



Postbloom Fruit Drop, Citrus Canker, and Citrus Black Spot



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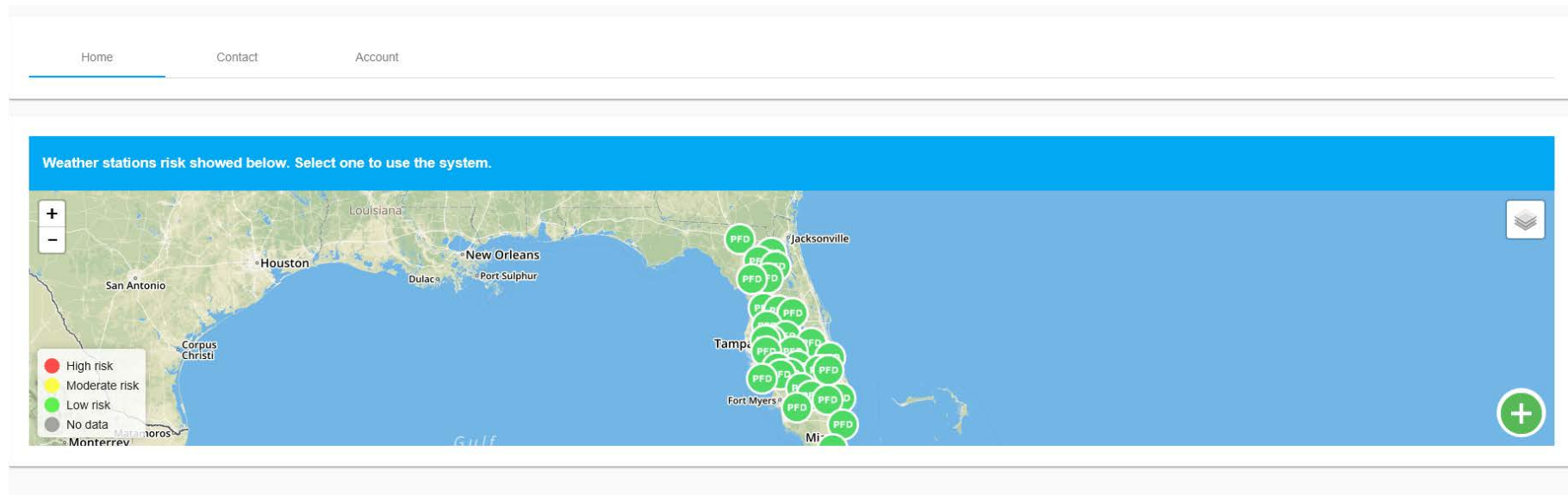
NEW POSTBLOOM FRUIT DROP FORECASTING SYSTEM

Development of new PFD advisory system

- o Project in collaboration with Natalia Peres and Clyde Fraisse
- o To simplify PFD predictions from PFD-FAD
 - Less data collection required
 - Automatically pulls in weather data
- o Based off of the FAWN system
 - Some stations with leaf wetness probes
 - Mostly calculated from available models

Homepage of new PFD advisory system

- o Hosted on Agroclimate.org
 - Under tools/crop diseases
 - Similar to Strawberry Advisory System (SAS)
 - Each circle represents a FAWN weather station



Criteria to select on model

- o St. Lucie West station selected
 - Blue check
- o Need to indicate bloom intensity
 - Will I recoup costs if application made?
- o Flowering stage
- o Last fungicide application

Home Contact Account

Weather stations risk showed below. Select one to use the system.

High risk
Moderate risk
Low risk
No data

St. Lucie West - 40

Flowering intensity:

☒ Sufficient bloom present on the trees to justify the cost of application

Flowering stage:

☒ Many open flowers, some pinhead or button bloom remaining

When was your last fungicide application:

☒ None

View recommendation ECRS: Postbloom Fruit Drop

Do not spray fungicide!

Sufficient bloom

Many open flowers, some pinhead or button bloom remaining

None

If there is an infection event

- o Conditions could allow for infection event
- o Still need sufficient bloom
- o Fungicide applications minimum 7 days apart

St. Lucie West - Recommendation

Flowering intensity:

☒ Sufficient bloom present on the trees to justify the cost of application

☐ Insufficient bloom present to justify the cost of application

Flowering stage:

☐  Pinhead bloom, few popcorn, no open flowers

☐  Pinhead, button bloom, few open flowers

☒  Many open flowers, some pinhead or button bloom remaining

☐  All flowers open, no pinhead or button bloom remaining

When was your last fungicide application:

☒ None

☐ Last 7 days

☐ More than 7 days

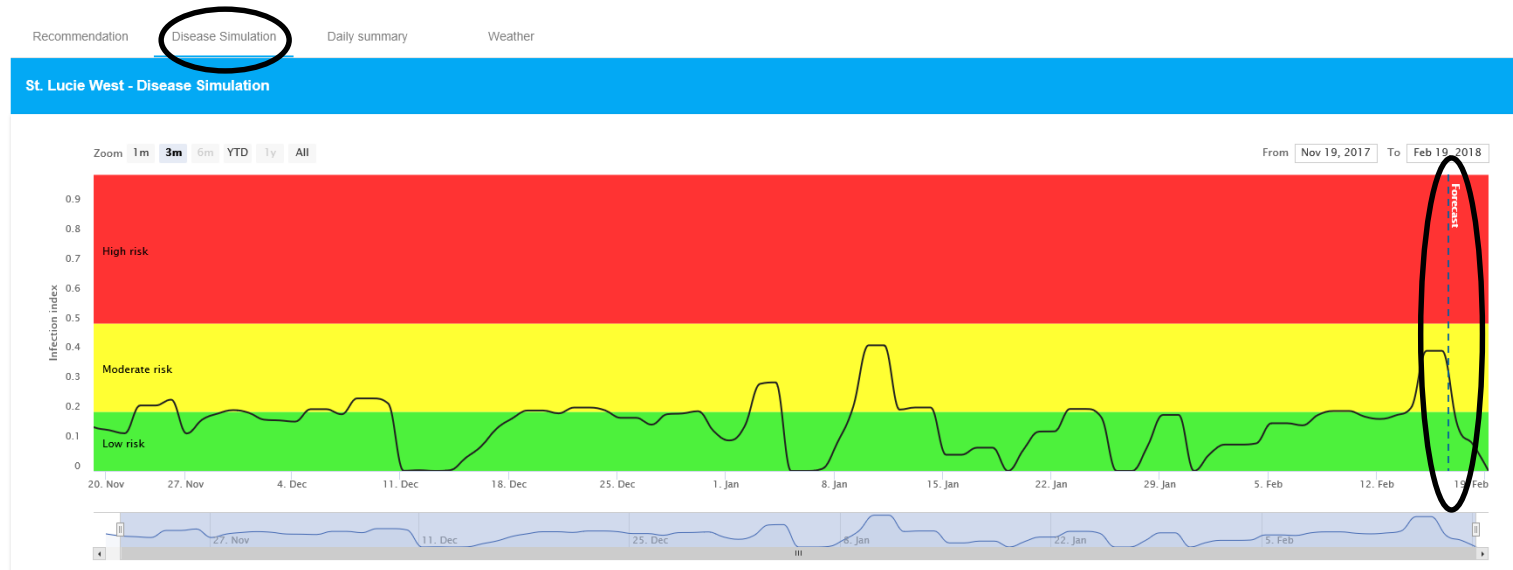
[View recommendation](#) EDIS: Postbloom Fruit Drop

Spray fungicide! We recommend the following products:

- Abound
Rate: 12-15.5 fl oz/acre
- Headline SC
Rate: 12-15 fl oz/acre
- Quadrif Top
Rate: 15.4 fl oz/acre
- Gem 500 SC
Rate: 1.9-3.8 fl oz/acre

Disease simulation tab

- o Graphical representation of infection risk
 - Can select time frame
- o Forecasted risk (from NOAA weather data) for three days from actual date
 - Help plan if infection will be favored by weather in near term



Infection risk levels

- o High risk (red area)

- Index above 0.51; Spray as soon as possible

- o Moderate risk (yellow area)

