Possible IPM approaches to pest management under HLB

Lukasz Stelinski

University of Florida, Entomology and Nematology Department, CREC, Lake Alfred, FL

Key Features of IPM

- Regular monitoring
- Combination of control methods
- Minimizing harm to beneficials and the environment
- Deciding whether treatment is necessary after assessing the pest populations

The Economic Threshold

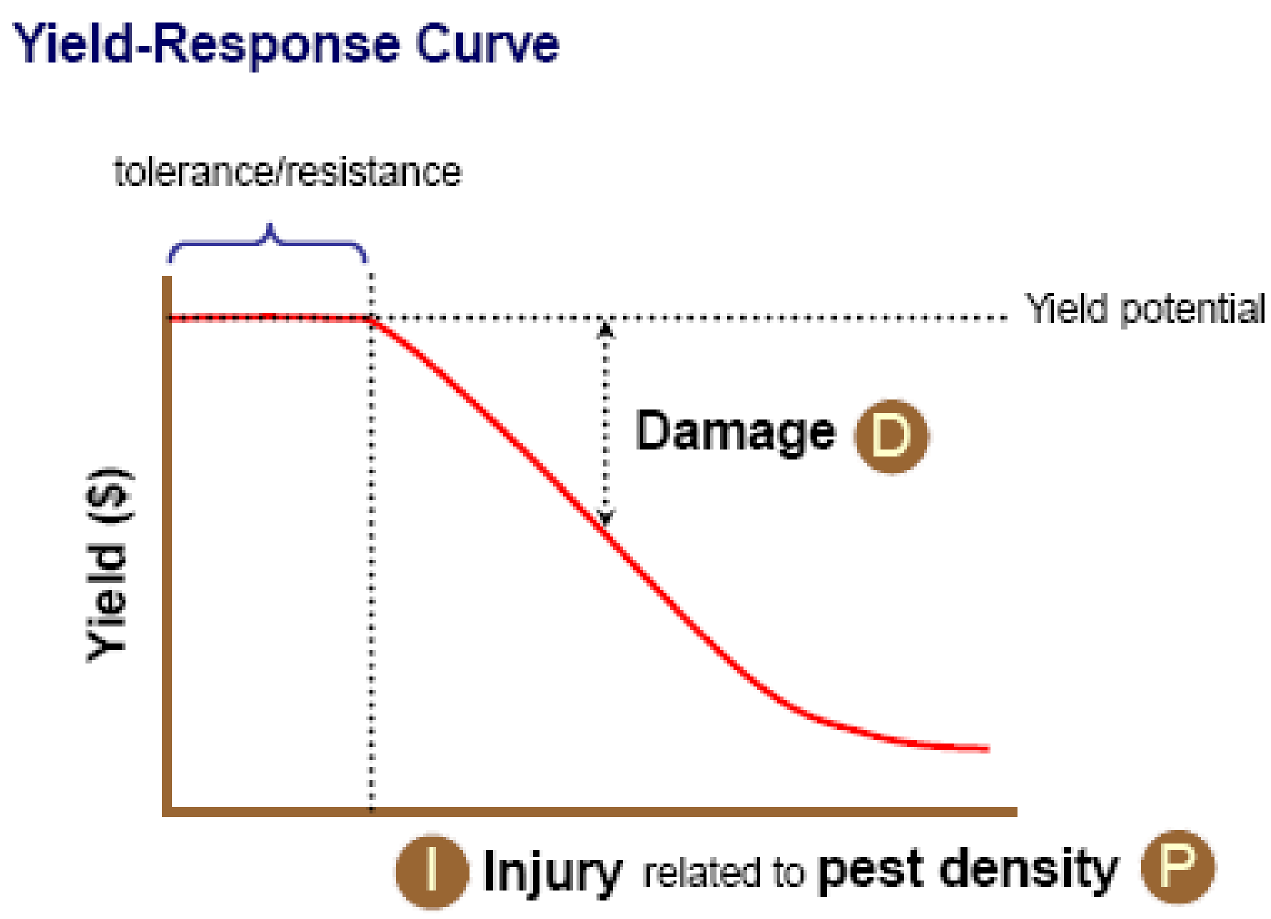
The difference between injury and damage

Injury
Physical or physiological losses of plants caused by pests:
Reduced leaf areas or photosynthesis

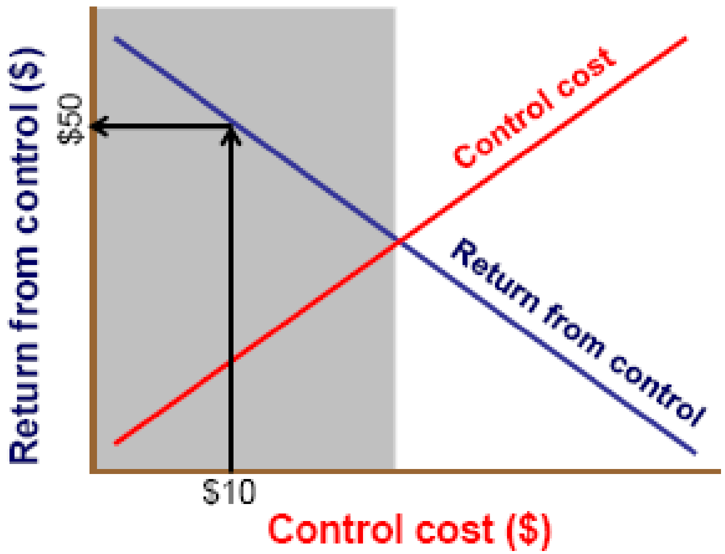
Damage
Economic losses of plants caused by pests:
Reduced yield or quality

Injury does not always cause damage

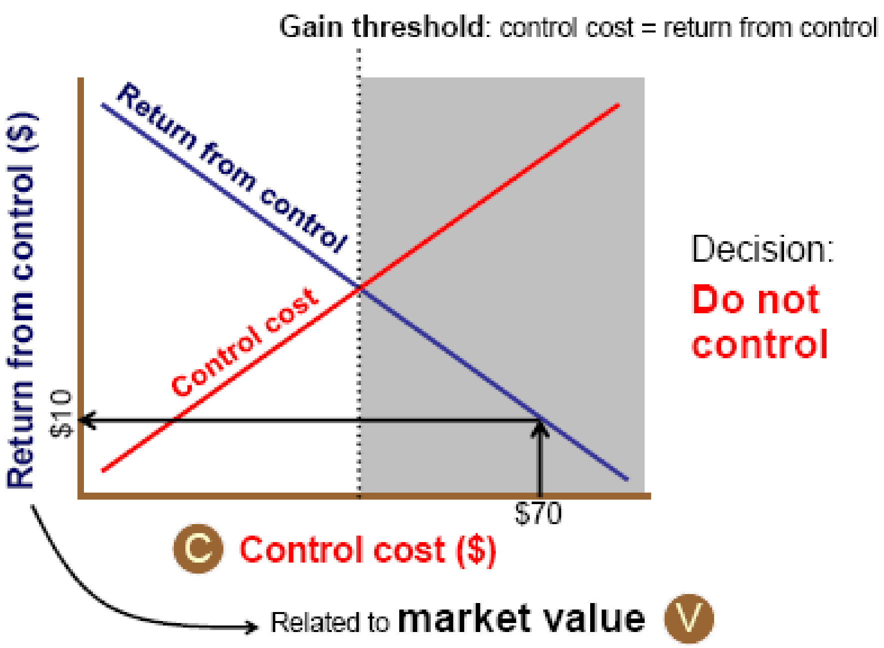
The relationship between injury and damage



