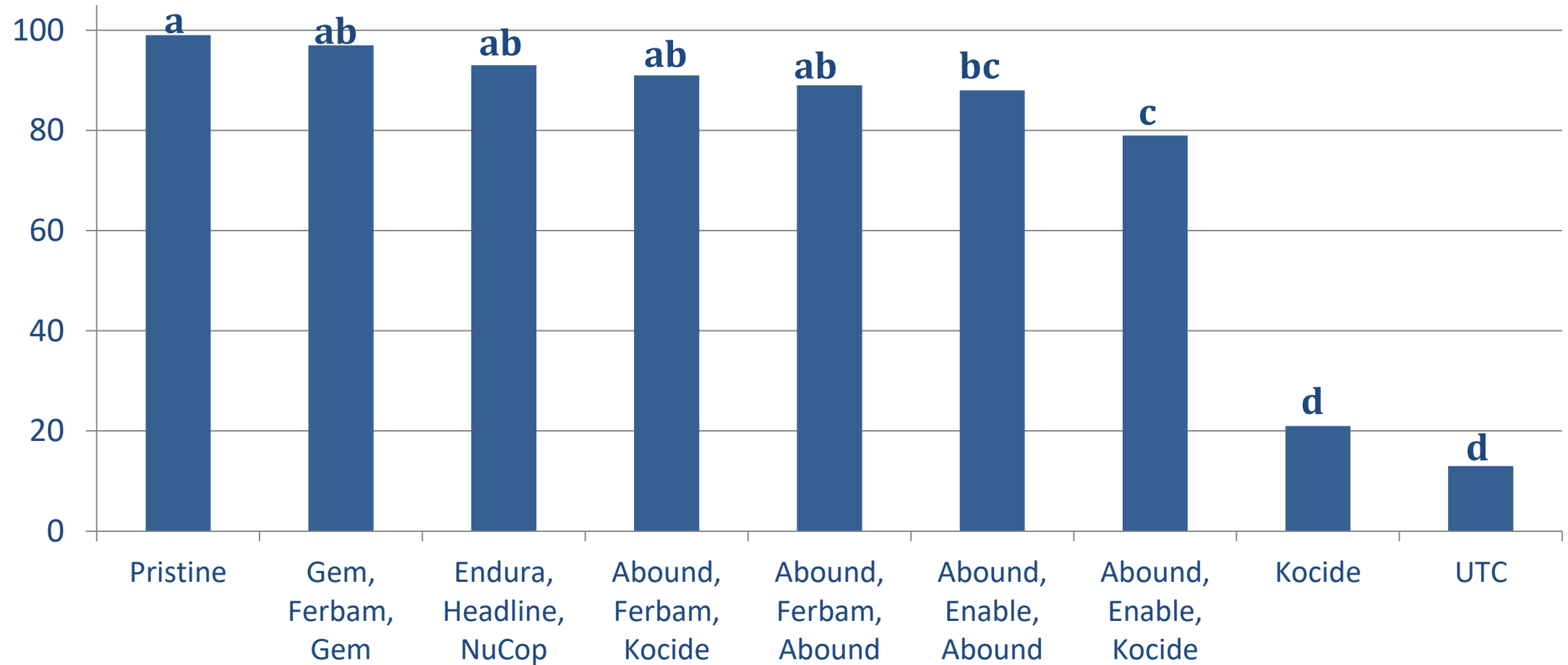
Date	March 6-7	April 4-5	May 3
Program 1	Untreated control (UTC)	Untreated control	Untreated control
Program 2	Pristine 38WG (16 oz)	Pristine 38WG (16 oz)	Pristine 38WG (16 oz)
Program 3	Abound 2.08EC (12.4 fl oz)	Enable 2F (8.0 fl oz)	Kocide 2000 (4.5 lb)
Program 4	Gem F (2 fl oz)	Ferbam Granuflo (5.0 lb)	Gem F (2 fl oz)
Program 5	Endura 70WG (4.5 oz)	Headline 2.09EC (9.2 fl oz)	NuCop 50DF (4.0 lb)
Program 6	Abound 2.08EC (12.4 fl oz)	Ferbam Granuflo (7.5 lb)	Abound 2.08EC (12.4 fl oz)
Program 7	Abound 2.08EC (12.4 fl oz)	Ferbam Granuflo (7.5 lb)	Kocide 2000 (4.5 lb)
Program 8	Abound 2.08EC (12.4 fl oz)	Enable 2F (8.0 fl oz)	Abound 2.08EC (12.4 fl oz)
Program 9	Kocide 2000 (2 lb)	Kocide 2000 (2 lb)	Kocide 2000 (2 lb)