- Index between 0.21 -0.5; Spray recommended

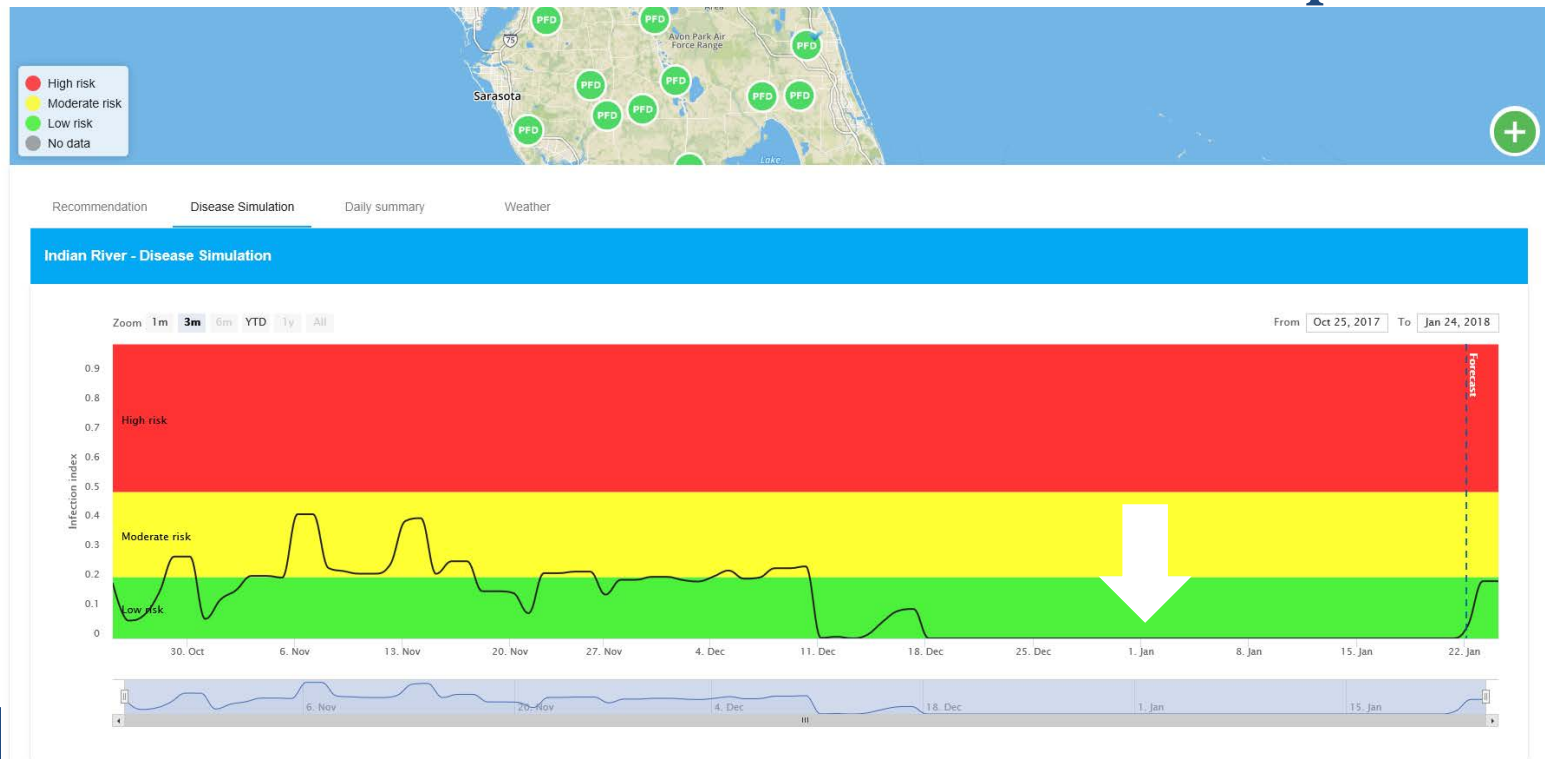
- o Low risk (green area)

- Index between 0-0.2; No spray recommended



Problem with station

- o Problem with leaf wetness estimates
 - Should see an increase in infection index overnight from dew
- o Please let us know ASAP if there is a problem



Daily summary of data

- o Gives leaf wetness, temperature, PFD index and risk level
 - Weather variables daily average
 - PFD index max. daily value

Recommendation

Disease Simulation

Daily summary

Weather

Loaded data!

Select a range of dates:

Begin date

2017-12-23

End date

2018-01-23

Export data

Date	LWD	Temp (F)	Temp (C)	PFD Index	PFD description
2018-01-23	15.00	67.0	19.4	0.198	Low risk
2018-01-22	15.00	56.8	13.8	0.134	Low risk
2018-01-21	14.00	57.8	14.3	0.133	Low risk
2018-01-20	15.75	50.0	10.0	0.072	Low risk
2018-01-19	0.00			0.000	Low risk
2018-01-18	13.00	52.0	11.1	0.078	Low risk
2018-01-17	13.00	52.0	11.1	0.078	Low risk
2018-01-16	13.00	49.4	9.6	0.055	Low risk
2018-01-15	13.00	49.4	9.6	0.055	Low risk
2018-01-14	17.25	64.8	18.2	0.214	Moderate risk

32 total

1

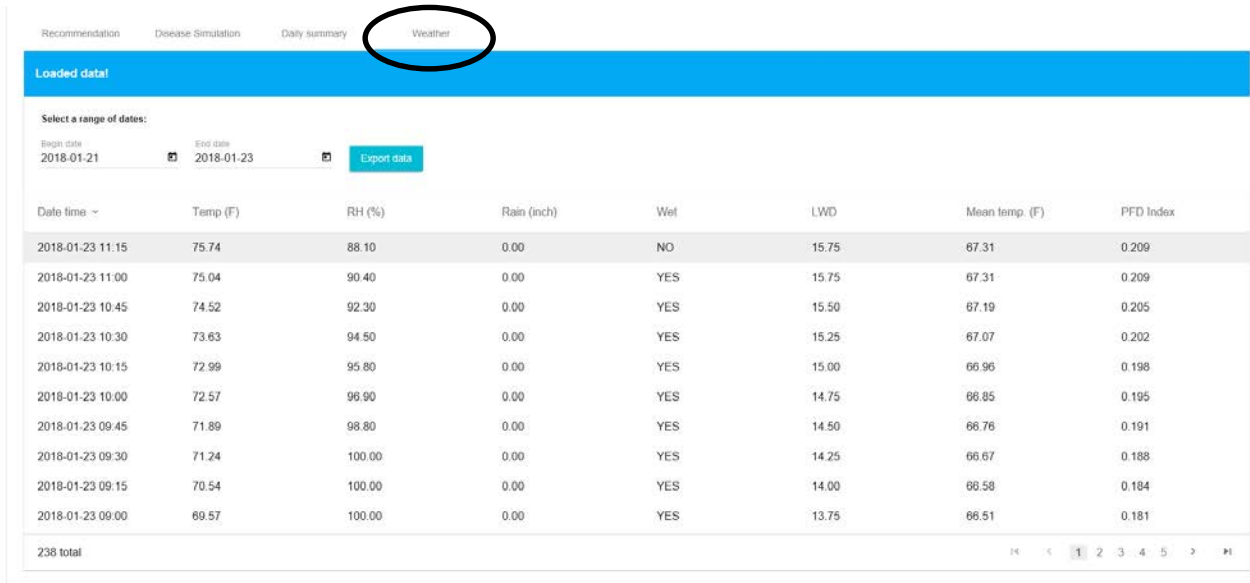
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3

4

Weather data

- o Can look at the weather data for every 15 min.
 - Temperature, relative humidity, rainfall, leaf wetness
- o Find out when drying periods occur
 - After 4 hours of drying, PFD index resets to zero



Recommendation Disease Simulation Daily summary **Weather**

Loaded data!

