

# Intercropping to improve fruit productivity



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# Overview

- Introduction
  - Master's research
  - Arkansas extension and research
- Papaya
  - Background and biology
  - Intercropping, windbreak, and shading
  - Field study
  - Conclusions
- Approach to this position

# Personal Background

- Raised in Elm Springs, Arkansas
- Bachelors in Journalism, Spanish (UA)
- MS horticultural science (UA)
- Worked in UACES
- PhD in progress (UF; Defended in March)
  - Papaya
    - Primed acclimation
    - Wind damage: intercrop mulching system

# Masters

Proposed

- Primocane-fruiting blackberries
- Hightunnels

Also:

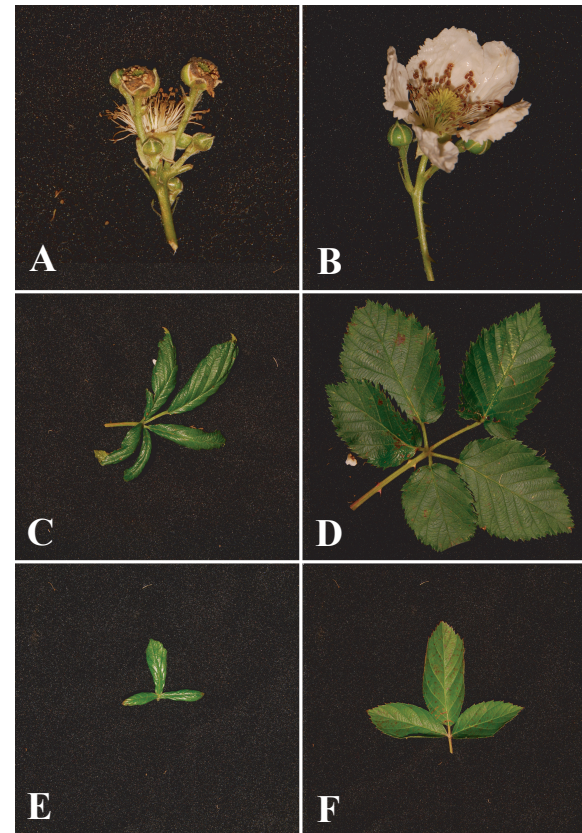
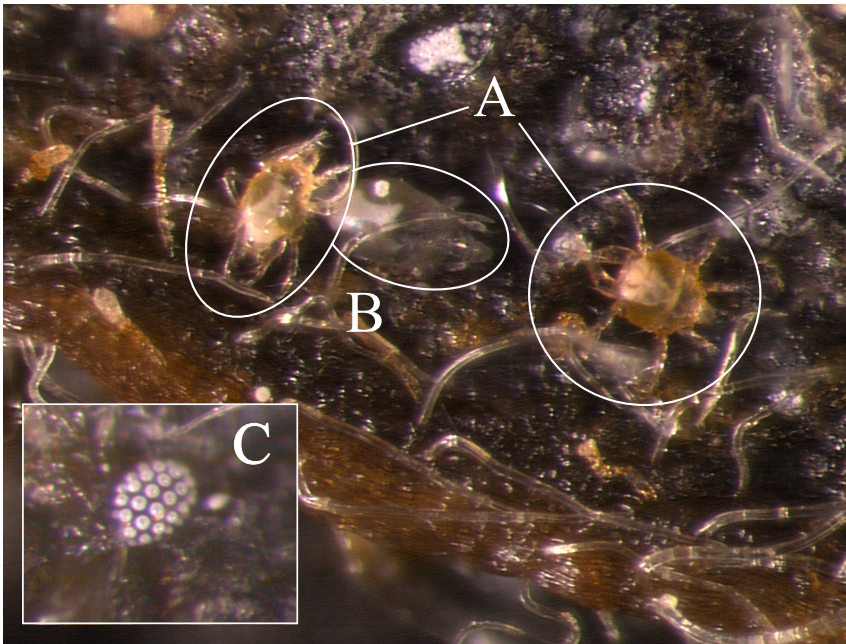
- Broad mites
- Bud phenology