# Severity Rating



# % Marketable Fruit

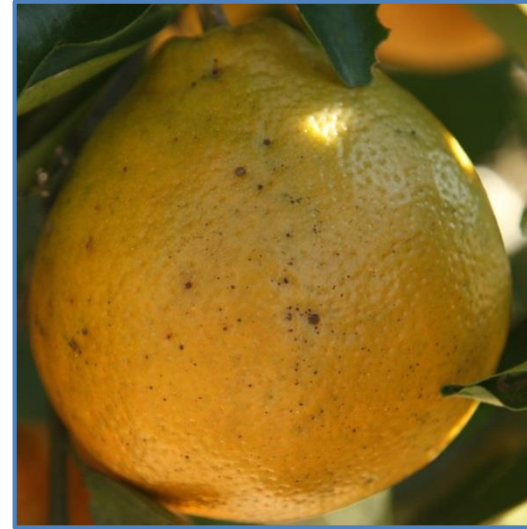
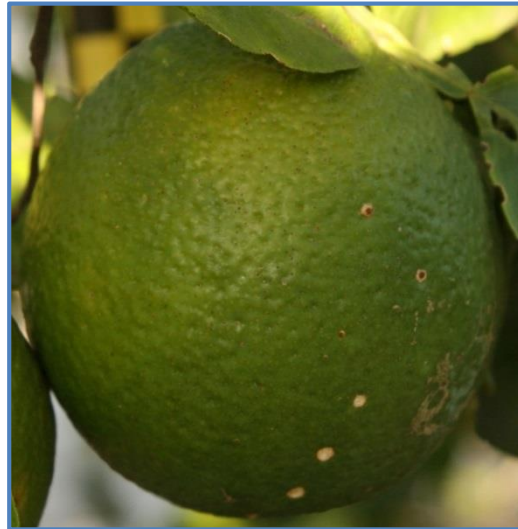




