Sensible sprays: Why bother? Keeping resistance in check; and contribution of biological control.

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Hypothesis: Plant health is affected by pathogen inoculation frequency

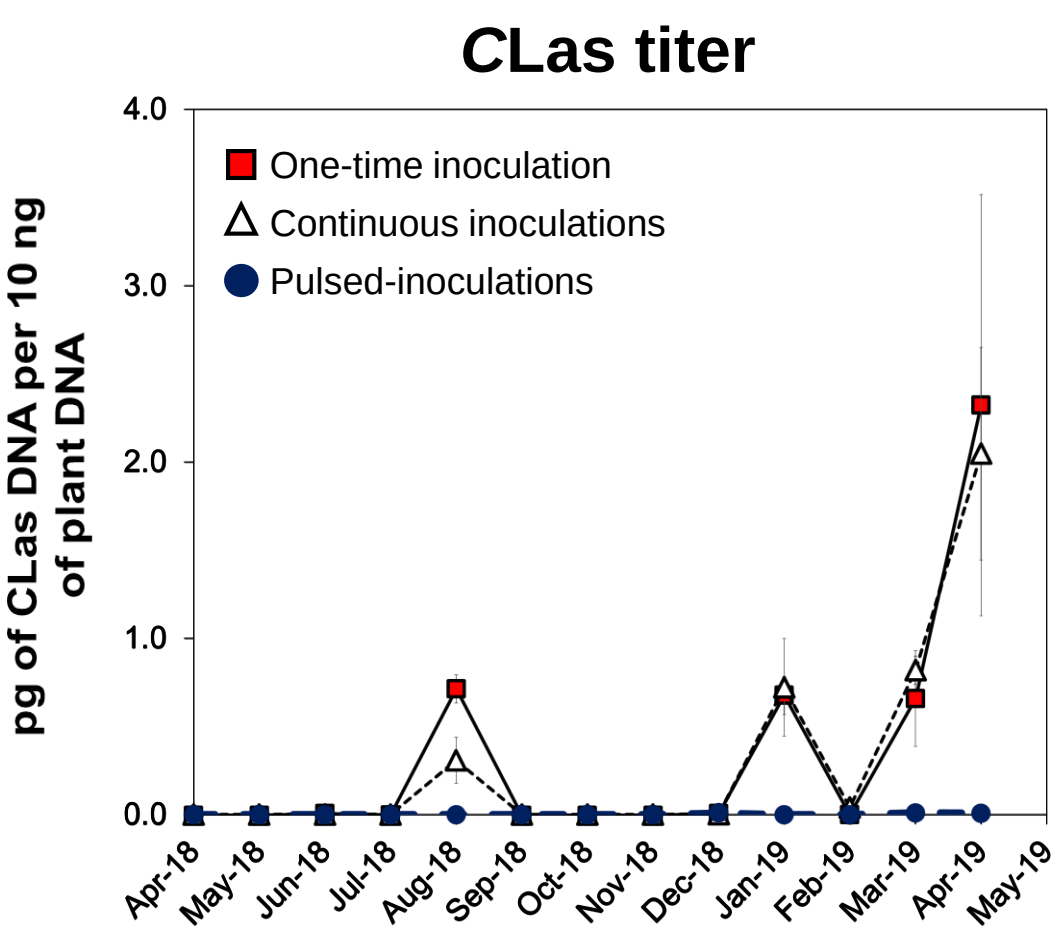
Citrus sinensis
cv Valencia

Challenged with:

1) *C*Las-infected
or
2) Non-infected
ACP

1. One-time inoculation
2. Pulsed inoculation
   (Periodic invasions)
3. Continuous inoculation
   (Constantly reproducing
   resident population)