# Broad mite on blackberry

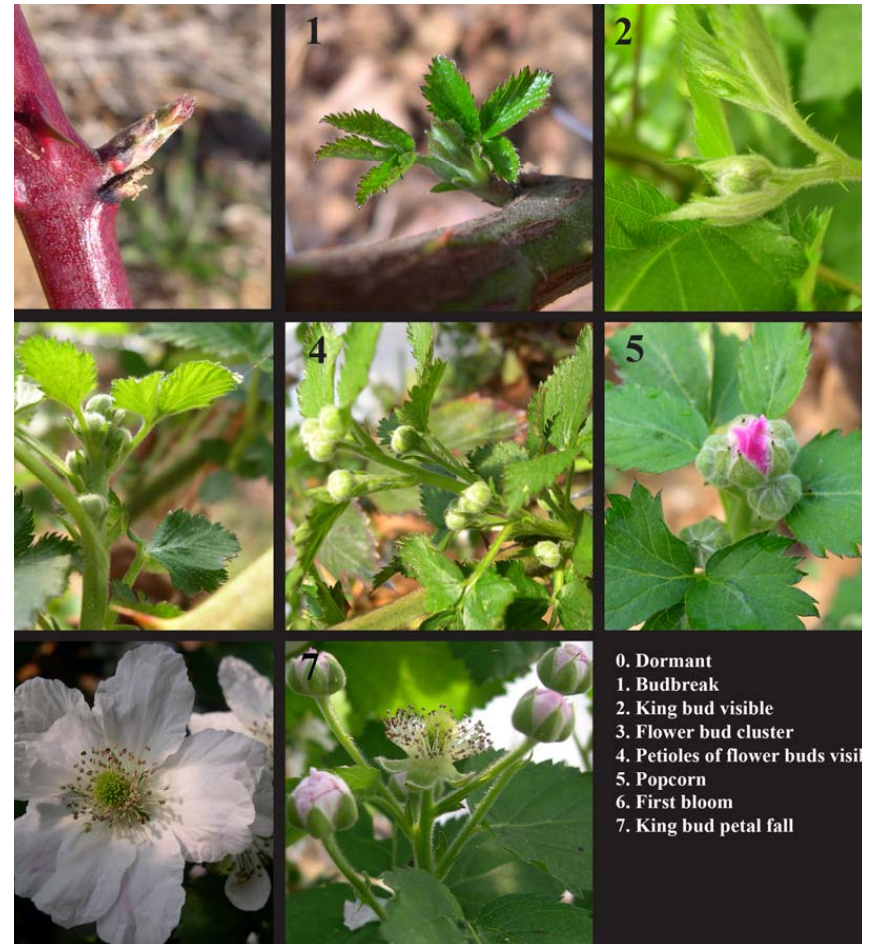
*Polyphagotarsonemus latus*  
(Banks)

- Damage
- Management



# Master's results

- Profound and detailed explanations of the obvious
- Phenological stages predicted freeze damage across locations and genotypes



# After-master's Blueberry planting decline



Photo by Luke Freeman



# Grower collaboration: Blueberry industry survey

- Needs assessment
  - Collaboration with virologist, nematologist, general pathologist, entomologist, horticulturist
  - Worked with county extension agents
  - General planting decline
- On-farm research
  - Testing short-term approach



Les Dozier, blueberry and blackberry grower  
Photo by Luke Freeman

# Blueberry research

- Research center
  - Testing potential longer-term approaches
- Results:
  - Strong relationship with individual growers and with growers' association
  - Potential approaches to improve production statewide



# Hightunnel winter strawberries

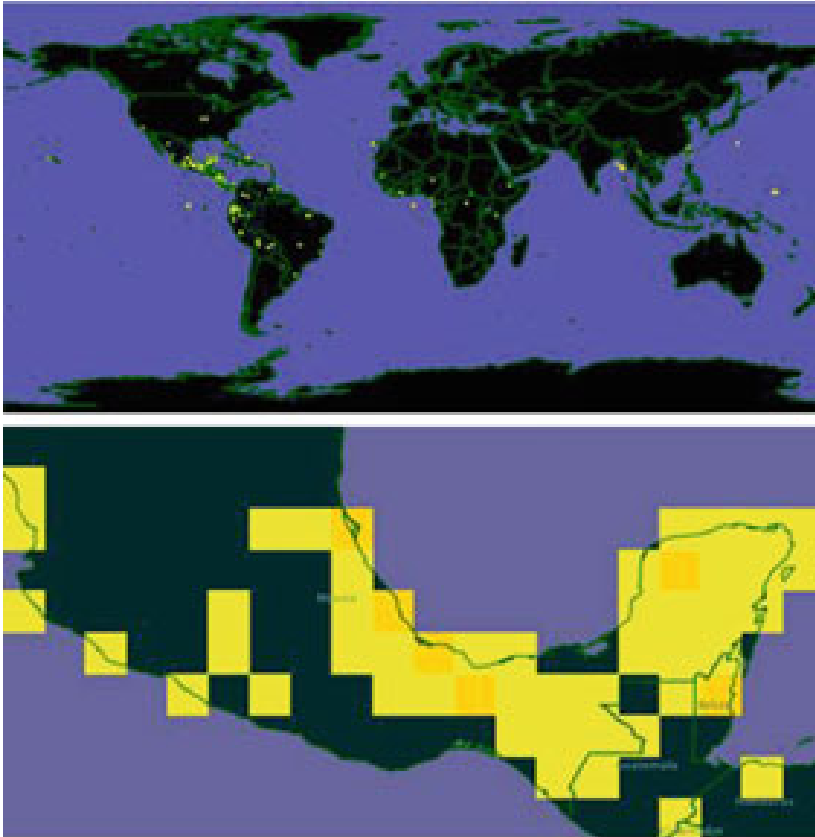
- Successful early winter and early spring production
- Day-neutral varieties best
- Some early grower adoption



# Papaya



# *Carica papaya* L. origin



From: G. Fuentes & J.M. Santamaria (2014)



From: Chavez-Pesquera et al. (2014)

# Wind damage



- Sensitive periods
- Constructed barriers costly
- Other major production challenges:
  - Papaya ring spot virus (PRSV)
  - Soil fertility

Photo by Kati Migliaccio

# PRSV



# Sunn hemp

- *Crotalaria juncea* L.
- Legume
- Vigor
- Cost! \$4.50/lb to \$1.50/lb
- Popular with growers
- Light stress?