# ALTERNARIA BROWN SPOT



# Symptoms



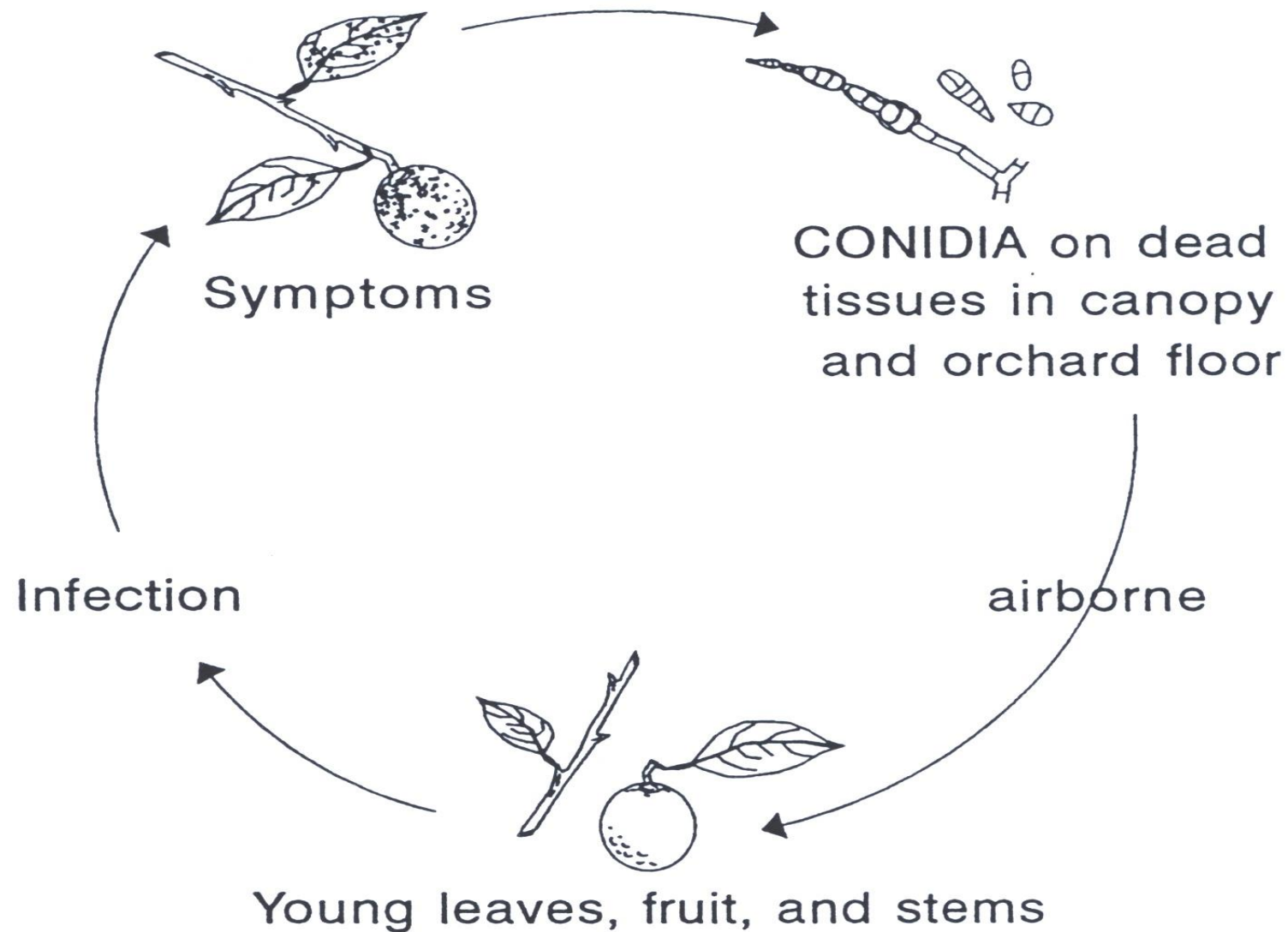


# Symptoms



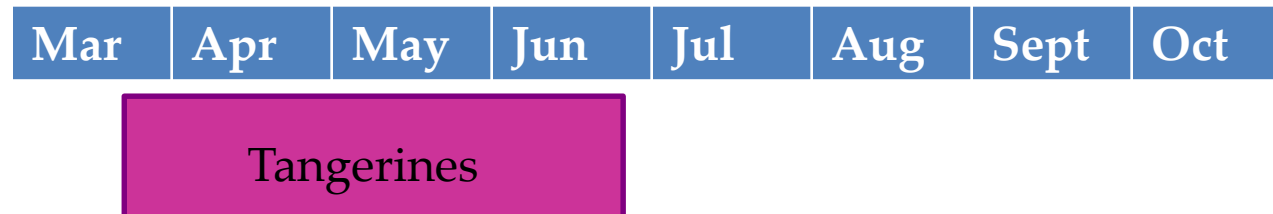


# Alternaria Brown Spot Disease Cycle Caused by *Alternaria alternata*



# Alternaria Brown Spot Control

- Common control products
  - Copper - All formulations at a high rate
  - Strobilurin-containing fungicides (Abound, Gem, Headline, **Amistar Top** and **Pristine**)
    - Bolded products are premixes with alternate modes of action
    - If severity high, useful for early sprays but also when hot
  - Ferbam