Pathogen titer not related to inoculation frequency

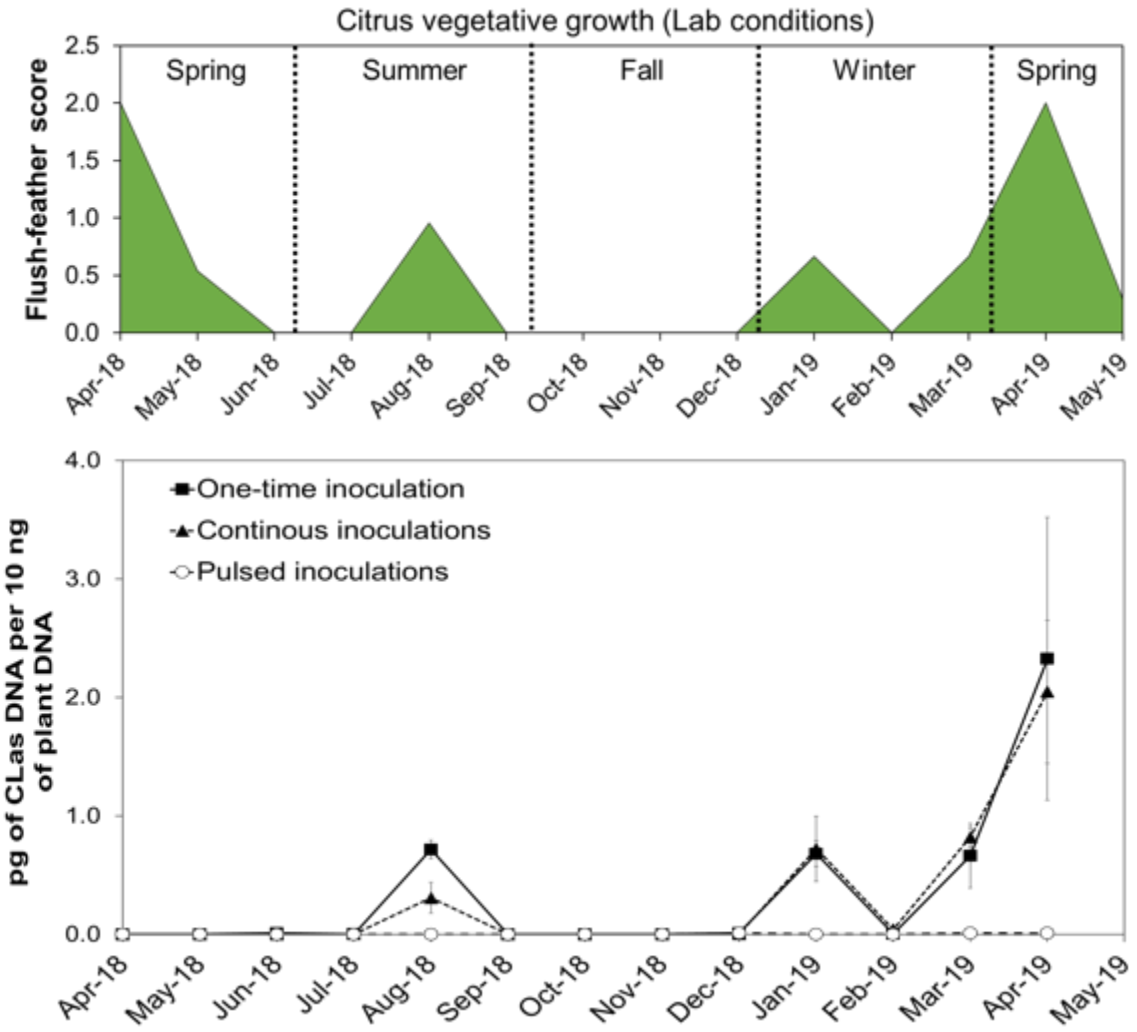


Plant health

	CLas-infected ACP	Non-infected ACP
→	Intermediate	Good
→	Poor	Poor
→	Good	Good

Temporal Dynamics of *Candidatus* Liberibacter asiaticus Titer in Mature Leaves from *Citrus sinensis* cv Valencia are Associated with Vegetative Growth. Journal of Economic Entomology. *In Press*

CLas titer fluctuations correlated with vegetative plant growth (flush); not to how many times a hot psyllid infects it.



Larger cage experiment in Texas (Mamoudou Setamou, Texas A&M)-same results

HLB +; No ACP

HLB +; Pulsed (monthly) ACP

HLB +; Continuous ACP

HLB -; No ACP

HLB -; Pulsed (monthly) ACP

HLB -; Continuous ACP

General observations

- CLas titer in leaf tissues is not affected by inoculum load imparted by the vector

- Fluctuations of bacterial titer are related to flushing cycles, suggesting that the CLas bacterium is transported through phloem during annual movement of carbon compounds needed for vegetative plant growth

- Plants respond to pulses of ACP feeding with boost to plant defense--against *C*Las? HLB symptoms?—Open questions