Select a range of dates:

Begin date: 2018-01-21 End date: 2018-01-23 Export data

Date time	Temp (F)	RH (%)	Rain (inch)	Wet	LWD	Mean temp. (F)	PFD Index
2018-01-23 11:15	75.74	88.10	0.00	NO	15.75	67.31	0.209
2018-01-23 11:00	75.04	90.40	0.00	YES	15.75	67.31	0.209
2018-01-23 10:45	74.52	92.30	0.00	YES	15.50	67.19	0.205
2018-01-23 10:30	73.63	94.50	0.00	YES	15.25	67.07	0.202
2018-01-23 10:15	72.99	95.80	0.00	YES	15.00	66.96	0.198
2018-01-23 10:00	72.57	96.90	0.00	YES	14.75	66.85	0.195
2018-01-23 09:45	71.89	98.80	0.00	YES	14.50	66.76	0.191
2018-01-23 09:30	71.24	100.00	0.00	YES	14.25	66.67	0.188
2018-01-23 09:15	70.54	100.00	0.00	YES	14.00	66.58	0.184
2018-01-23 09:00	69.57	100.00	0.00	YES	13.75	66.51	0.181

238 total

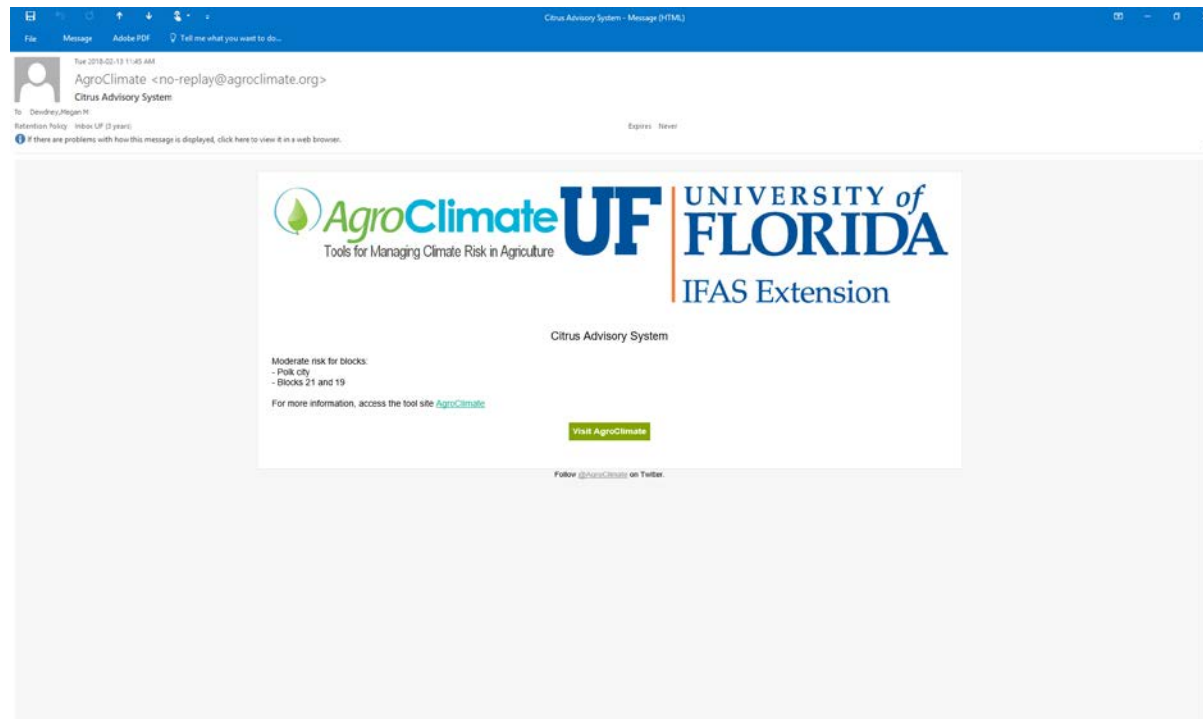
With an account

- o Can mark specific blocks of interest
 - Map and satellite views
 - Use map to find block and satellite to mark
- o Specific risk assessment for location



Will send alerts

- o SMS alerts for each location
- o E-mail notification
- o Can choose both

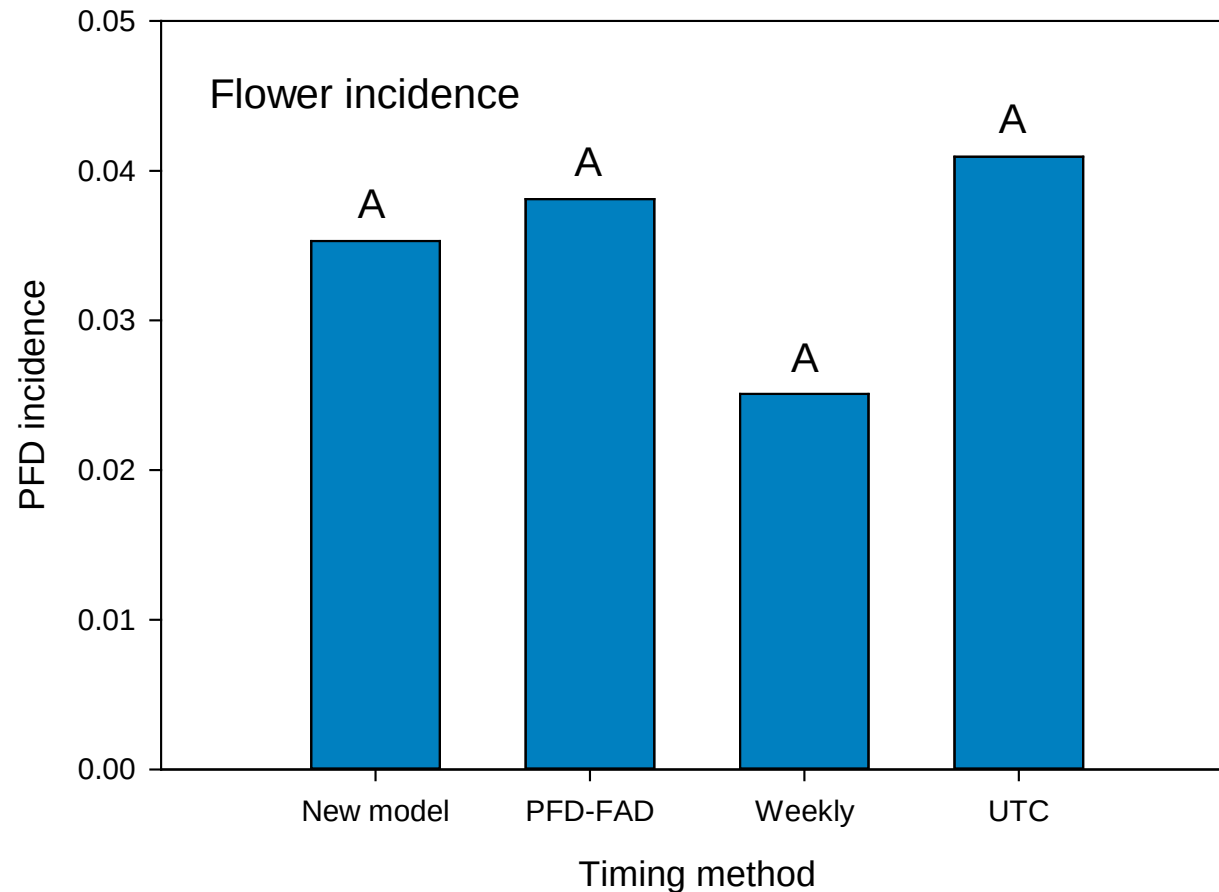


How do application timings compare?

- o Fort Meade grove in 2017
 - Valencia on Swingle with history of PFD
 - Headline at 15.5 fl. oz./acre
- o Four timing treatments:
 - No applications
 - Weekly for three applications
 - March 8th, 15th, 22nd
 - PFD-FAD (fungicide application decision)
 - Two applications recommended on March 15th, 24th
 - New PFD model
 - No applications recommended