Figuring out the economics of pest control

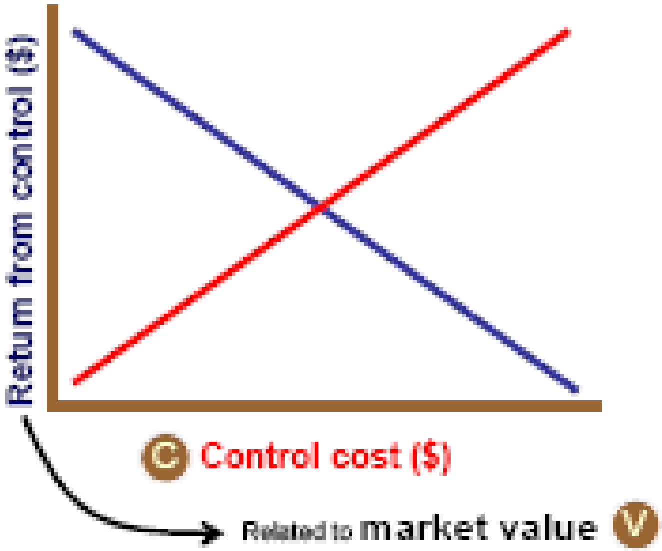


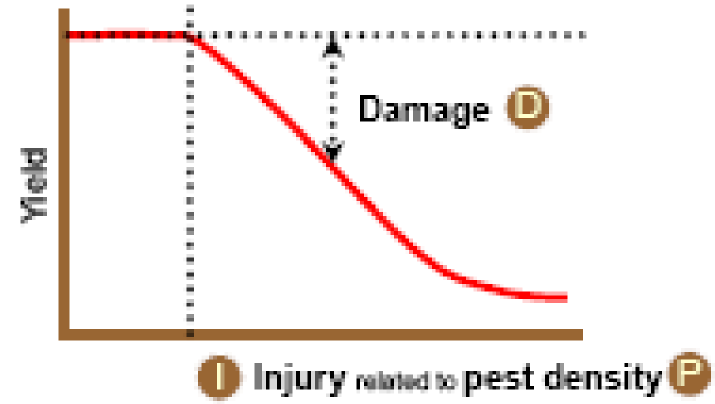
Decision:
Control



Decision:
Do not control

The Economic Injury Level (EIL)