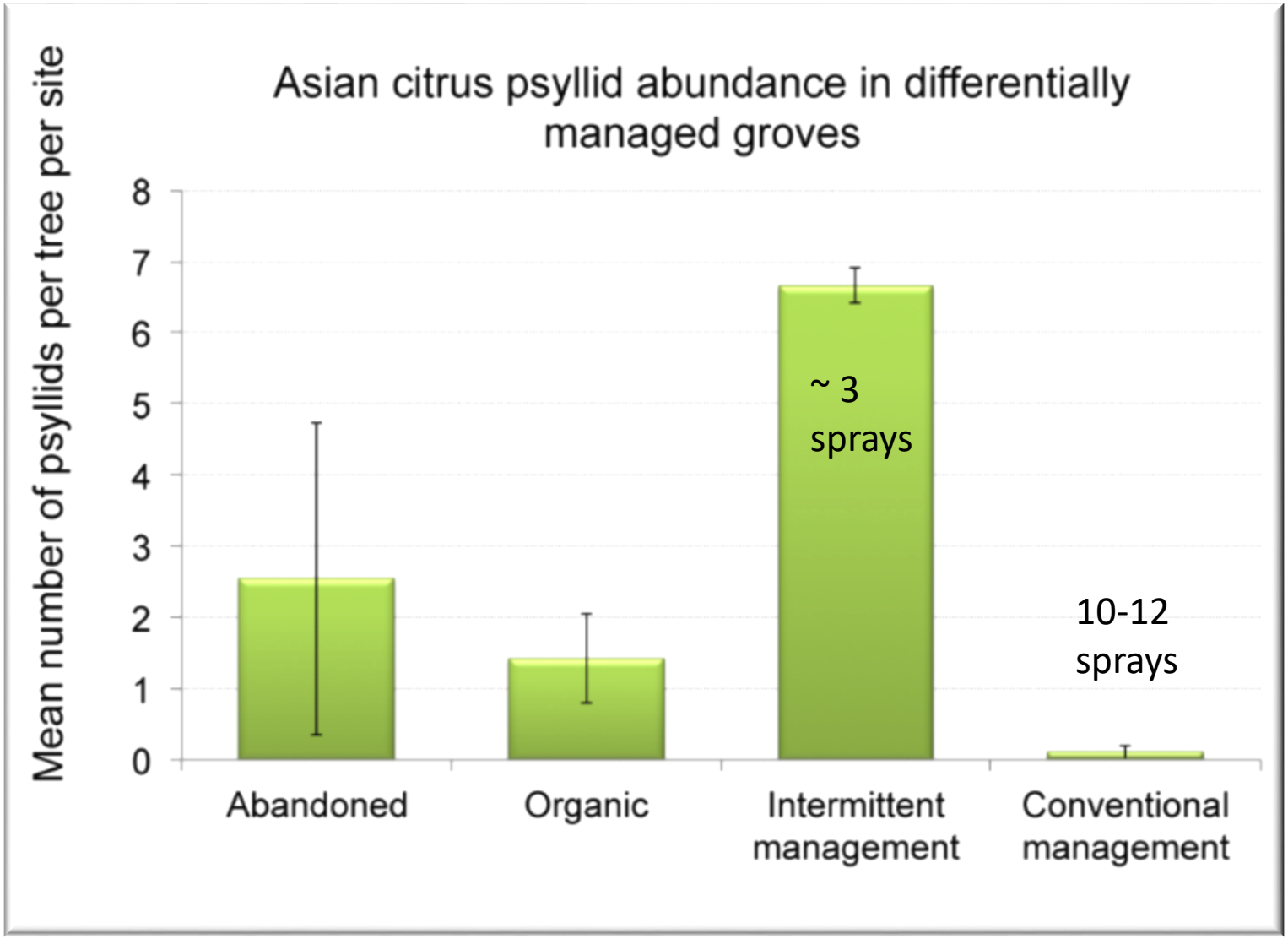
- Long-term ACP feeding suppresses plant immunity and inhibits growth, which may highlight the importance of vector suppression as part of HLB management