# Sunn hemp intercrop

- Objectives:
  - Test the effect of sunn hemp intercrop and mulching system on papaya growth, yield, physiological variables, and agricultural water use.
  - Test the effect of timing of mowing-mulching on the same.
  - Test whether mowing sunn hemp induces high light stress.



# Controlled studies

- Drought stress
  - Papaya resistant to drought stress
- Primed-acclimation
  - Moderate water deficit can stimulate photosynthesis and water uptake in the short term
- Light stress
  - Plants acclimated to 50% shade didn't show signs of high-light stress
- **Field study**



# Field study - methods

- Treatments
  - SH-mown early (10 WAP)
  - SH-mown late (15 WAP)
  - No sunn hemp
- SH used as mulch



Sunn Hemp Intercrop

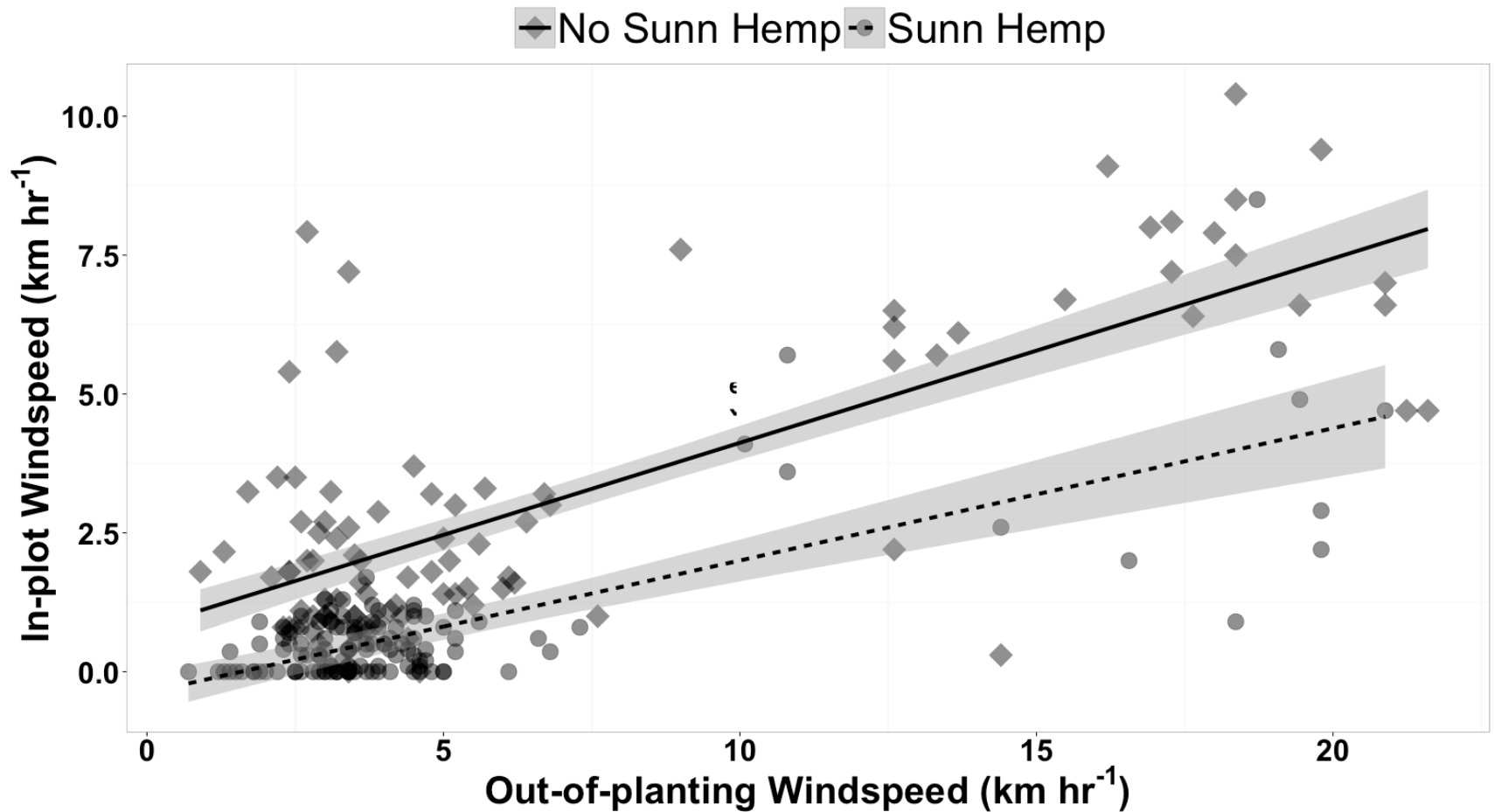
# Methods

- RCB
- Measurement
  - Environment: wind speed, light above the papaya canopy, water application
  - Growth: stem diameter, stem length, others
  - Gas exchange (photosynthesis)
  - Light acclimation:
    - Chlorophyll fluorescence (light stress)
    - Specific leaf weight (shade acclimation)
- Analysis
  - Linear models for single dates (anova)
  - Linear models (repeated measures) for multiples dates
  - nlme package in R

# Wind



# Wind speeds over papaya canopy with and without intercrop



◆ No Sunn Hemp    ● Sunn Hemp

In-plot Windspeed (km hr<sup>-1</sup>)

Out-of-planting Windspeed (km hr<sup>-1</sup>)

Bands represent 95% confidence intervals.