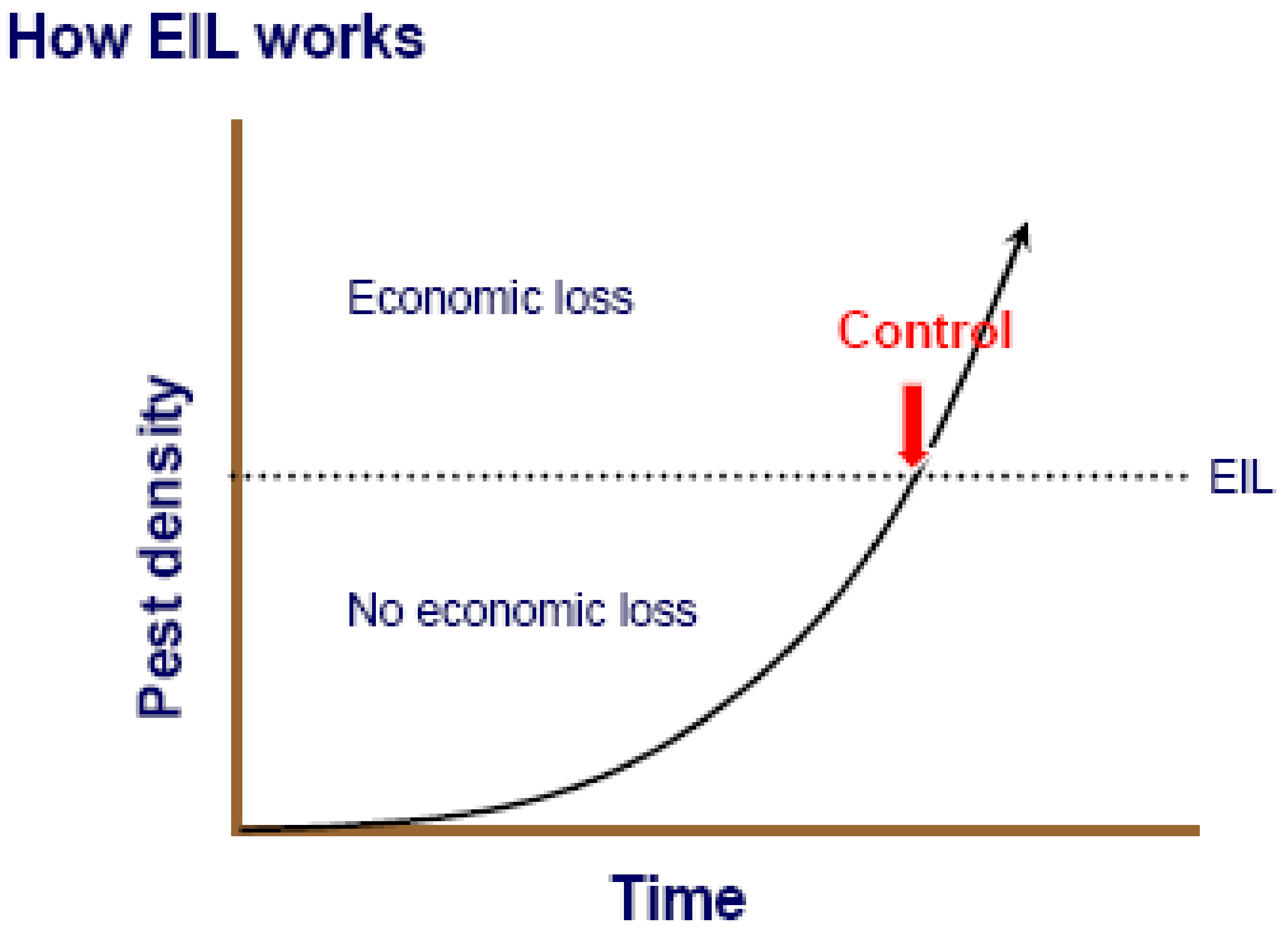




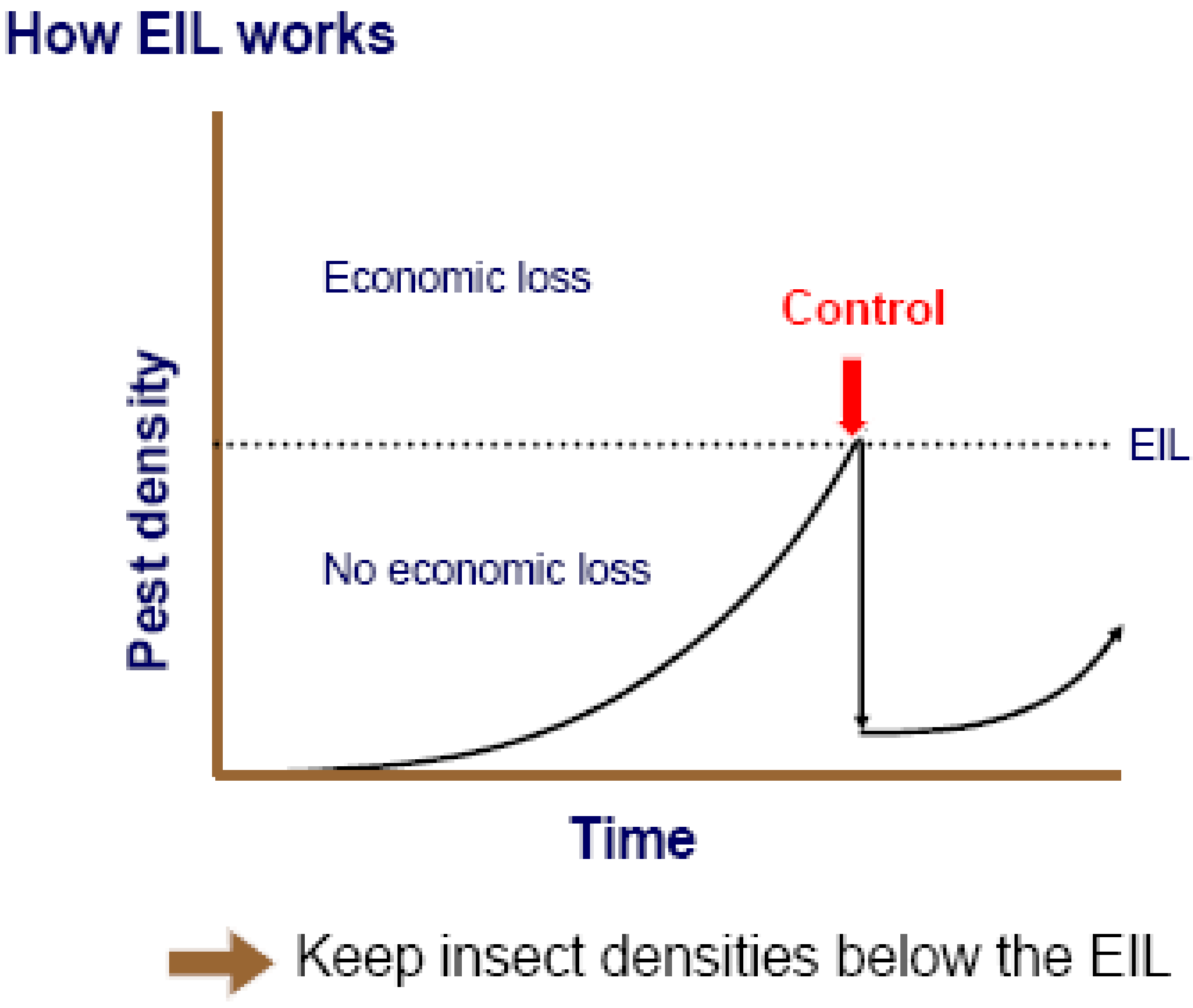
$$C = V \times I \times D \times P$$

$$EIL = P = \frac{C\text{ost}}{\underset{\text{Value}}{V} \times \underset{\text{Injury}}{I} \times D\text{amage}}$$

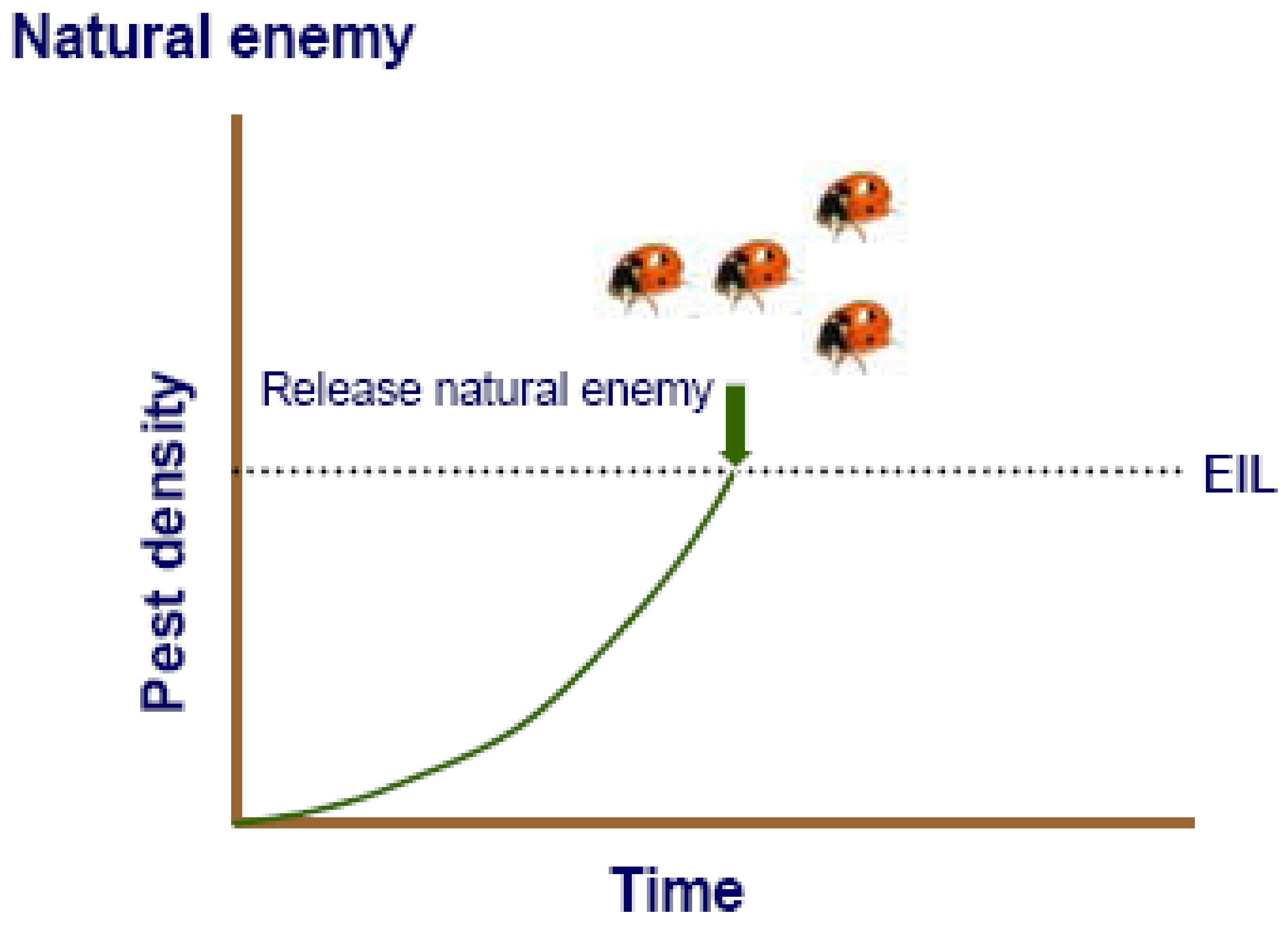
The Economic Injury Level (EIL)