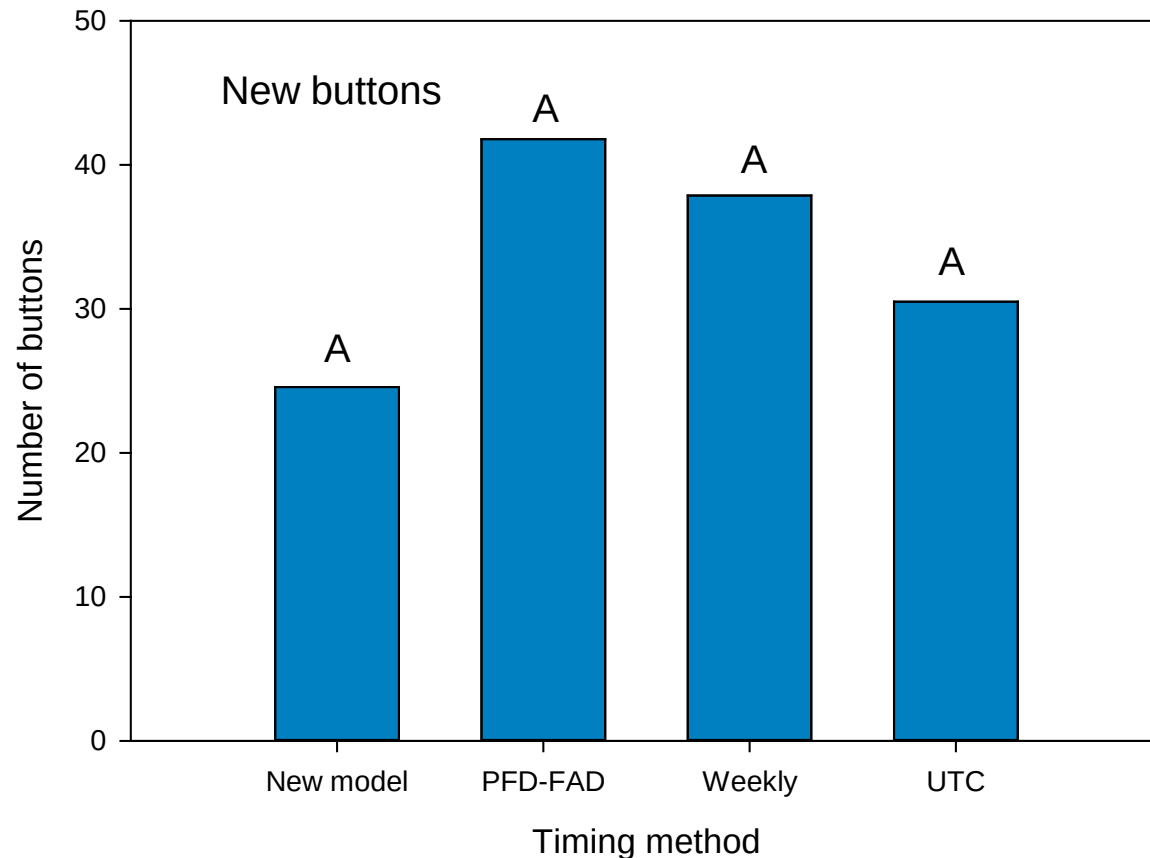
Flower incidence

o Data collected March 27th



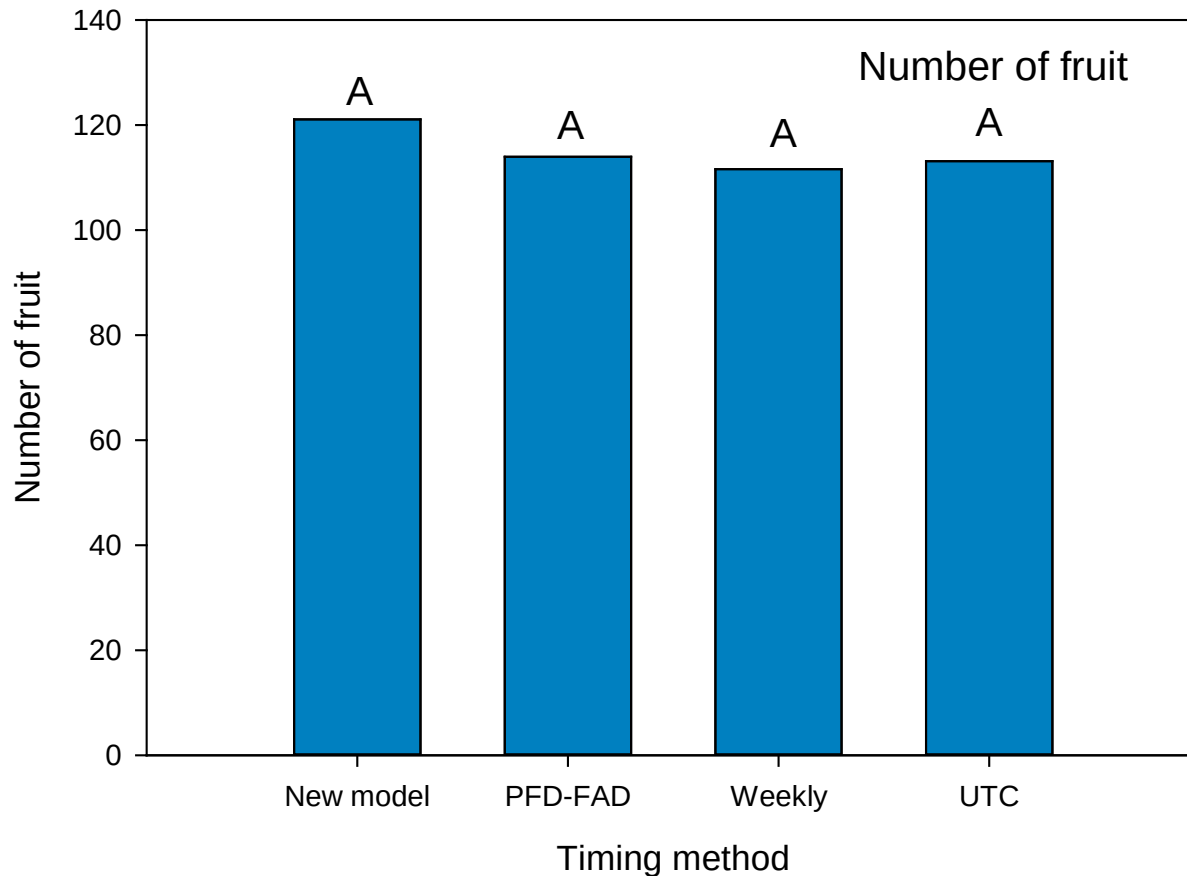
Post-application buttons

o Button data collected June 8-9th



Number of fruit

o Data collected July 20th



Conclusions

- o New model was released this week for the 2018 PFD season
 - Fewer data inputs; easier to use
 - Login system should make block-by-block planning easier
 - When infection triggered should make fungicide recommendation
- o Working with programmer to detect and fix bugs
 - Expect occasional difficulties with program first year
 - Want your feedback on problems and ways to improve

Model performance conclusions

- o 2017 season had low PFD incidence
- o New model did not recommend a spray
 - There were no disease intensity differences among treatments
 - Means that the ‘no application’ recommendation was correct
 - Cost savings of three applications compared to weekly applications
 - Repeating experiment in 2 locations in 2018
 - Validation is an important part of model design

Up-coming season

- o Bloom should be more concentrated than last year
 - Still at least three waves of flowers
 - Not sure what Irma did to bloom
- o Key to season will be timing of rain in relation to flowers
 - If have open flowers with rain, could be setting up initial round of infections
 - No more rain - no PFD
 - La Niña season like last year; supposed to be dry
 - If continues to rain – PFD very likely
 - Would still conserve fungicides for largest bloom period
 - Use a model to time applications

Recommended products

- o Nearly all recommended products contain a strobilurin (Abound, Gem, Headline)
 - Rotation is difficult
 - Ferbam with a strobilurin is a good combination
 - Preformed well in several seasons of trials
- o Premixes with alternate modes of action (in addition to a strobilurin)
 - Priaxor (SDHI), Pristine (SDHI), Amistar Top (DMI)
- o Remember 4 applications of strobilurins within year is legal limit
 - 3 applications of ferbam

CITRUS CANKER



Some slides adapted from E. Johnson

Fruit susceptibility to canker

- Fruit most susceptible from 3/8 in. diameter until fruit reach ~1.5 in. dia
- Rains in April, May, and June promote early season infection
- Rind becomes much more resistant fruit > 1.5 in. dia
- The rind susceptible throughout entire fruit growth period
- Early bloom may affect timing of susceptible fruit size



Cu sprays at 21 day intervals protect fruit beginning at 3/8 in.: Spray volume and tractor speed important for fruit coverage



Why a 21-day interval?

- oCopper residue is significantly reduced by rain washing
- oCopper does not move once dried
- oCopper residue is cracked by fruit growth



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

Proper Application of Copper

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

Field Trials

- o 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
- o Compare soluble and fixed copper formulations for efficacy
 - 2011, 2014, and 2015