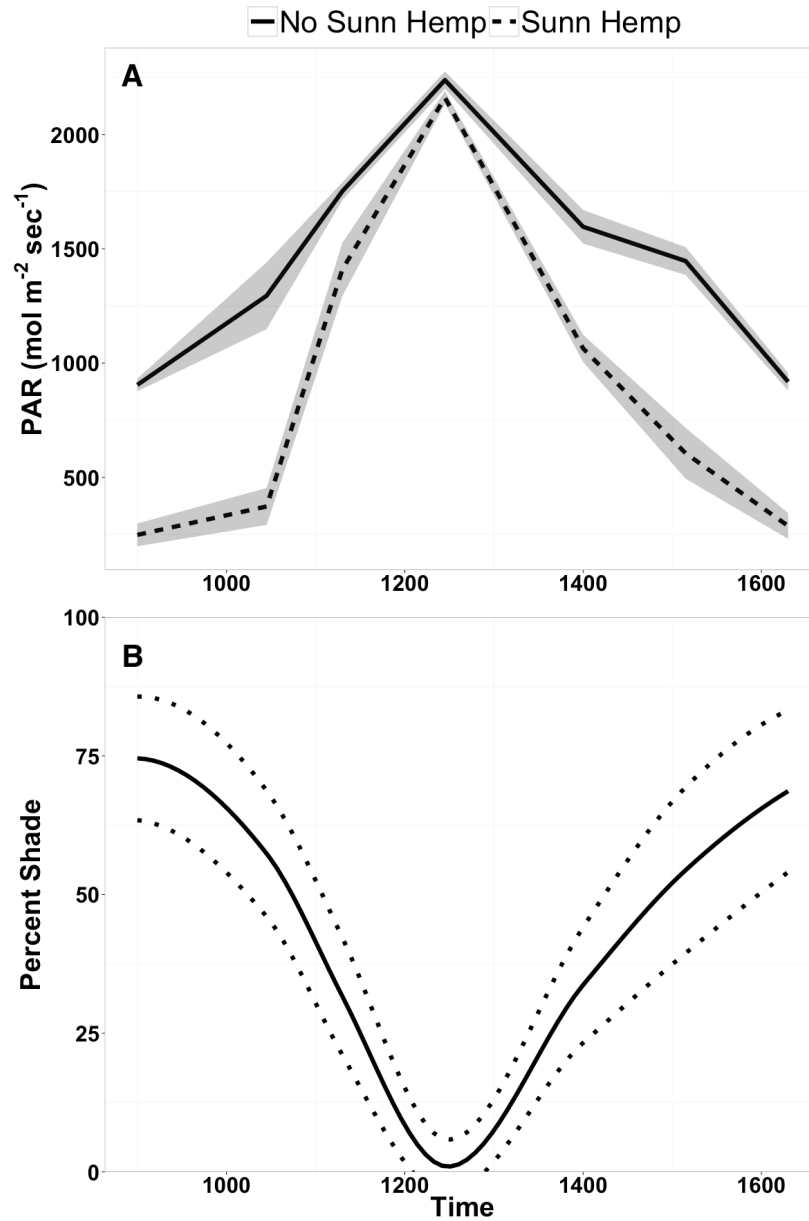
Sunn Hemp Intercrop

# Shade



Sunn Hemp Intercrop

# Shading

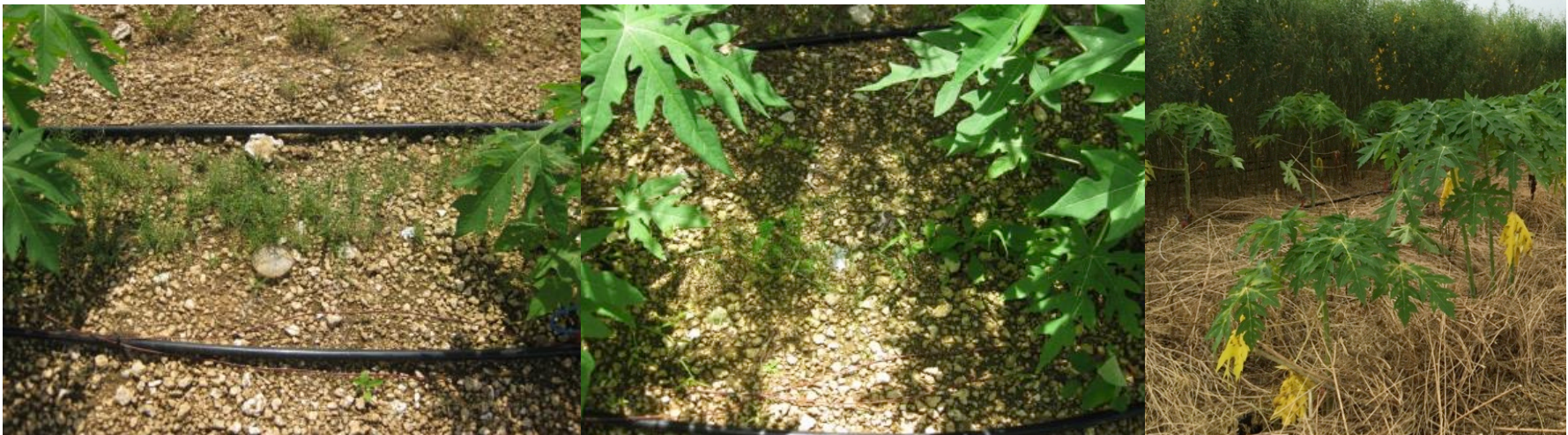


Sunn Hemp Intercrop

# Horticultural Results

Planting Year	Treatment*	Weeding (hrs ha <sup>-1</sup> )			SH FW (Mg ha <sup>-1</sup> )			SH DW (Mg ha <sup>-1</sup> )			Flowering (DAT)		
		Mean		SE	Mean		SE	Mean		SE	Mean		SE