The Economic Injury Level (EIL)



Problems with use of Economic Injury Level (EIL)



EIL under citrus greening (Stansly et al. 2017)

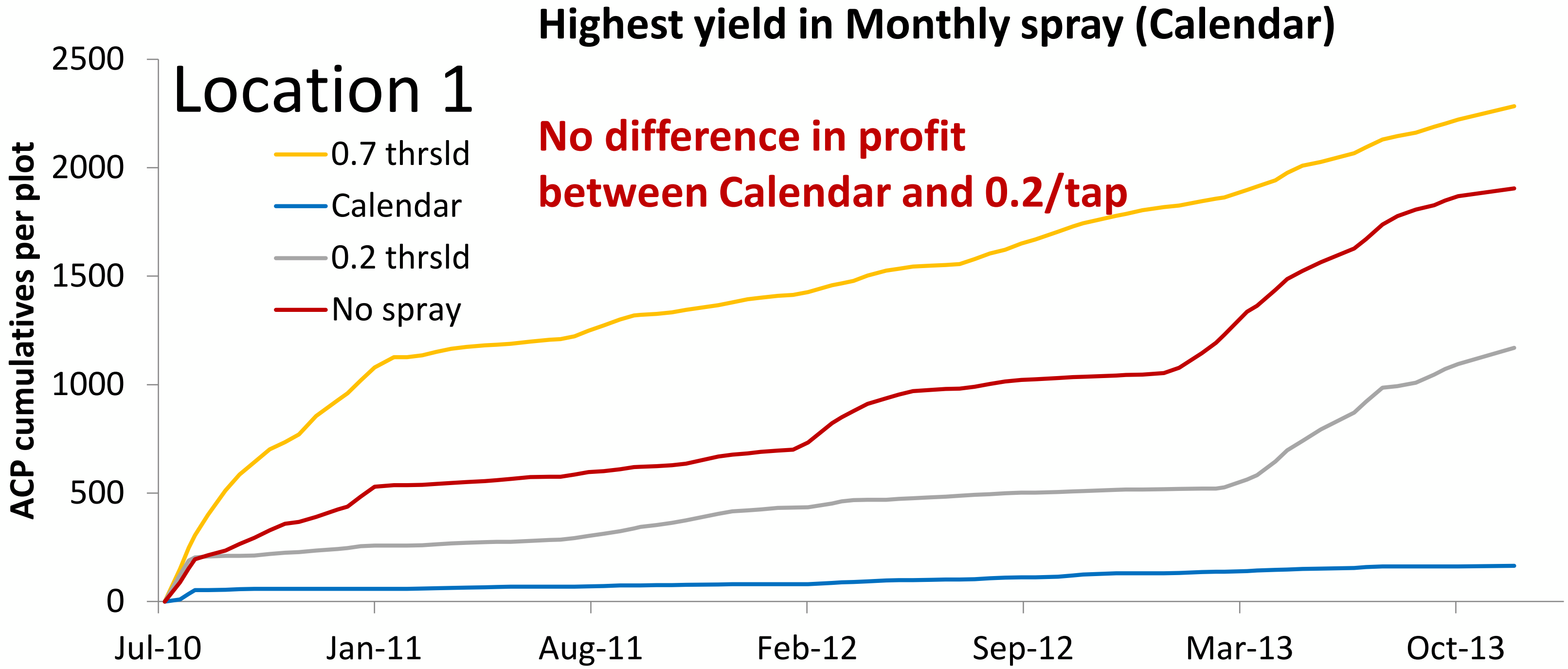
Treatments: # of insecticide sprays:

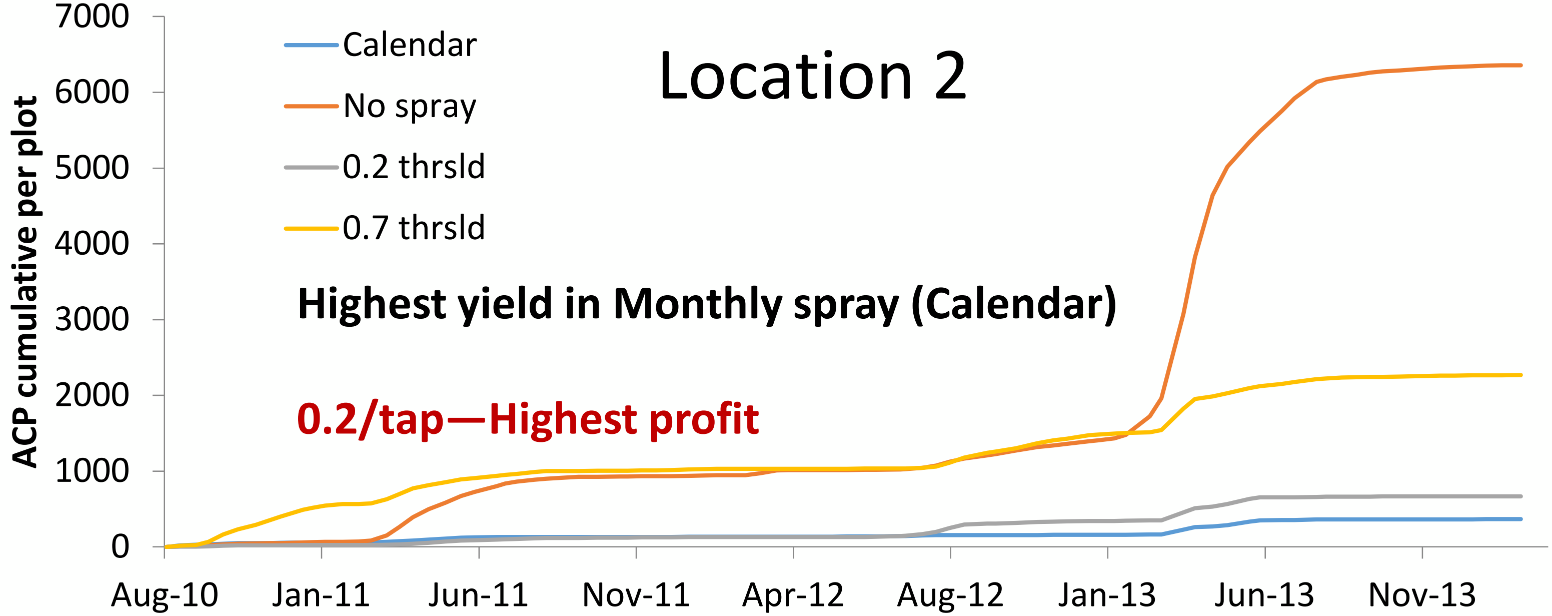
Calendar applications: 10
0.2 ACP threshold: 4
0.7 ACP threshold: 2
No insecticide: 1