Brainstorming

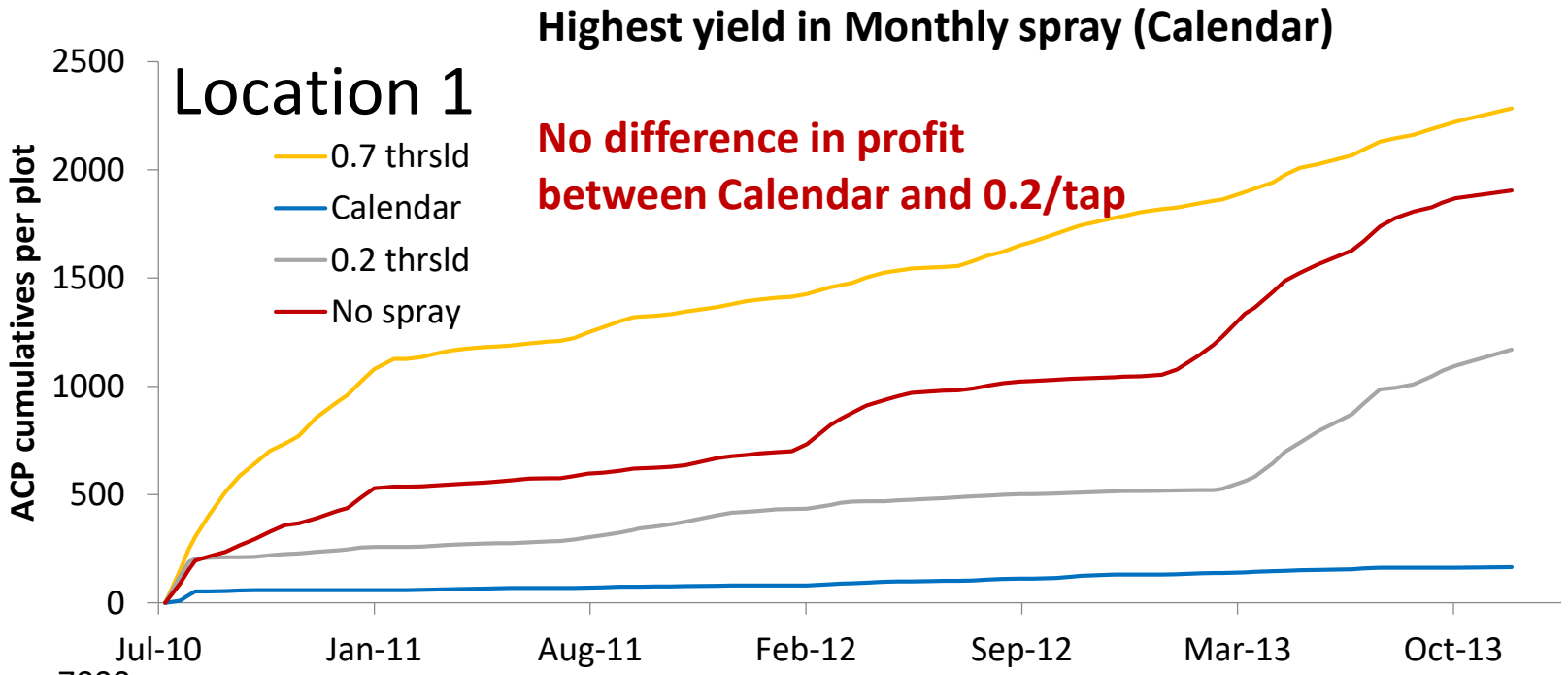
- Keeping ACP out of the equation seems important for maintaining productivity

- What can be done?