2014	No-SH	266.2	a	51.8	0		.	0			112		3.2
	SH-ME	103.5	b	17	11.2		3.2	3.7	b	1.1	104		1.7
	SH-ML	96.9	b	11.7	23.2		4.8	8.8	a	1.7	108		3.5
2015	No-SH	72.8	a	8.7	0		.	0			143	a	3.3
	SH-ME	35.9	b	7.5	9.9	b	1.6	5.7	b	0.6	128	b	2
	SH-ML	33.8	b	5.2	23.9	a	1.9	8.3	a	0.7	121	b	1.8

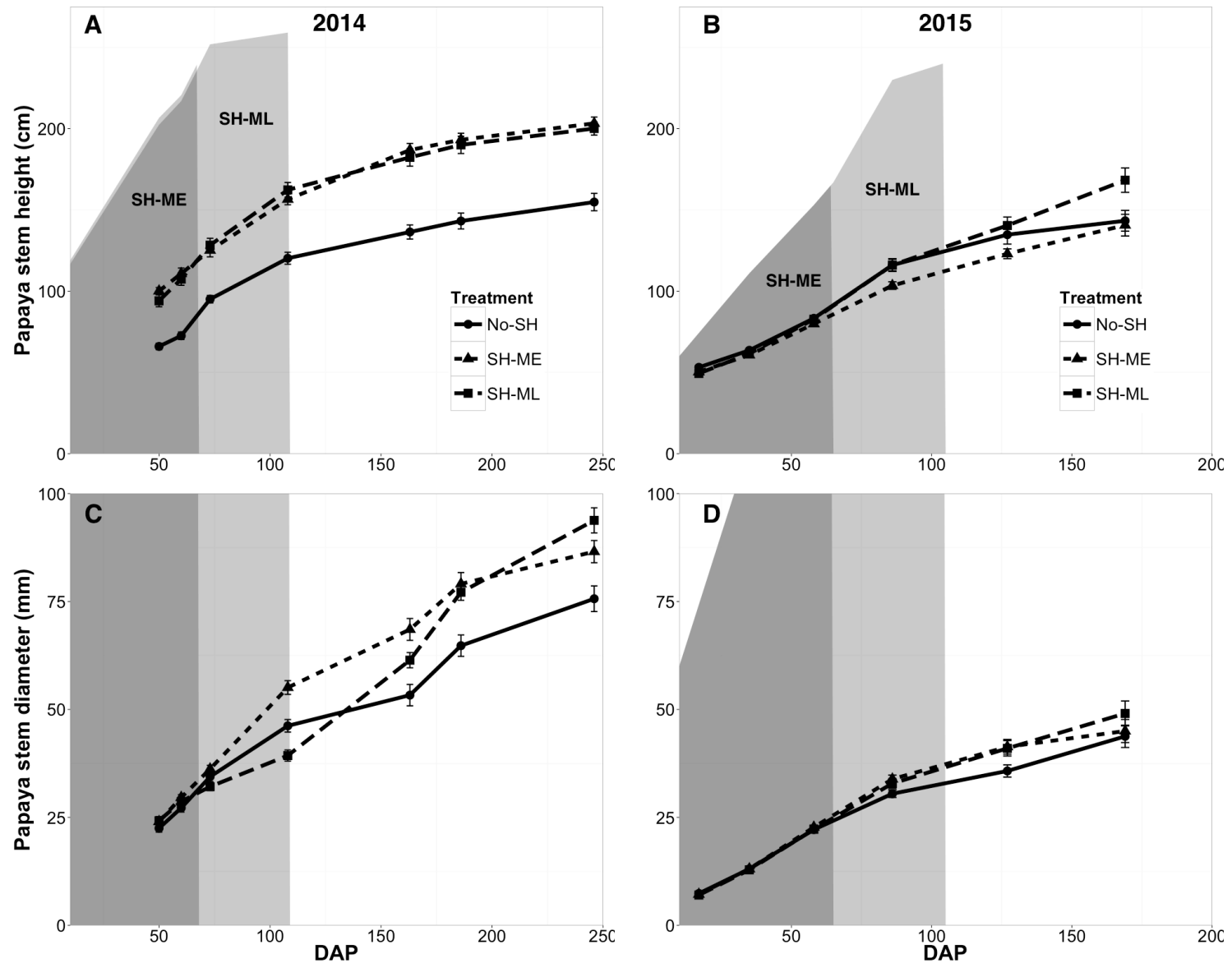
No differences in yield or irrigation water use