HLB was 80% and higher

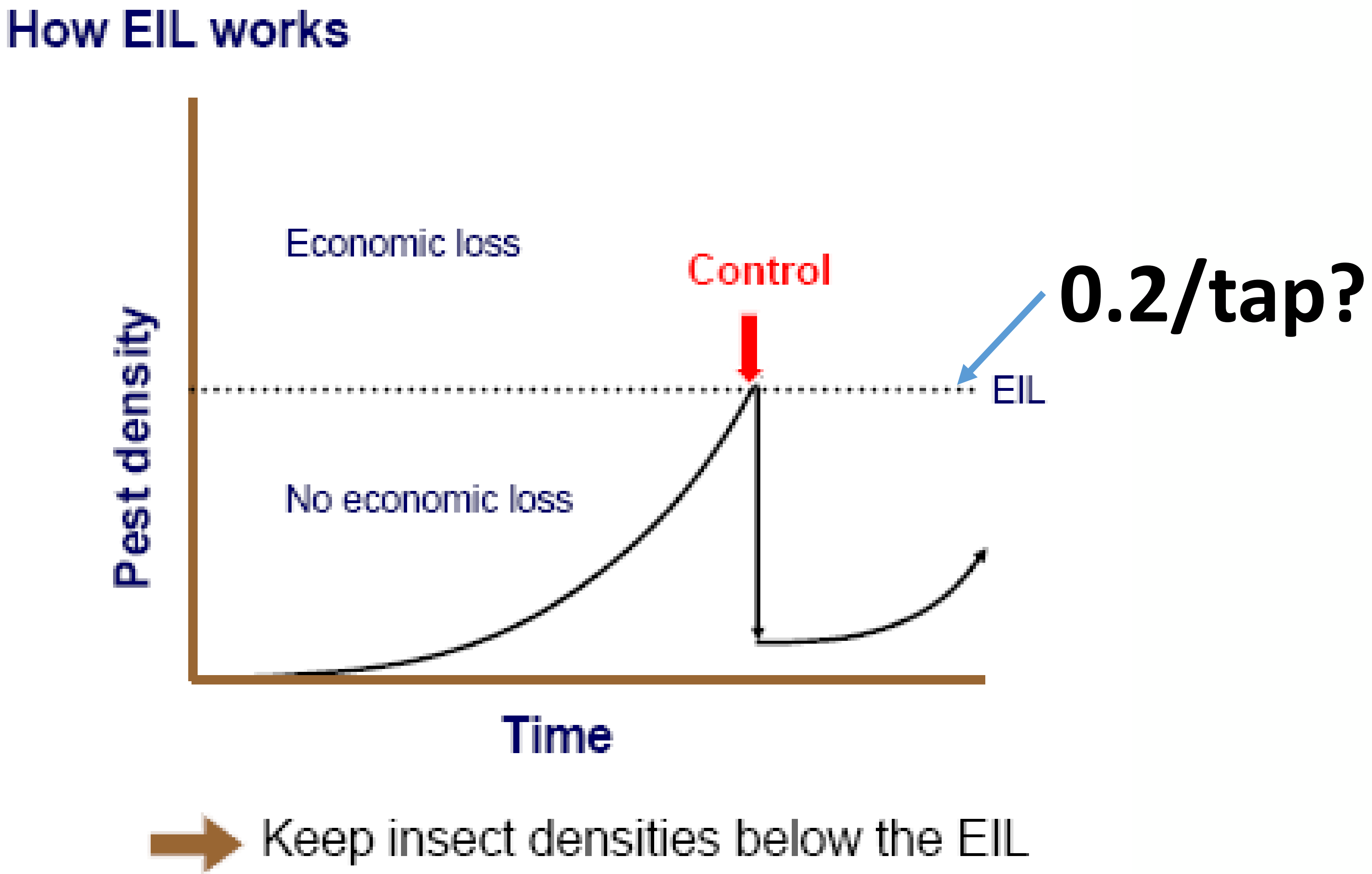
Looked at ACP suppression and yield, calculating cost of ACP management