# Cultural Controls

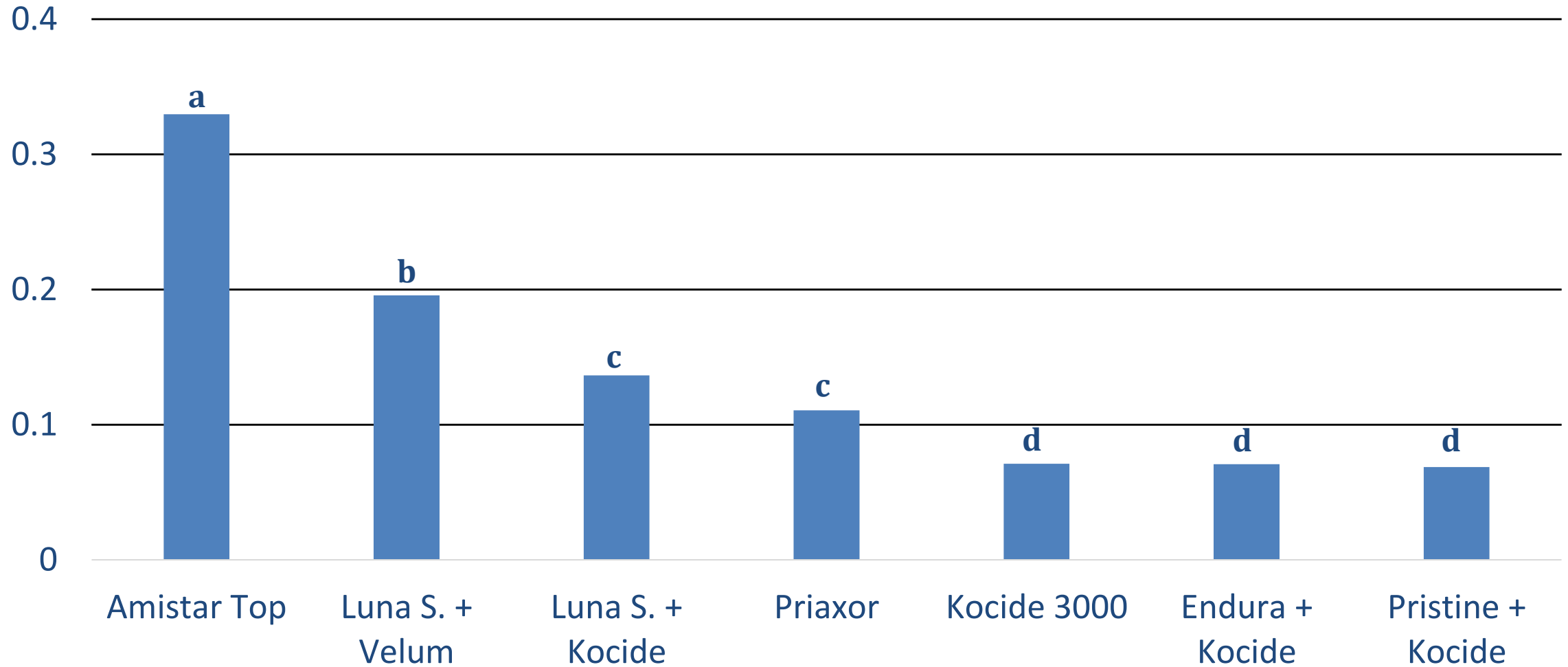
- Start with clean trees
- Increase air drainage in grove when planting
- Avoid excessive growth promotion
  - Too much nitrogen
  - Overwatering
  - Severe hedging
  - High vigour rootstocks