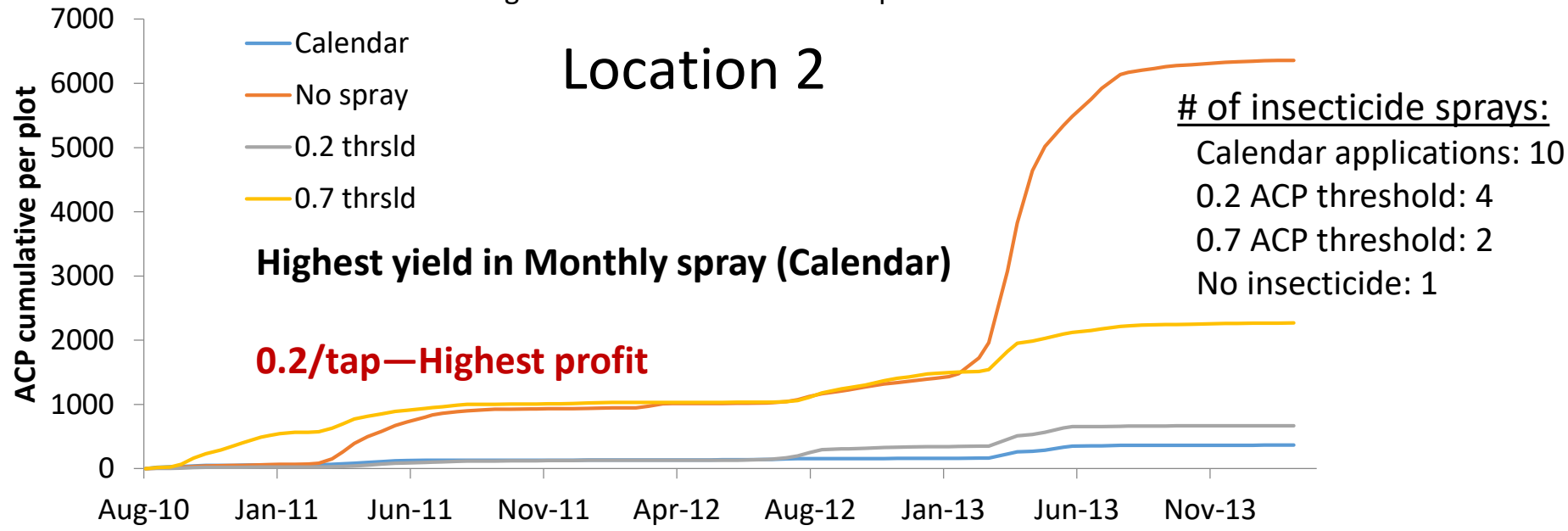
Most psyllids found where management is intermittent (2016-17) – Average from 4-13 groves



Reduce spray frequency by incorporating economic threshold



How many is too many?



# of insecticide sprays:

Calendar applications: 10

0.2 ACP threshold: 4

0.7 ACP threshold: 2

No insecticide: 1

Measuring contribution of biological control

Two ACP management practices were compared: i) Organic and ii) Low input (2-4 annual sprays) conventional. Trees were 10-12 year old sweet orange 'Valencia'. The study was conducted in 2019 form March to June and July to September