Cumulative ACP Adults in Stem Tap Samples

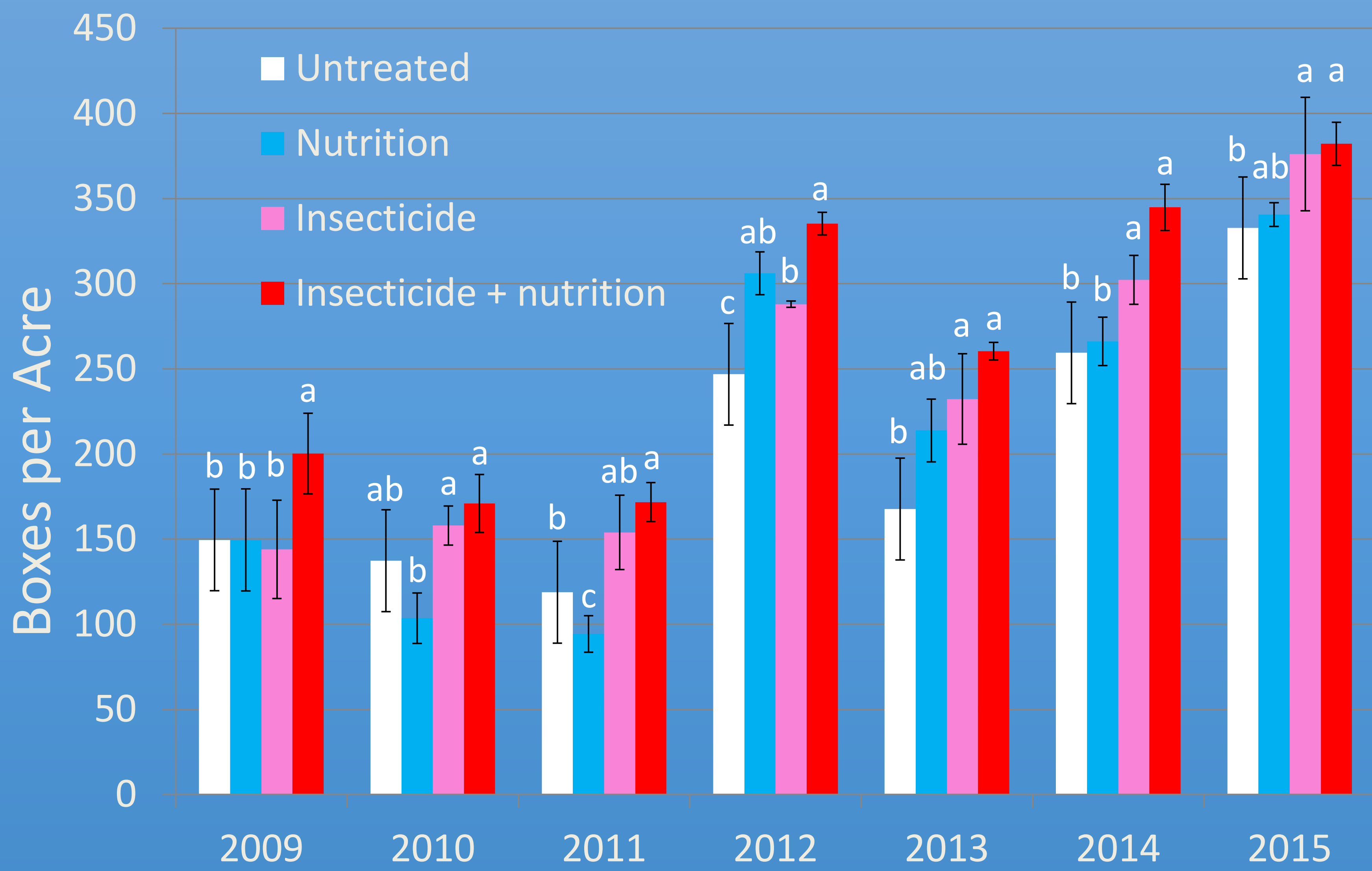




What's the best EIL for your situation?



Keeping ACP down seems to help yield



Challenging plants to infestation and pathogen under controlled conditions

Citrus plants cv Valencia

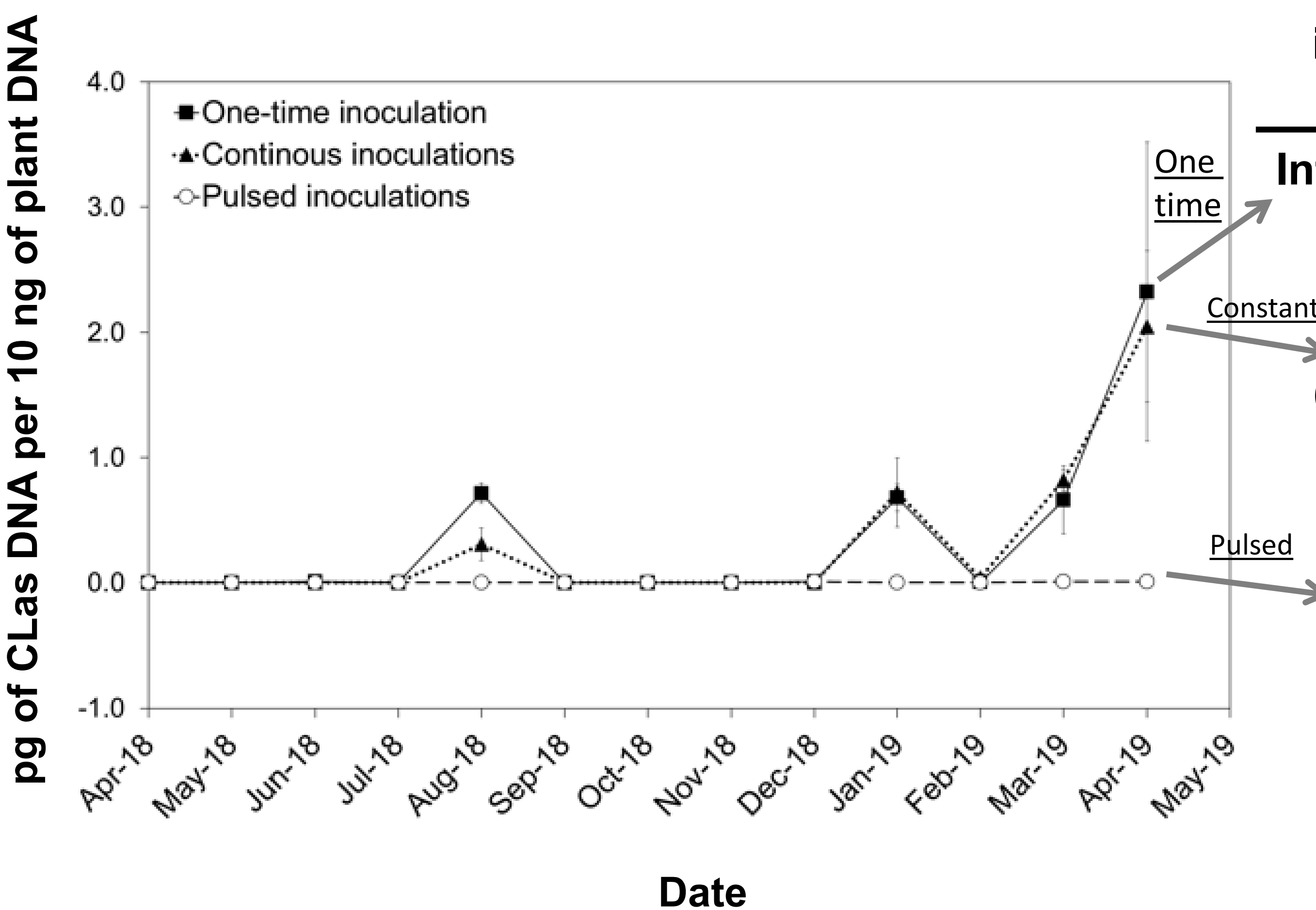
Challenged with:

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)