# 2018 Trial Details – Rates

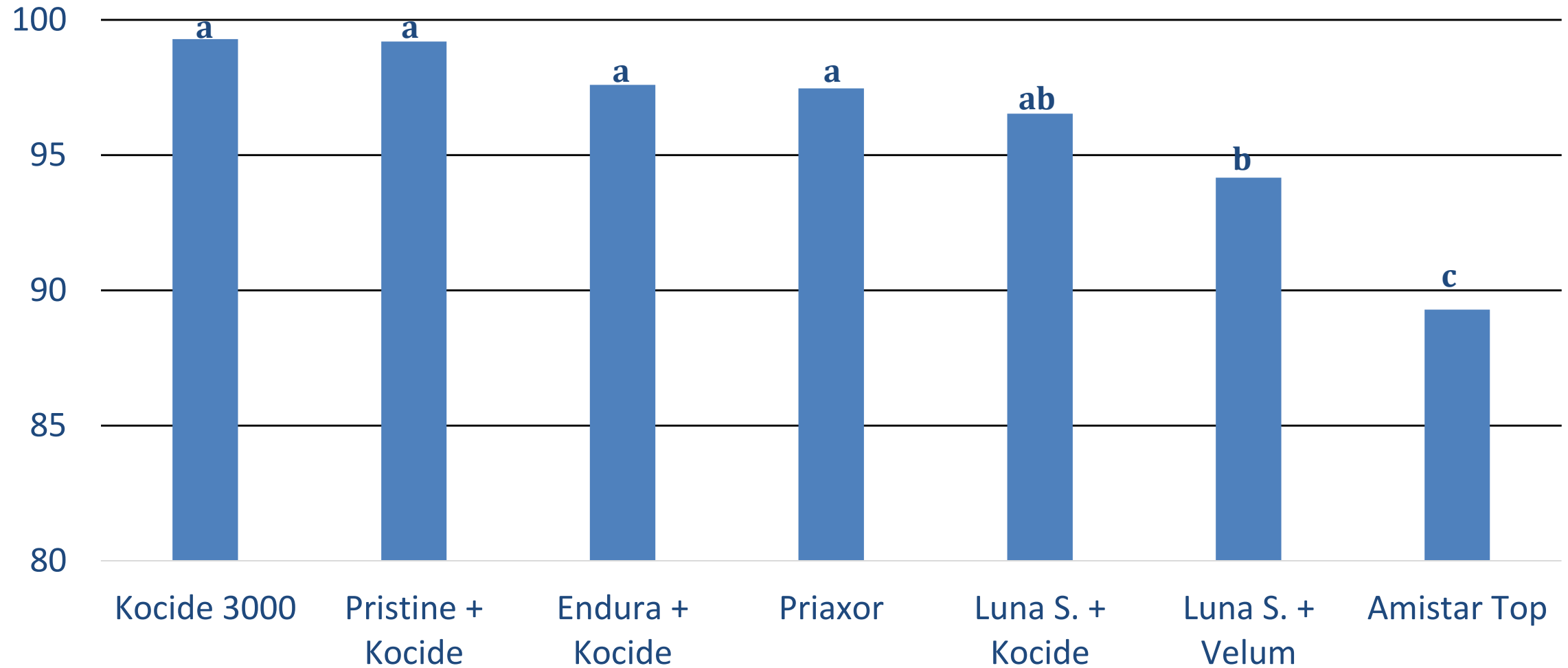
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# Disease severity