4 days

Uncaged

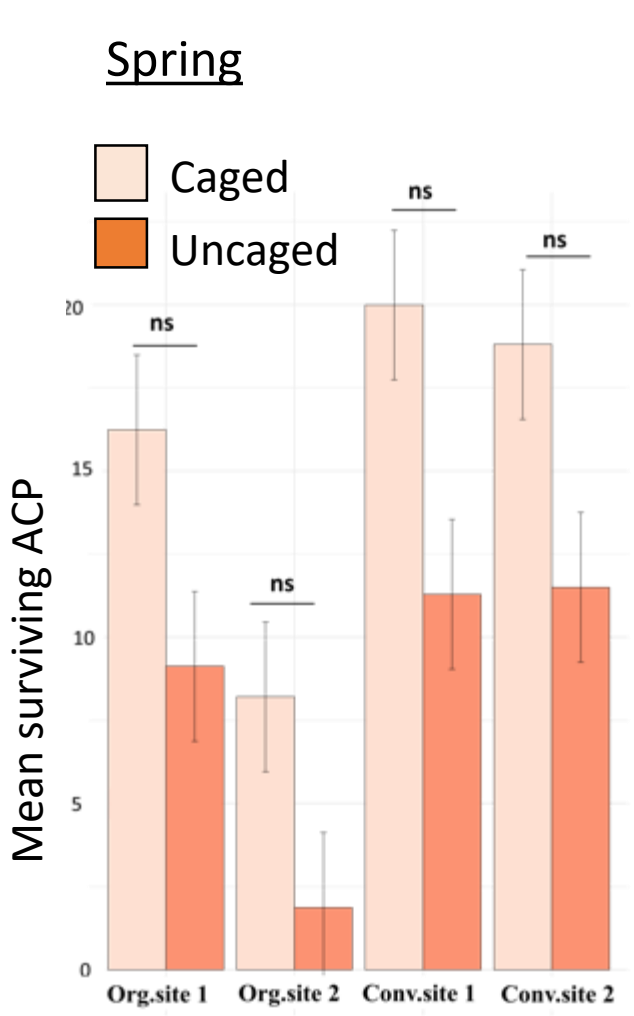
Caged

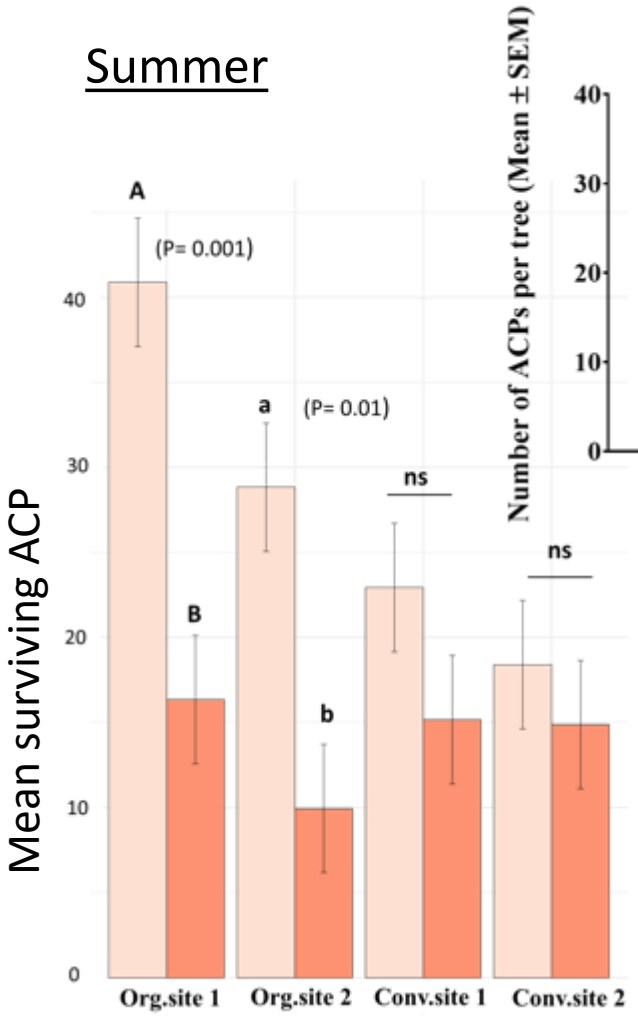
Released two pairs of ACP sentinels with and without exclusion cages

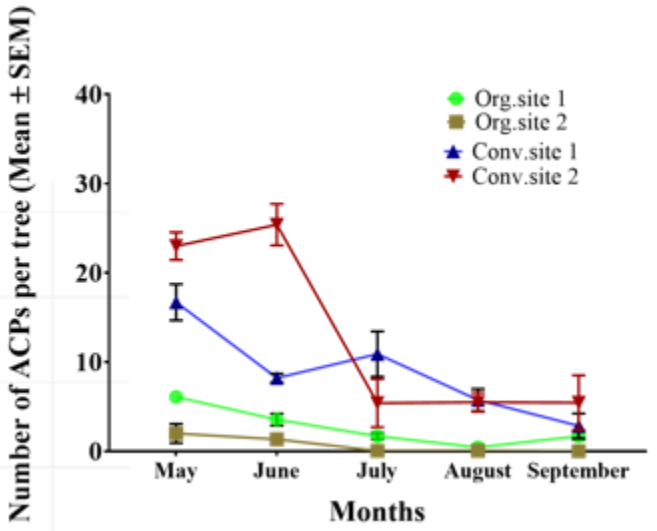
- Natural enemies were recorded during 2-minute visual inspections.
- Tap samples were used to monitor the abundance of ACP.

Number of ACP were counted for three weeks after deployment

Mortality of uncaged ACP significantly higher than caged ACP in organic; not so in conventional (~ 3 sprays) groves during summer.







ACP densities lower in both organic groves than in groves treated intermittently with conventional insecticides

Grove management type

Insecticides-What seems to work?

- Initiating sprays during the dormant period and then continuing to spray when populations begin to rise (associated with flush). A threshold can be useful

- You can hold back from spraying if there are no psyllids, but you can't forgo spraying and allow periods of standing populations.

- Managing psyllids on a large, continuous scale

What doesn't seem to work and what are the challenges?