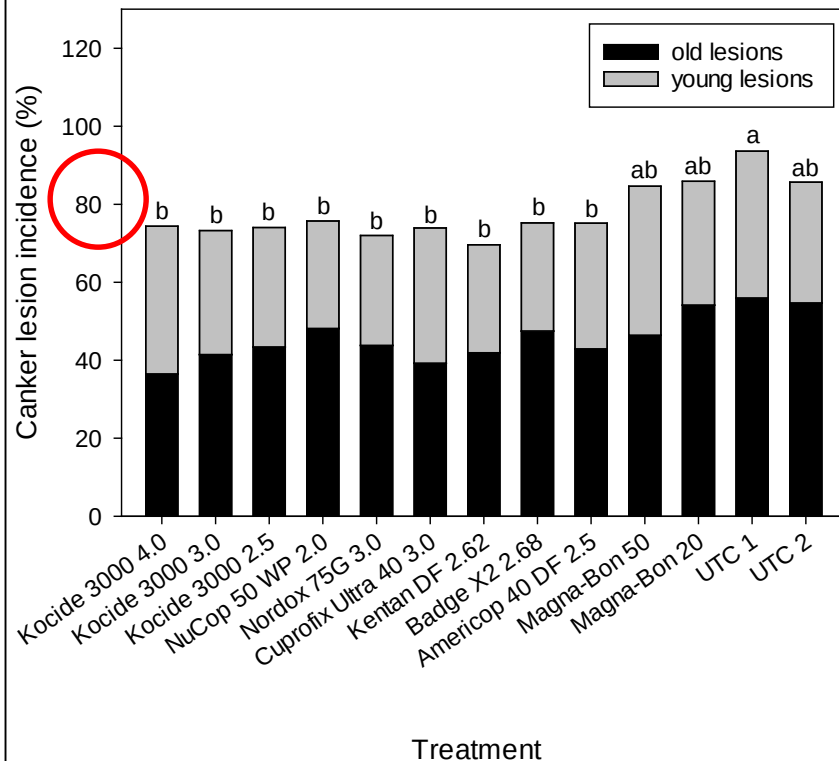
Timing and weather matters

- oNeed to watch early season weather forecasts for rain

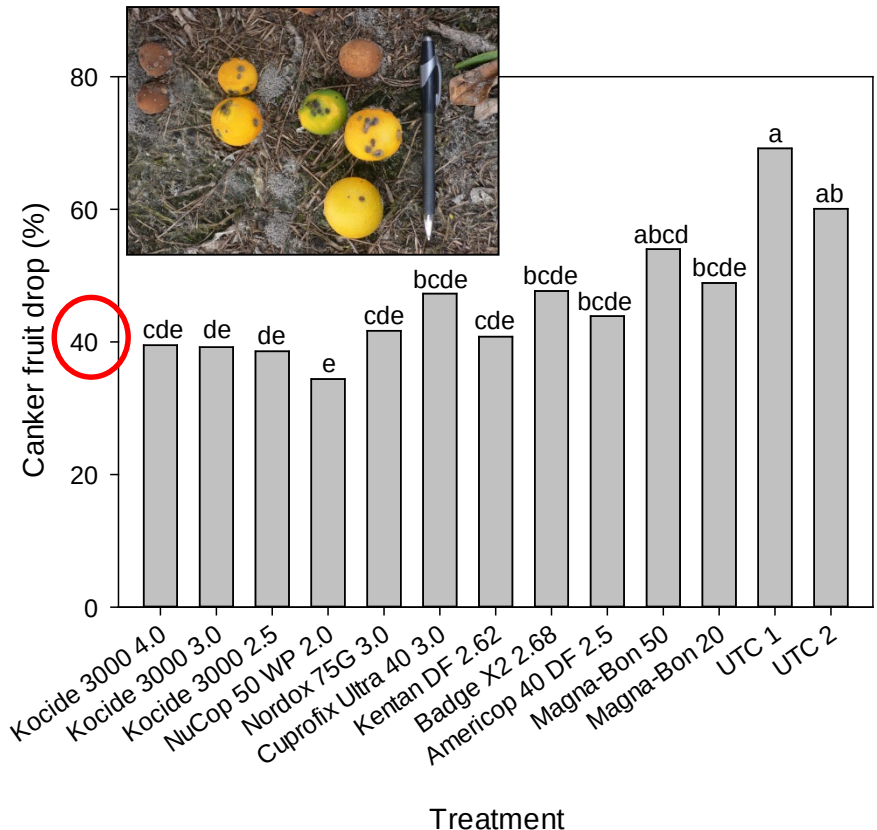
- oEffects of being too late

- In 2011, 9 sprays began 15 April (too late) to 27 Sept attempting to reduce impact of early epidemic

Fruit canker 2011



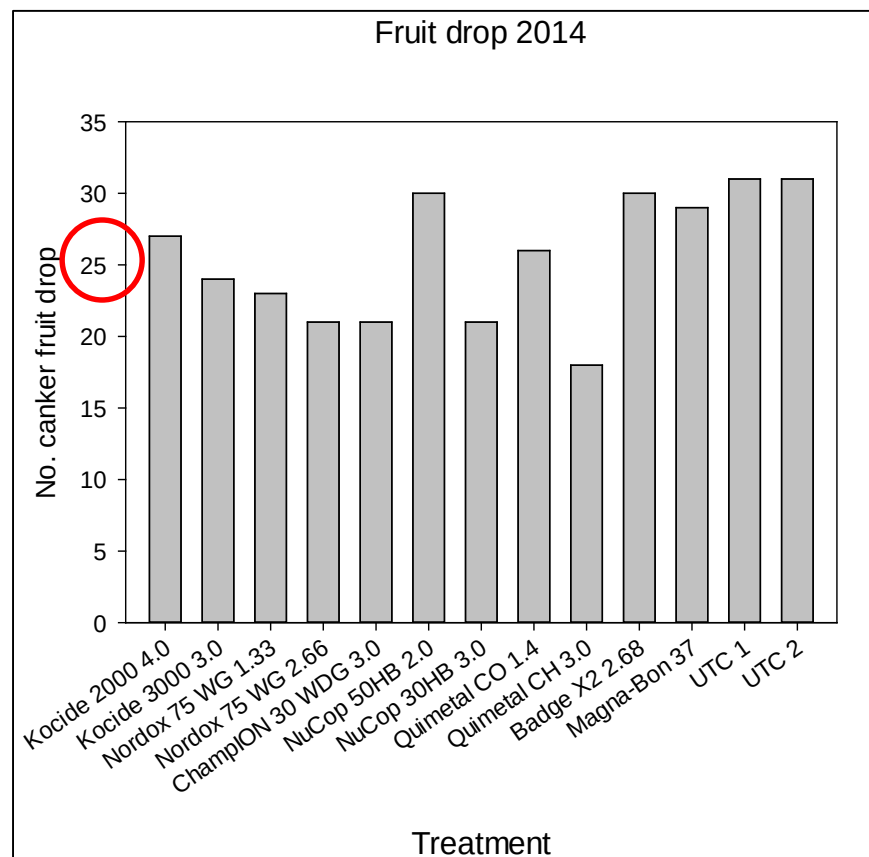
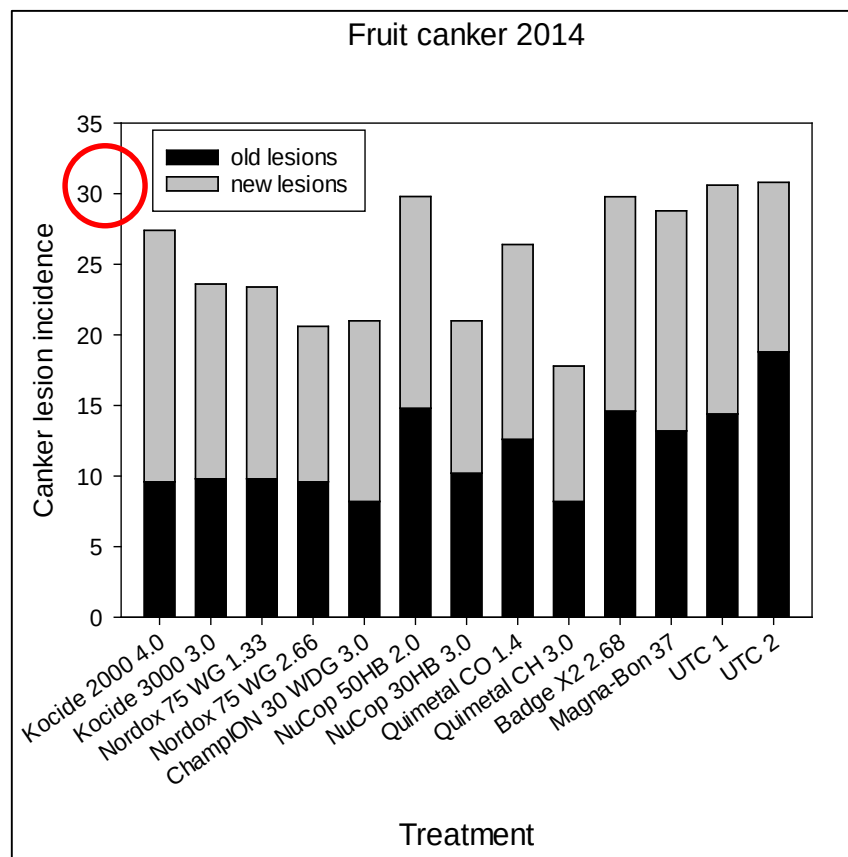
Fruit Drop 2011