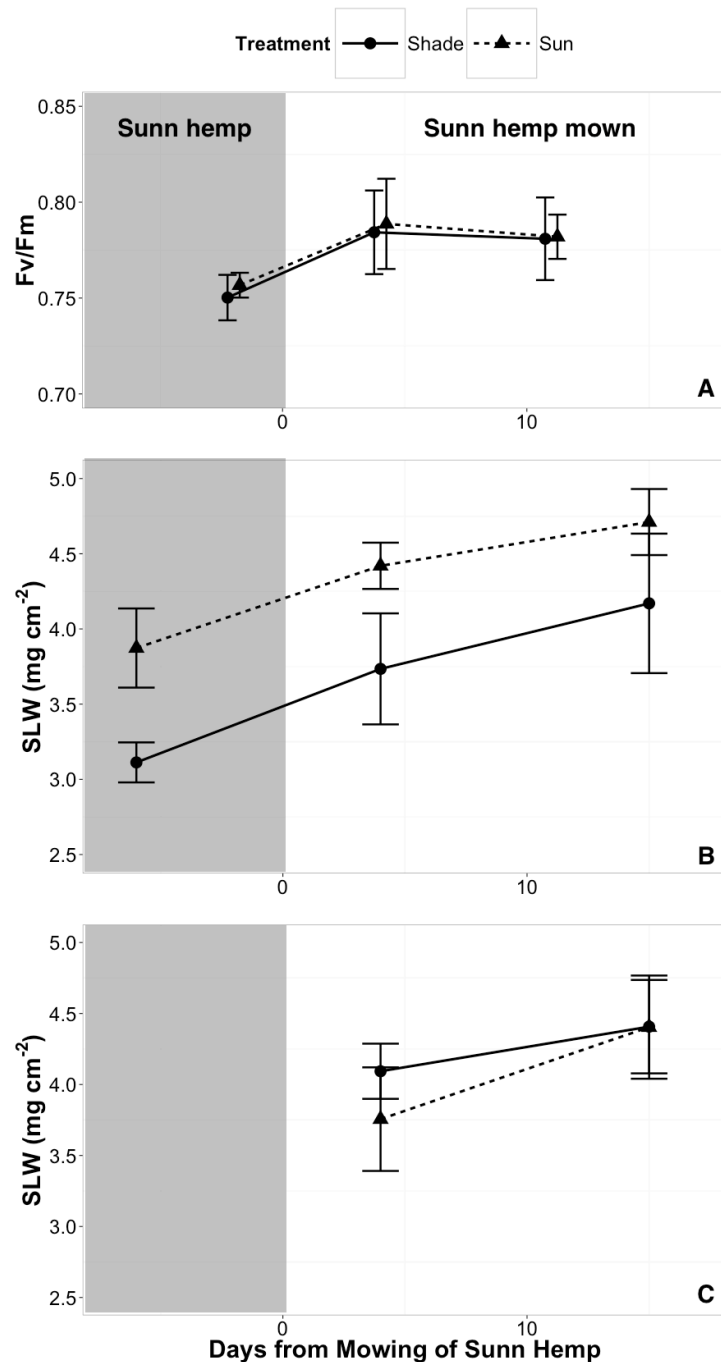


Sunn Hemp Intercrop

# Papaya growth



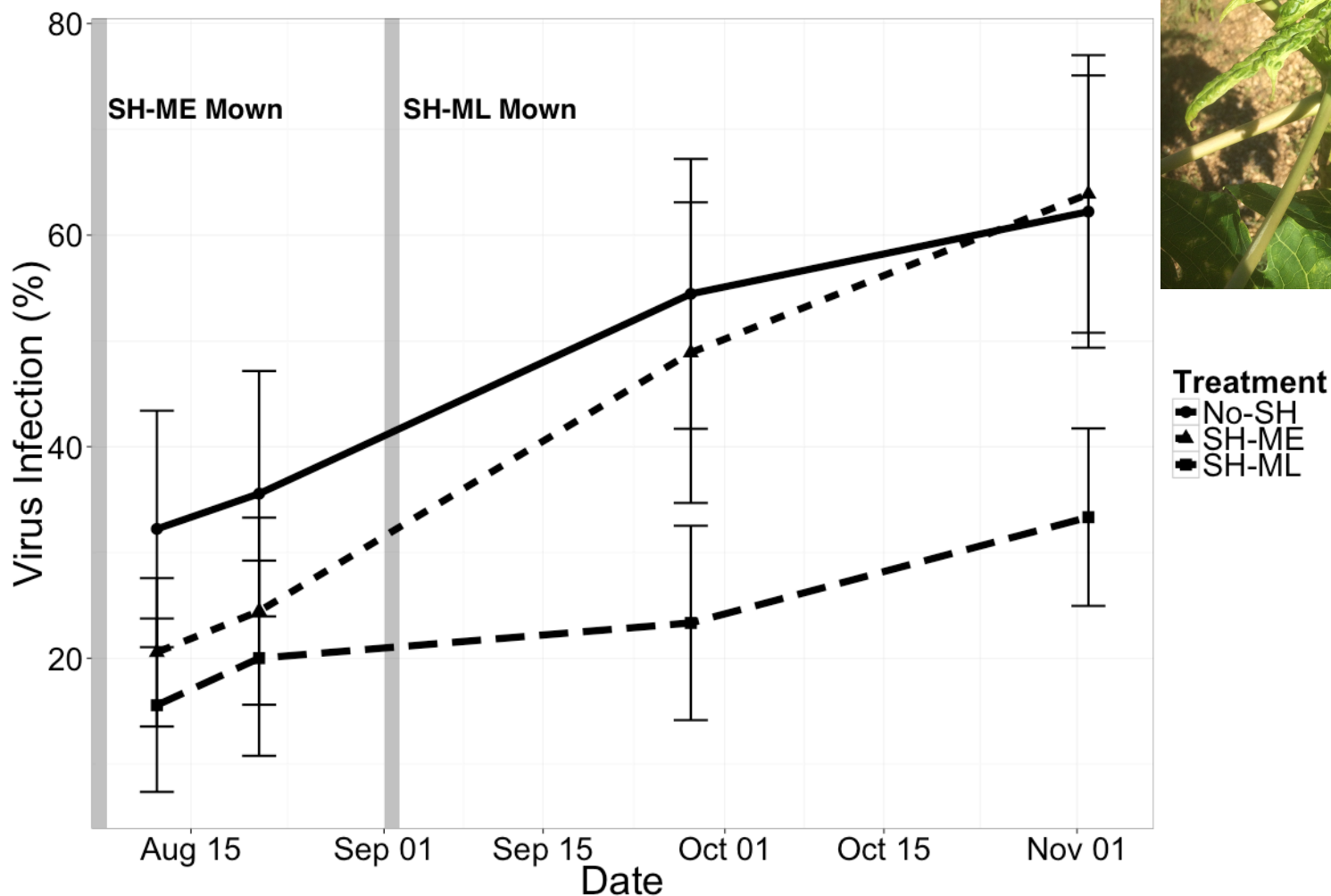
# Light Stress and acclimation



- Between the intercrop, leaves acclimated to shade (SLW)
- New leaves developed as sun leaves
- Shade leaves did not show signs of high light stress (Fv/Fm)

Lines represent means and error bars represent standard errors. The shaded area represents periods with sunn hemp present in the shaded treatment.

# Virus infection, 2015



Virus infection rates (%) by date for 'Red Lady' papaya plants with and without sunn hemp intercrop mown 27 July or 2 Aug 2015 in Homestead, FL. Lines represent means and bars represent standard errors.

# Study Conclusions

- Sunn hemp intercrop has potential to protect and improve papaya crop growth.
- When prolonged, sunn hemp intercrop shading of papaya reduced growth.
- Sunn hemp mulch improved subsequent growth.
- Papaya acclimated rapidly to shifting light environments, avoiding photo-oxidation.
- Sunn hemp intercrop and mulch system reduced weed pressure and likelihood of virus infection.