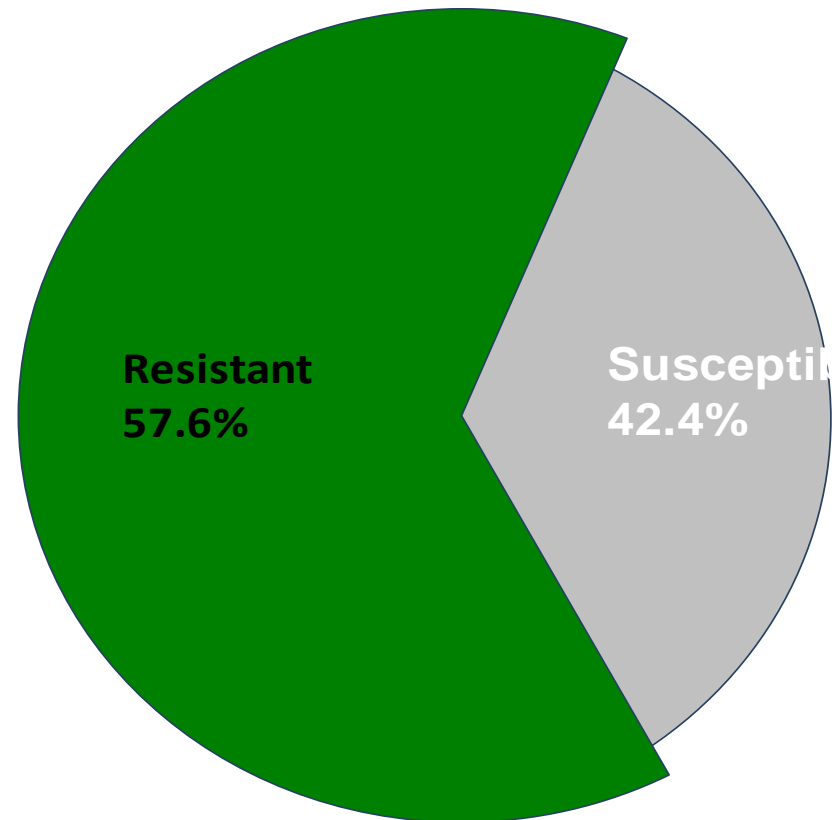


# Marketable Fruit



# Proportion of Population Sampled

○ 2008 - 2012



# Manage Tangerines As If Resistance Present

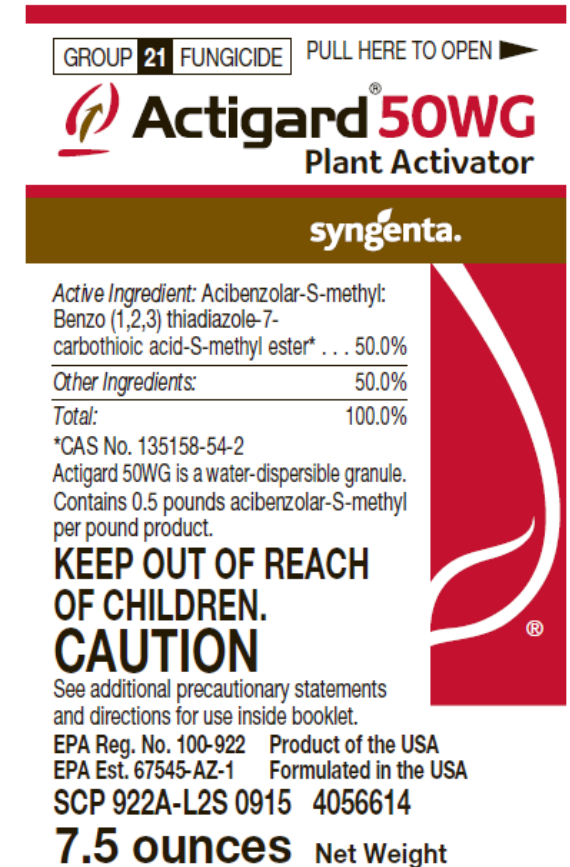
- Should use mixture fungicides with alternative modes of action (in Pest Management Guide)
- Frequent rotation with copper or other multisite fungicides like ferbam
- So far no sign of resistance
- Sample spray program

Quadris Top or Pristine	Copper	Opposite premix	Ferbam	Copper	Quadris Top or Pristine
11/3 or 11/7	M1	11/7 or 11/3	M3	M1	11/3 or 11/7

**QUESTIONS?**

# Newer product: Blockade (formerly Actigard)

- Not a traditional pesticide
  - Plant activator that triggers natural defense mechanism called systemic acquired resistance (SAR)
- No direct effect against pathogens
- Intended to supplement copper applications for fruit protection
  - Some foliar activity on **non-bearing** trees
- Activates plant defense system prior to disease
- Active ingredient: Acibenzolar-S-methyl
  - Group 21 fungicide mode of action
    - Not a reference to efficacy against bacteria





# Chemical versus natural induction

- SAR can be naturally or chemically induced
  - Natural induction is caused by a low level of plant pathogen attack
  - Systemic throughout the plant
- Disease can develop before natural induction becomes effective
- High inoculum levels can overcome activation
- Chemical induction can occur before disease onset
  - Apply in anticipation of disease

# Blockade use recommendations

- New plantings (0-3 year-old trees)
  - Start as first growth beginning and continue non-bearing cycle
  - Soil applied neonicotinoid insecticides can induce SAR and can be alternated with Blockade
  - Use other canker management methods too
  - Maintain SAR throughout season
- Objective to limit the establishment of canker during juvenile phase

# Blockade use recommendations

- Young bearing plantings (4-5 year-old trees)
  - Initiate post-bloom, prior to conditions favorable to canker
  - Use other canker management methods too
  - Continue throughout spring, summer, and fall on 30-60 day intervals depending on tree size and planting density
- Mature plantings (6+ year-old trees)
  - Continue throughout summer on 30-45 day intervals depending on tree size and planting density
- Can limit foliar lesion development and reduces inoculum potential