Dry spring

o Limited early season infection

- In 2014, rain below average when fruit most susceptible size

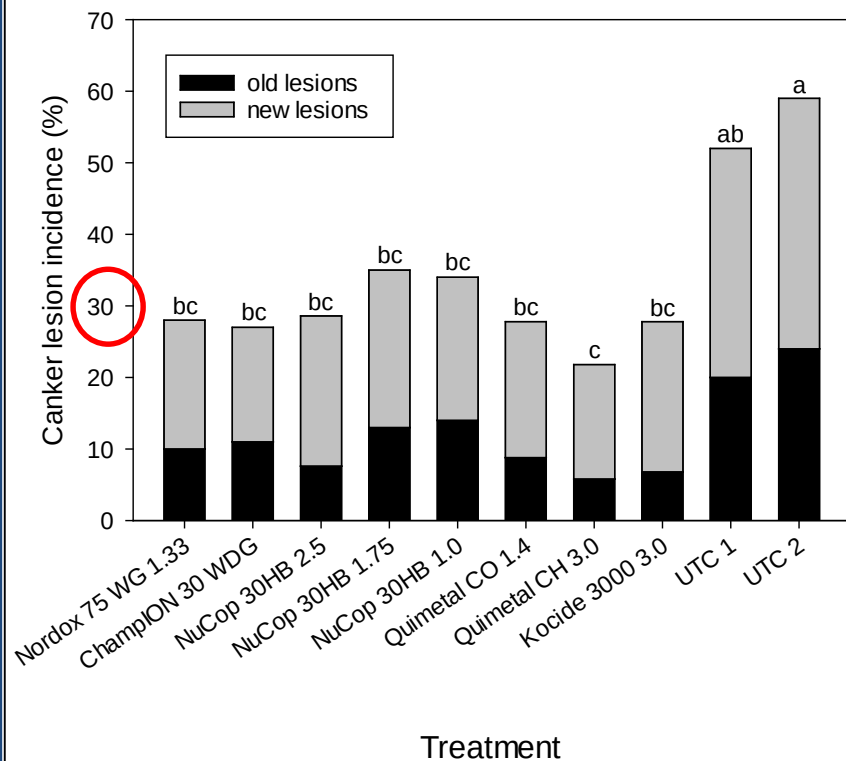


Well timed application

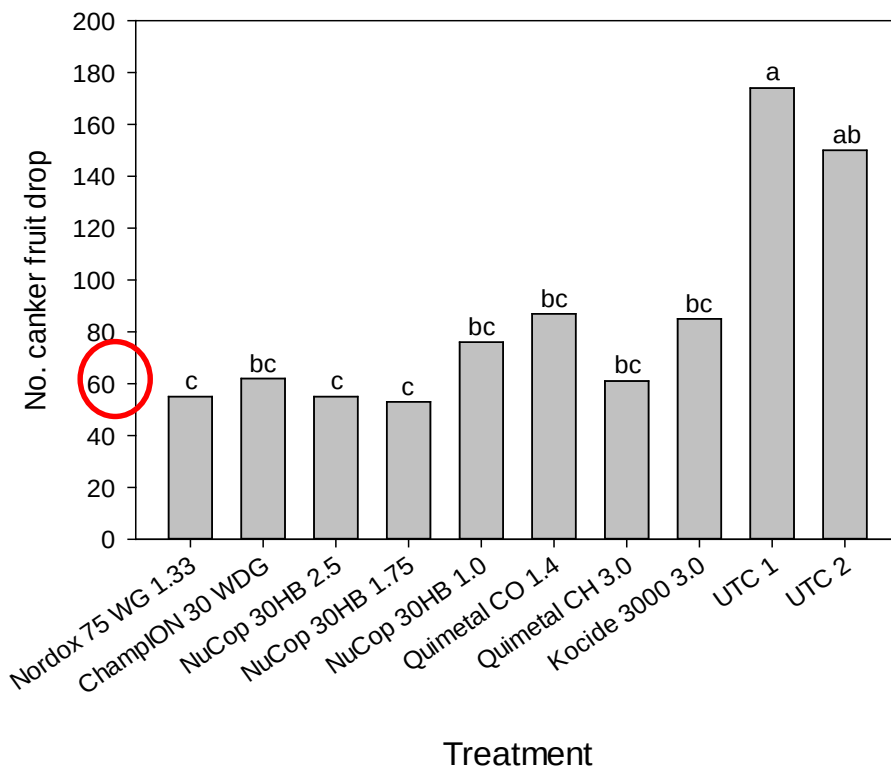
o Well timed applications can mitigate unfavorable rainfall patterns

– 2015, April rain greater than average when fruit at most susceptible stage

Fruit canker 2015

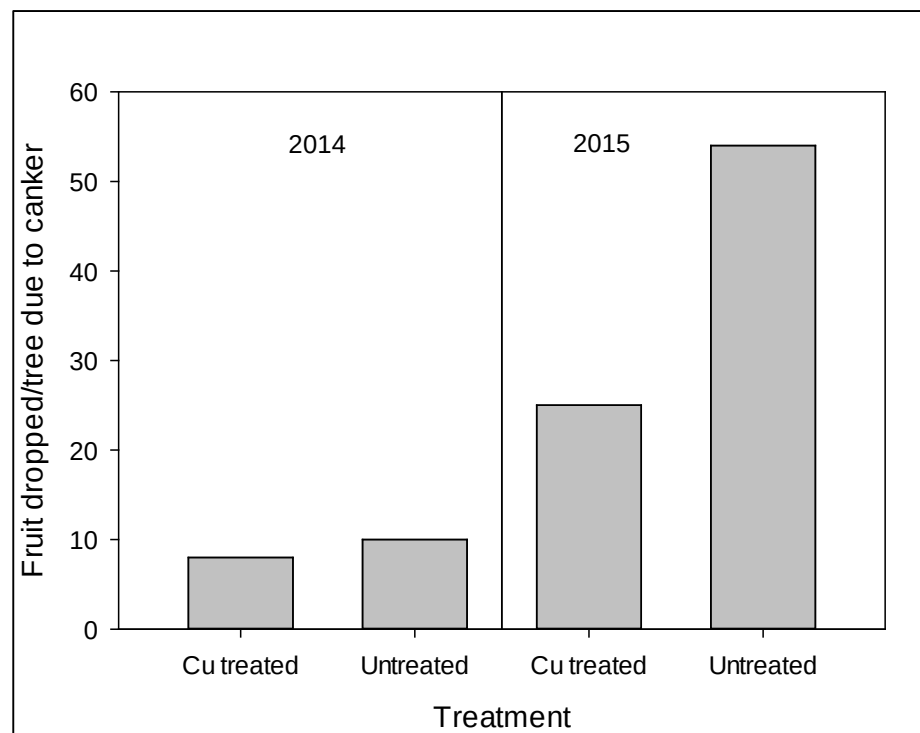
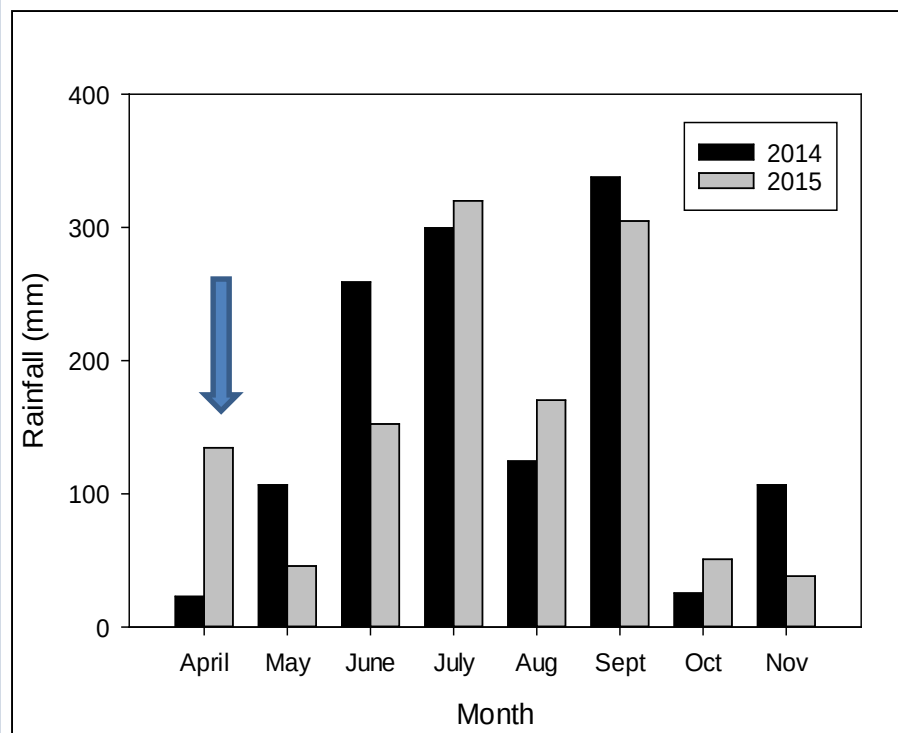


Fruit drop 2015



Effect of inoculum carry over

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



How does Irma change things?