Preventing a standing infestation with or without pathogen prolongs tree life

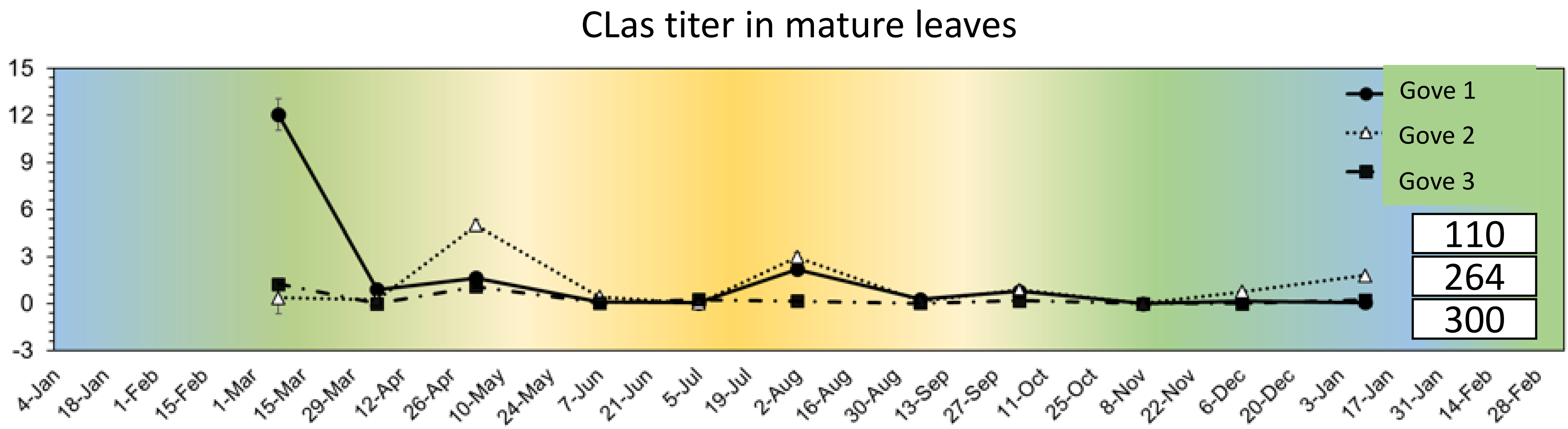
*C*Las titer

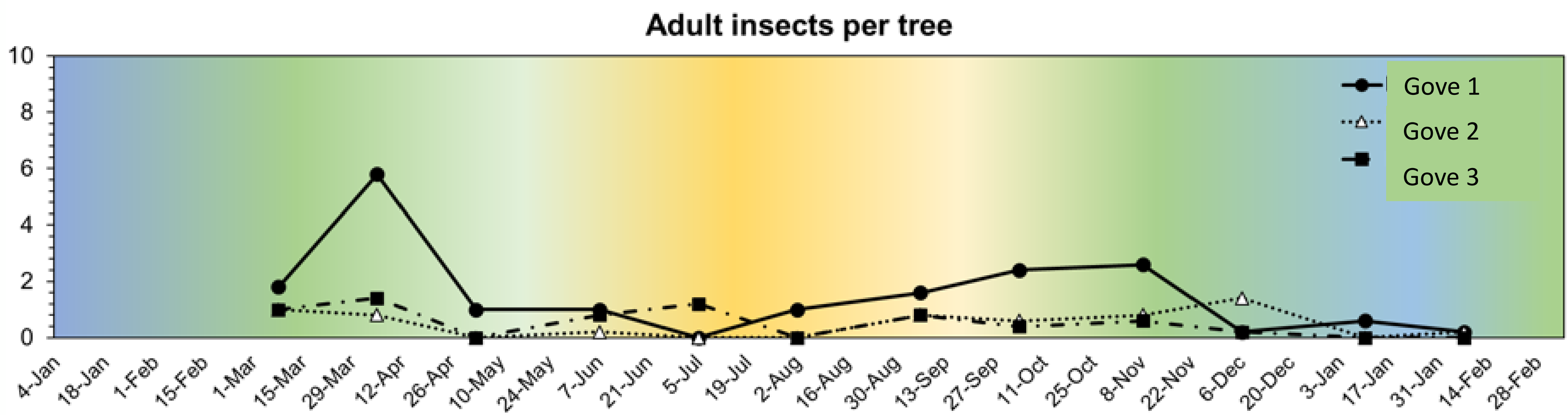


Plant health

CLas-infected ACP	Non-infected ACP
Intermediate	Good
Poor (several dying)	Poor (some dying)
Good	Good

2018 Nonreplicated trial: Fewest fruit per tree where psyllid numbers were highest

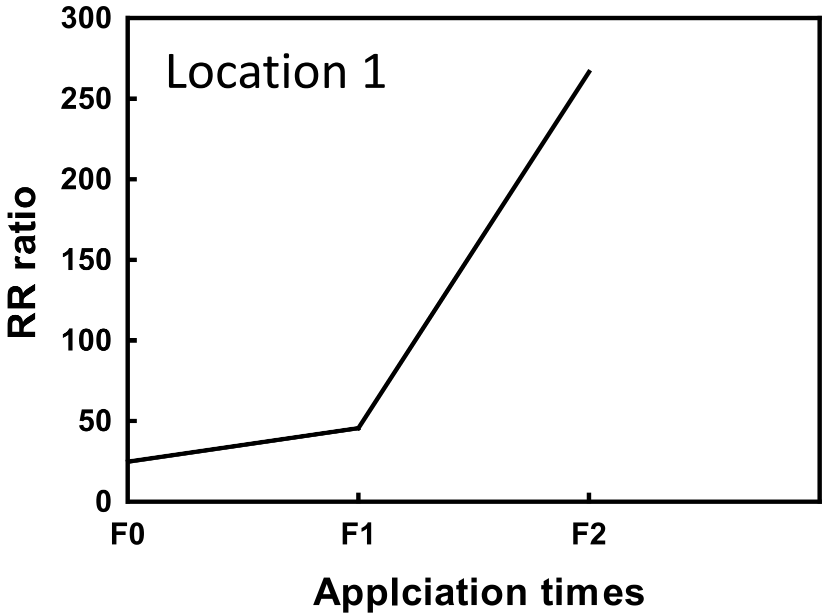




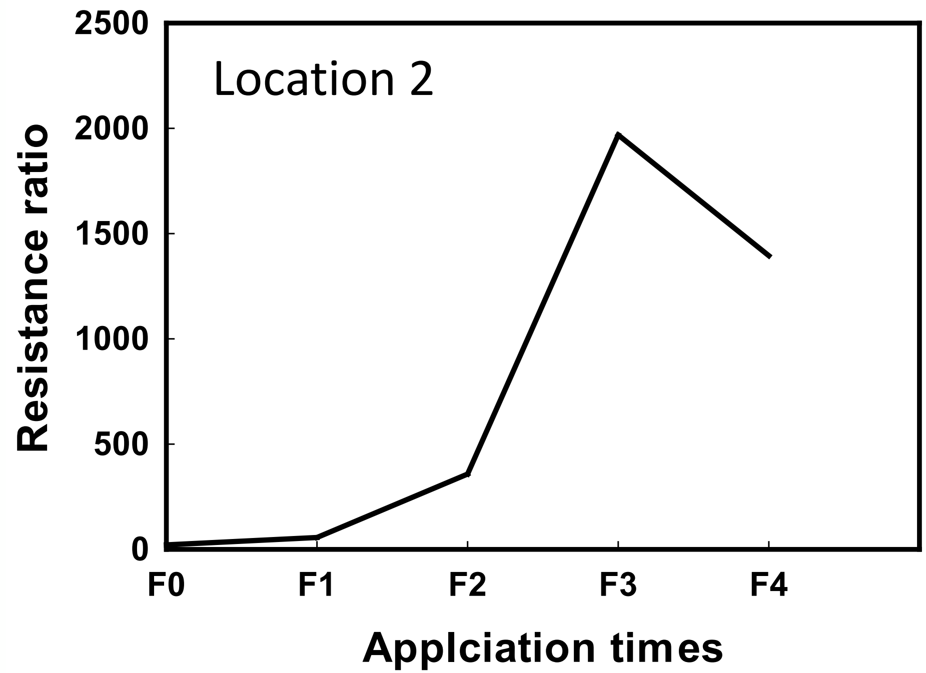
Rotation schedules effectively suppress resistance; consequences of not rotating show up nearly immediately