- Spraying intermittently without staying on top of the population. Should not allow population to rebound if you're going to be killing off the biocontrol agents anyway

- If you're on an island of management surrounded by a sea of psyllids; the storm never ends

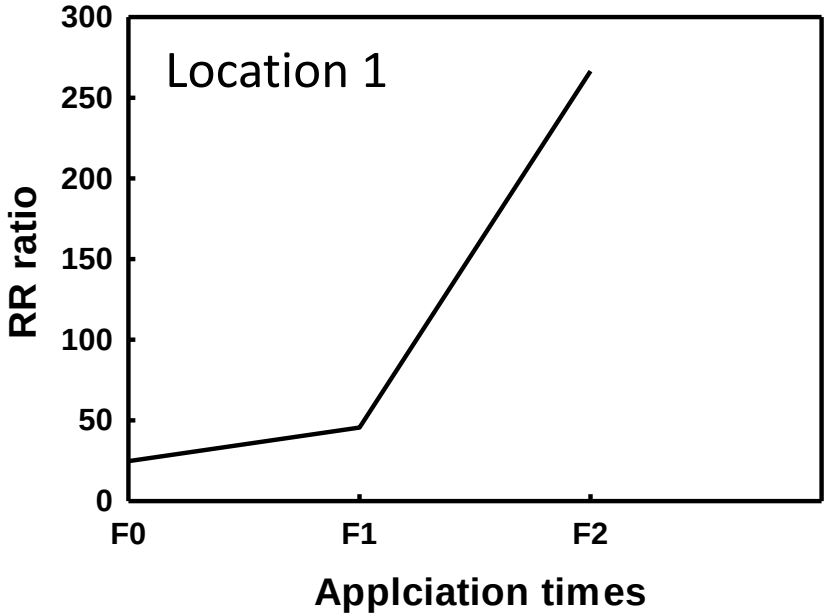
- Seamless integration of sprays and biological control is a challenge; This has stumped me to date.

What else (beyond insecticides) seems to work?

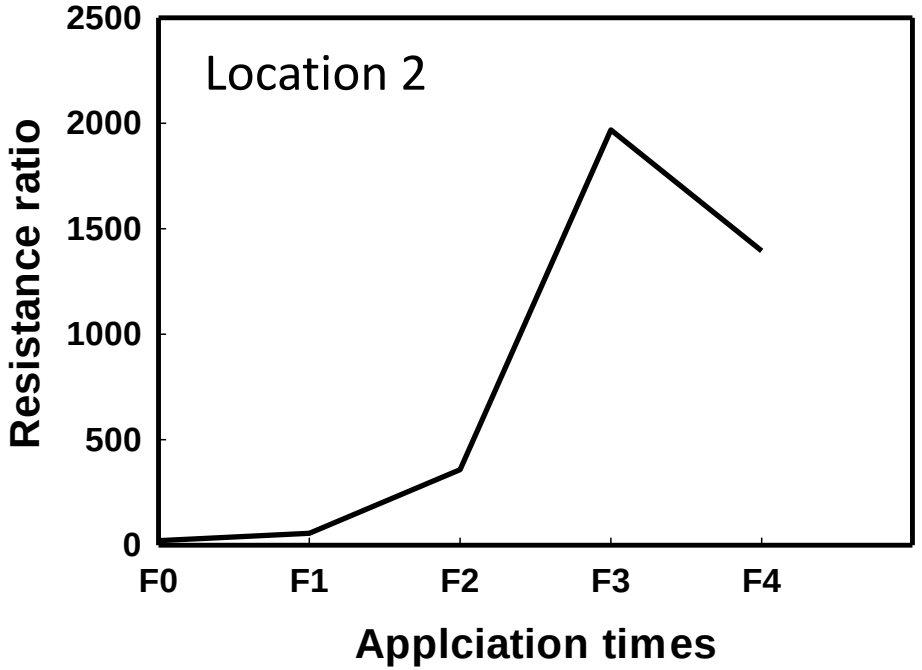
- Psyllid exclusion techniques to keep psyllids off, if those tactics can somehow be integrated into your practices

- Biological control under certain circumstances seems to keep ACP populations at bay; however, those groves with no other means of reducing ACP are not usually producing pre-greening yields

Resistance shows up fast!