- o On all trees, hurricane force winds force bacteria past any barriers
 - Considerable mature leaf infection (even Valencia) and stem lesions
 - Particularly bad in young blocks, especially if high canker in surrounding blocks
- o Stem lesions found on twigs with green bark
 - Quite visible still and advisable to prune out in young blocks while still dry
 - Will contribute years of inoculum; leaves only supply significant inoculum for a few months
- o For non-bearing and young blocks, Actigard recommended
 - Copper does not control stem or leaf lesions
 - Will help to suppress inoculum

Conclusions on Application Timing

- Spray timing before rains in late-March to early-April 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
 - Irma has amplified inoculum this spring and in future
- Early fruit infection leading to fruit drop depends on late March-April 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
 - If for juice production, these are less of a concern

New materials under development

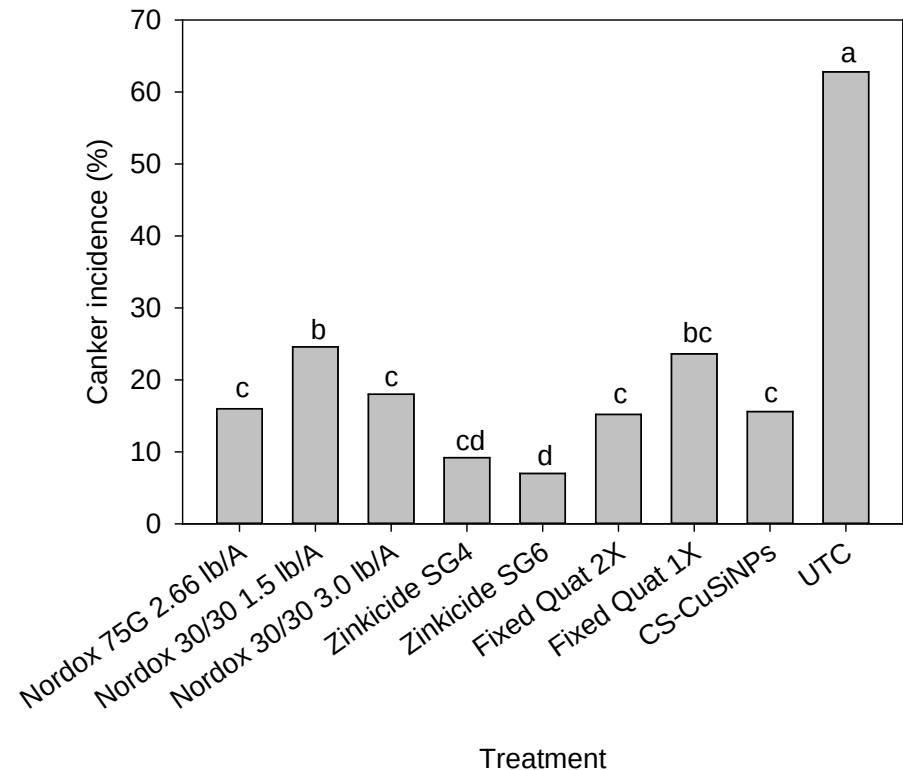
In collaboration with: Evan Johnson and Swadesh Santra, UCF

Multiple new products under development

- o Core-shell Copper
 - Reduced copper based on surface area
- o Fixed-Quat
 - Quaternary ammonia immobilized to keep bactericidal activity and prevent phytotoxicity
- o Zinkicide
 - Zinc-based nanomaterial using plant metabolizable ingredients
- o Tested in grapefruit trial because of susceptibility

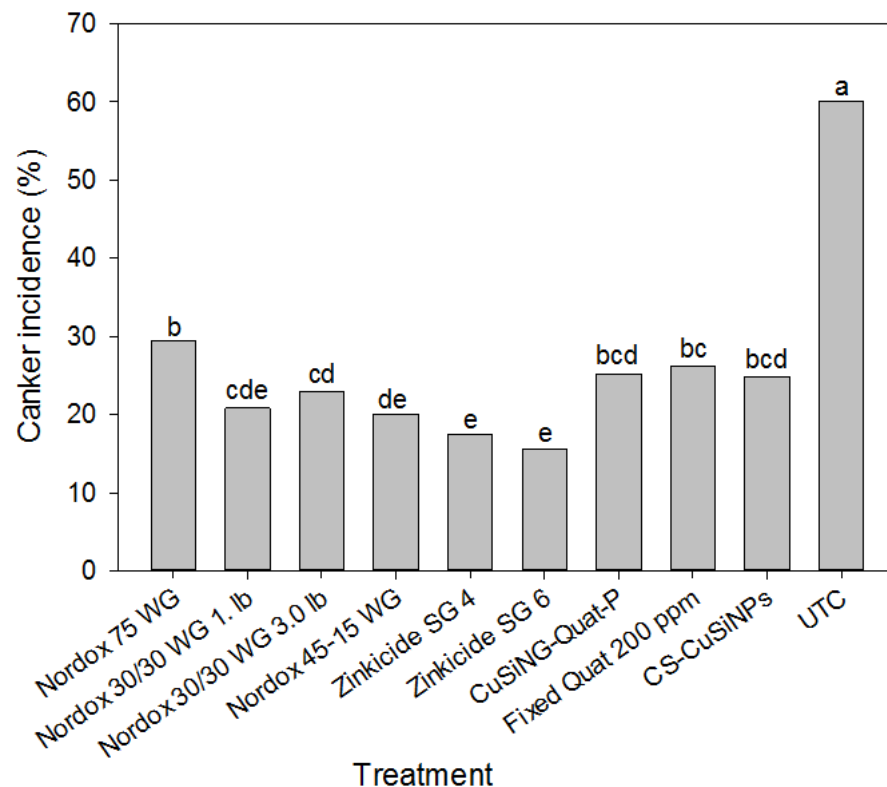
2014 Grapefruit canker trial

- o Equivalent efficacy to copper
 - Core-shell copper
 - Fixed-Quat
- o Zinkicide control exceeded Cu and Cu/Zn



2015 Grapefruit canker trial

- o Equivalent efficacy to copper
 - Core-shell copper
 - Fixed quat
- o Zinkicide control matched commercial Cu/Zn at same rate of Zn



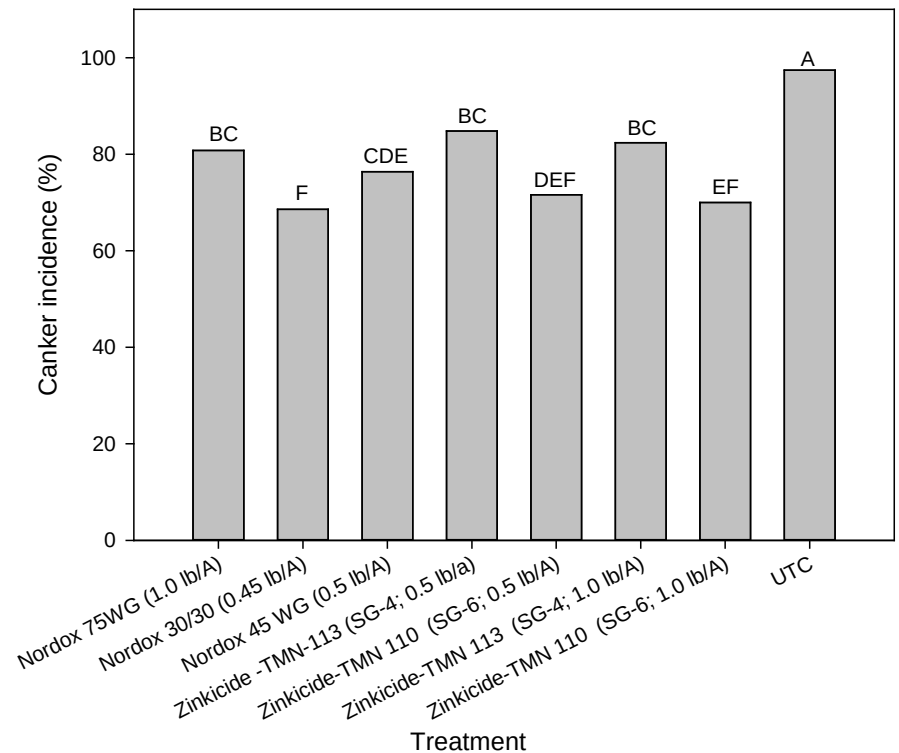
2017 Grapefruit canker trial

o Oh Irma!