Treatment	Selection 1 Mar 24, 2019 Apr 22, 2019	Selection 2 May 5, 2019 May 31,2019	Selection 3 Jun 10, 2019 Jun 28, 2019	Selection 4 Jun 22, 2019 ----------------
Rotation 1	dimethoate	cyantrniliprole	fenpropathrin	diflubenzuron
Rotation 2	fenpropathrin	dimethoate	cyantrniliprole	imidacloprid
Rotation 3	thiamethoxam	clothianidin	thiamethoxam	imidacloprid

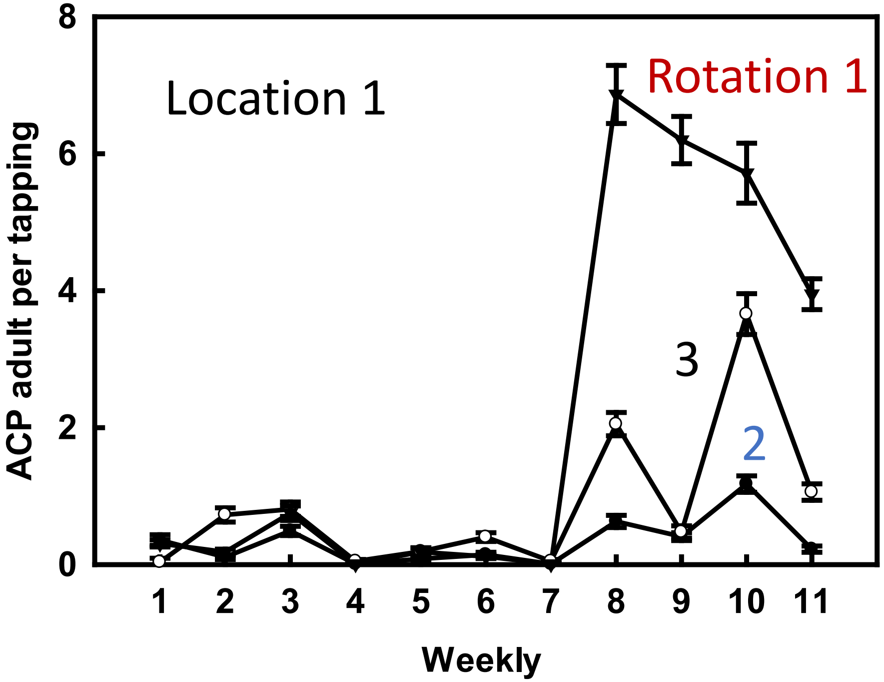
Things ‘get real’; fast!



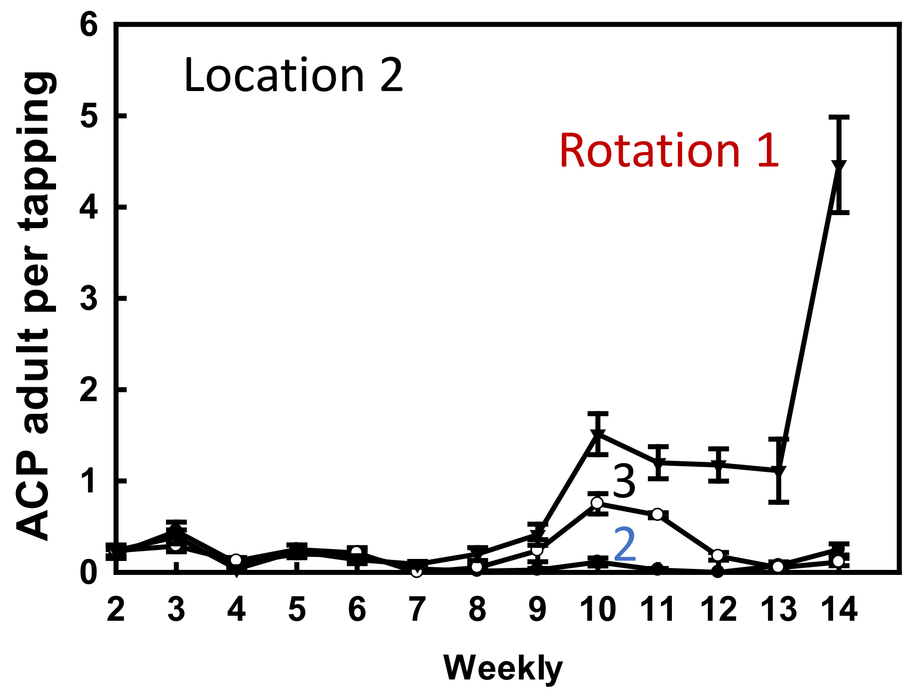
We observed 200-500 fold resistance with 2 back-to backs; ~2000 fold after 3 consecutive failures to rotate



Once we start to see > 100 fold resistance in the lab, failures in the field are evident.



Some rotations emerging as superior in terms of population suppression and resistance management interaction



Does order of the sequence matter?

Treatment	May	June	July	September	October
Rotation A	dimethoate	abamectin + thiamethoxam	fenpropathrin	diflubenzuron	imidacloprid
Rotation B	imidacloprid	fenpropathrin	abamectin + thiamethoxam	dimethoate	diflubenzuron
Rotation C	thiamethoxam	diflubenzuron	dimethoate	imidacloprid	fenpropathrin

~~No~~

fenpropathrin **dimethoate** **cyantraniliprole** **imidacloprid**

IGR **Oil** **Kaolin** **butenolide**

Kaolin: Non-toxic particle film; affects ACP ability to grasp/feed on leaves

Studies in FL citrus began around 2005: (Hall, D. G., S. L. Lapointe, and E. J. Wenninger. 2007. Effects of a particle film on biology and behavior of *Diaphorina citri* (Hemiptera: Psyllidae) and its infestation in citrus. J. Econ. Entomol. 100: 847-854.)

It’s not full proof; as leaves grow surfaces become unprotected; like anything applied to foliage in FL, can wash off; does not prevent HLB. Nonetheless, several studies have indicated efficacy against ACP comparable to toxic poisons.

Reflective mulch to repel ACP

Summary: Ways to Lower ACP Control Costs and Resistance

1. **Thresholds can guide spray frequency and reduce sprays**
2. **Target control to reduce ACP in flush**
   - **Preemptive sprays may be best**
   - **Don’t let a standing population linger**
3. **Use border sprays to control psyllids where they congregate and reduce sprays to whole block**
   - **Selective products for whole block sprays**
   - **Cheap products for border sprays**
4. **Conserve beneficials by eliminating unnecessary sprays**
5. **Rotate between at least 5 modes of action**
6. **Other techniques (mulches, kaolin, mesh, windbreaks) either available and more coming (attract-and-kill)**