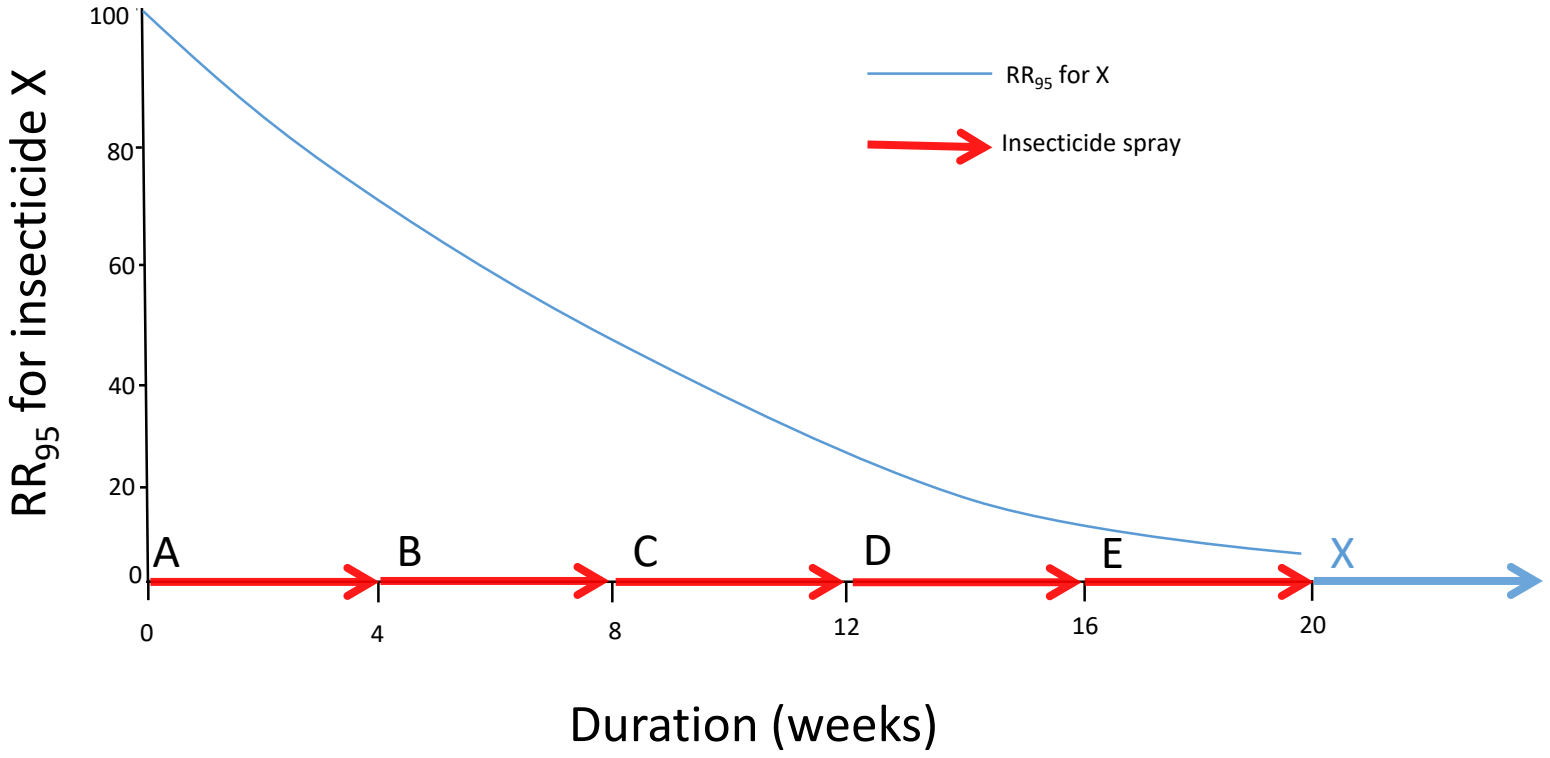
We observed 200-500 fold resistance with 2 back-to backs; ~2000 fold after 3 consecutive failures to rotate



Rotating 5 modes of action in sequence cause reversal to susceptibility for over-selected MOAs

5 sequential MOAs-Protocol if known resistance to insecticide X

5 sprays every 4 weeks under ideal conditions is close to 5 ACP generations



Conclusions:

- ACP in Florida are insecticide resistant in numerous locations and regions; primarily to the neonics. *It's sporadic*

- Insecticide resistance can be effectively managed by rotating 5 modes of action in sequence

- Six ACP generations are required to for reversal of insecticide-resistant populations to susceptibility; approximate field time of 20 weeks

The best solution: Integrated Pest management (IPM)

- Combination of cultural, chemical and biological control tactics
- Diversifying selection forces and complicating adaptation
- Resistance to one tactics can be compensated for by other tactics
- Investigating whether thresholds can predict need for sprays