– Nearly 100% incidence in UTC

o All treatments significantly better than UTC

– Nothing gave satisfactory control



Conclusions

- o Provide Copper equivalent or better efficacy
- o Reduce metal or Cu applied to the field
- o Provide rotation alternatives to Cu
 - Resistance management
- o Licensing and registration for commercial availability underway
 - Time to available product is difficult to predict
- o Hurricane force winds break any form of control



CITRUS BLACK SPOT



Spores of importance

- o Only one spore type present in Florida
 - Only splash dispersed conidia present
 - Every other location with disease has two: ascospores and conidia
- o Known to be abundant in the leaf litter
 - Present in high numbers all year
 - When in canopy, tend to move down more than splash up
 - Rain splash likely moves spores into lower canopy from leaf litter

Large Scale Field Trial

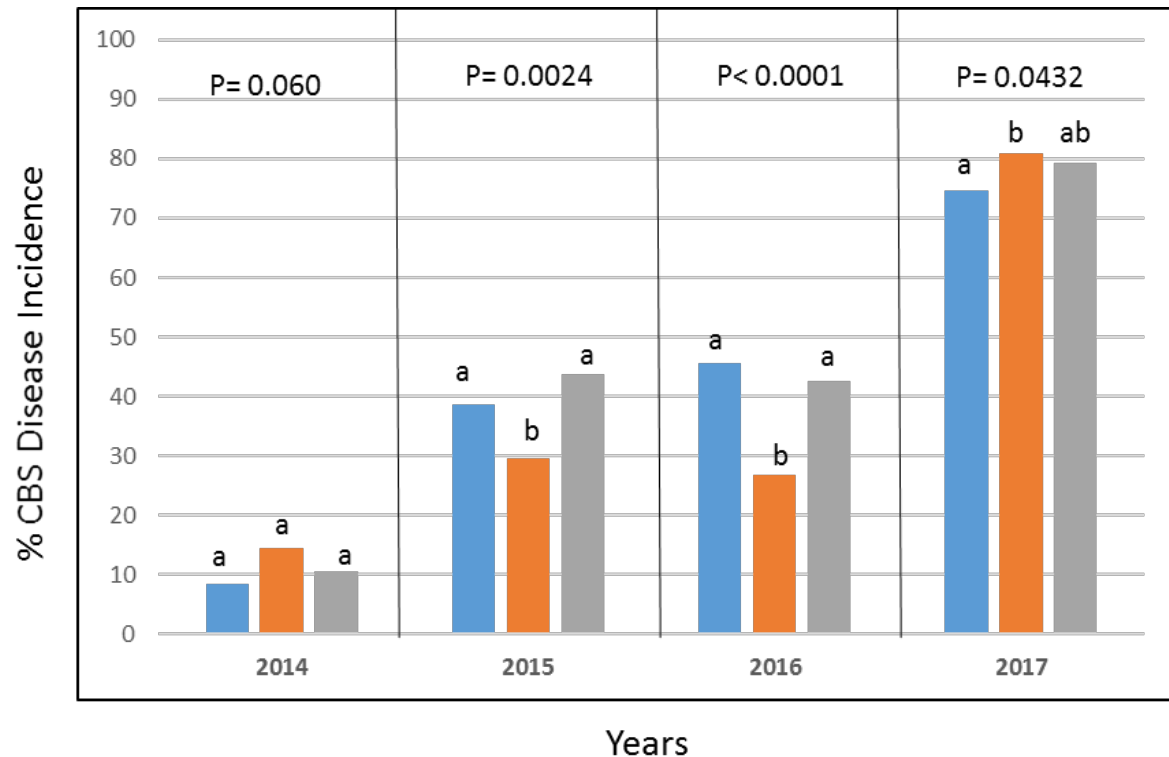
- o 20 year-old Valencia
- o 3 treatments
 - Urea (40 lb/acre)
 - Soil-set (1.3 fl oz/acre)
 - a compost accelerator
 - Untreated control
- o Applied with herbicide booms at 50 gal/acre in a 10 ft strip
- o Three rows treated per rep, middle row evaluated for disease



Disease Incidence

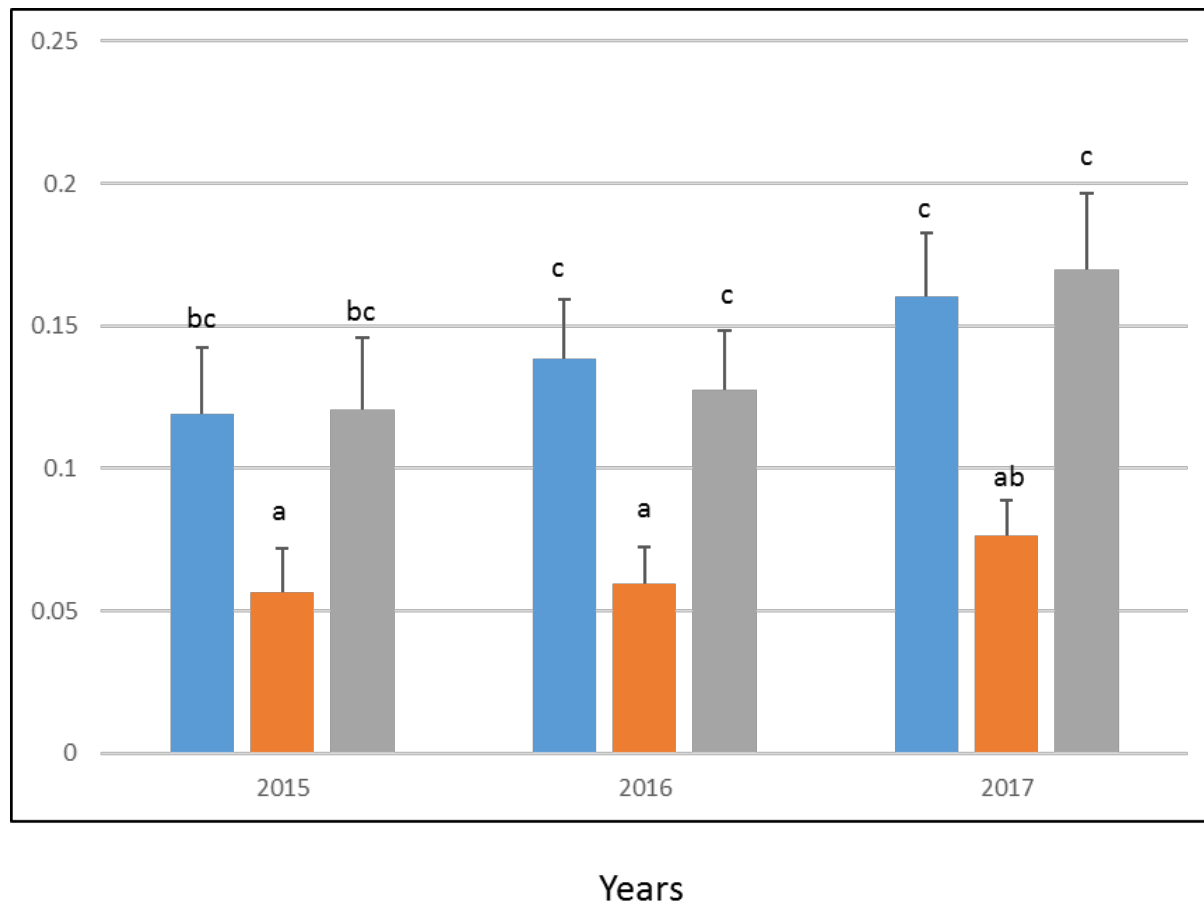
- o Data taken spring following treatment
- o Disease incidence lower in 2015, 2016 post-trt for Soil-set but not 2017

Blue = urea
Orange = Soil-set
Gray = UTC



Disease Severity

o Soil-set consistently had the lowest disease severity



Summary

- o Disease incidence consistently increased over the four years of the trial
- o Despite conidia being only spore type present, enhanced leaf litter management improved disease management
- o Soilset had the greatest reduction in disease incidence and severity
 - Urea did not have the same effect

Black spot program

- o Fungicide applications should start mid-April to early-May
 - Dependent on April rainfall
- o Monthly applications until September of fungicide
- o Alternate copper (full rate of chosen product) with a strobilurin, a premix, or Enable
 - Preferable to alternate among modes of action
 - Strobs are Abound, Gem, Headline
 - Premixes are Pristine (SDHI), Amistar Top (DMI), and Priaxor (SDHI) and contain a strobilurin
- o Coverage is key so at least 125 gal/acre and slow!

Acknowledgments

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Any Questions?



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