# What's that got to do with the price of apples?

- Consider unintended consequences
- Think about the whole system
- Unique uses of cover crops may lead to win-win scenarios
  - Benefits of diversity or conservation without sacrificing yield

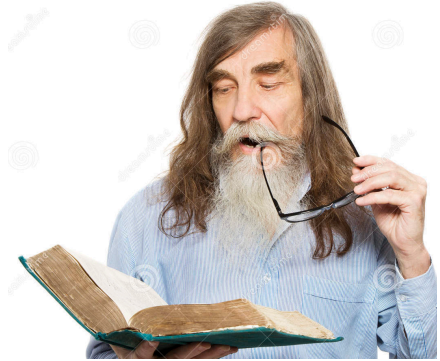
# My approach



## Grower Dialogue

What are the challenges?

Do growers accept the recommendations?



## Homework

What was done before?  
How does the biology work?

## Recommendations

Yes, No, Maybe

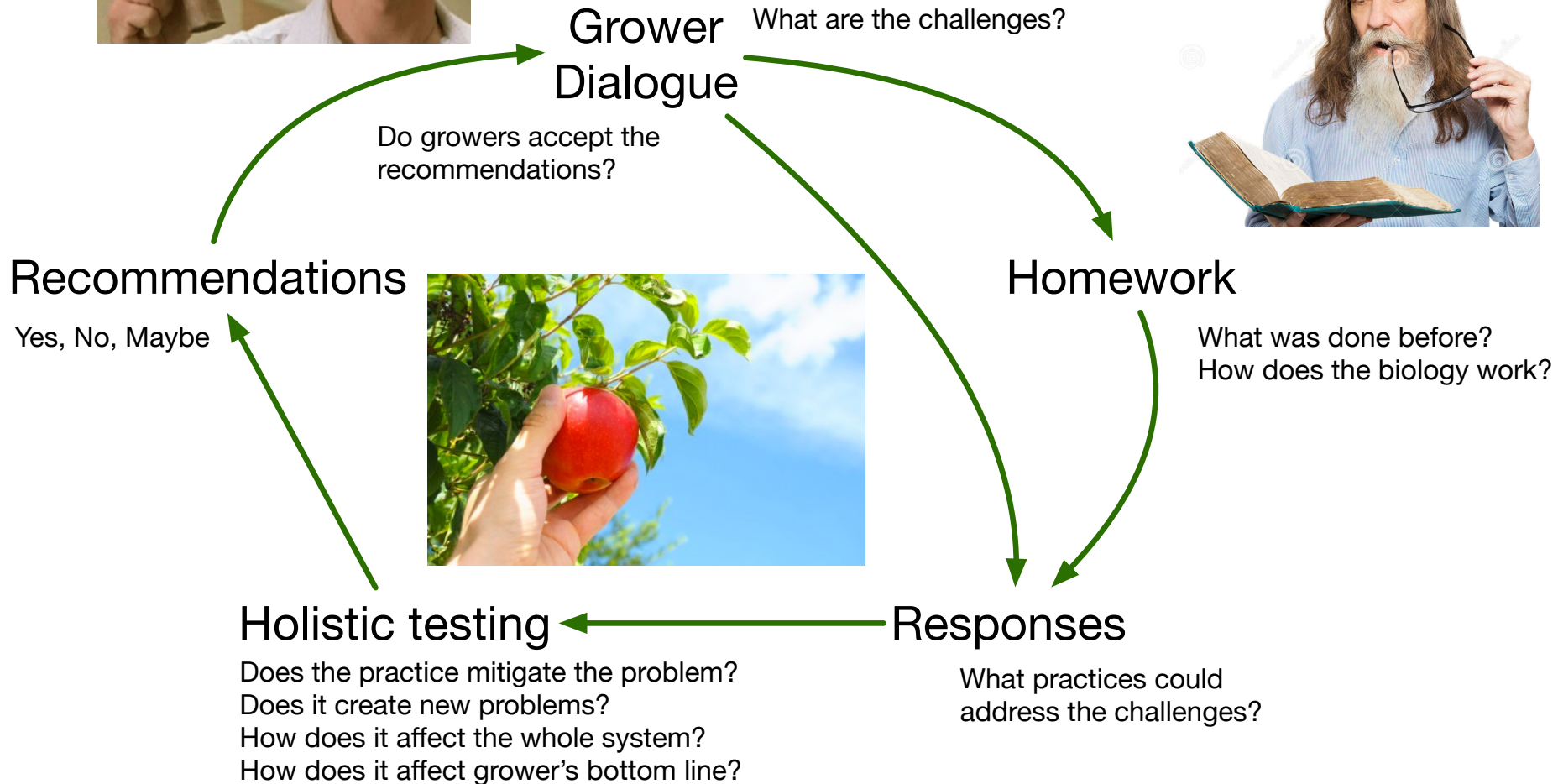


## Holistic testing

Does the practice mitigate the problem?  
Does it create new problems?  
How does it affect the whole system?  
How does it affect grower's bottom line?

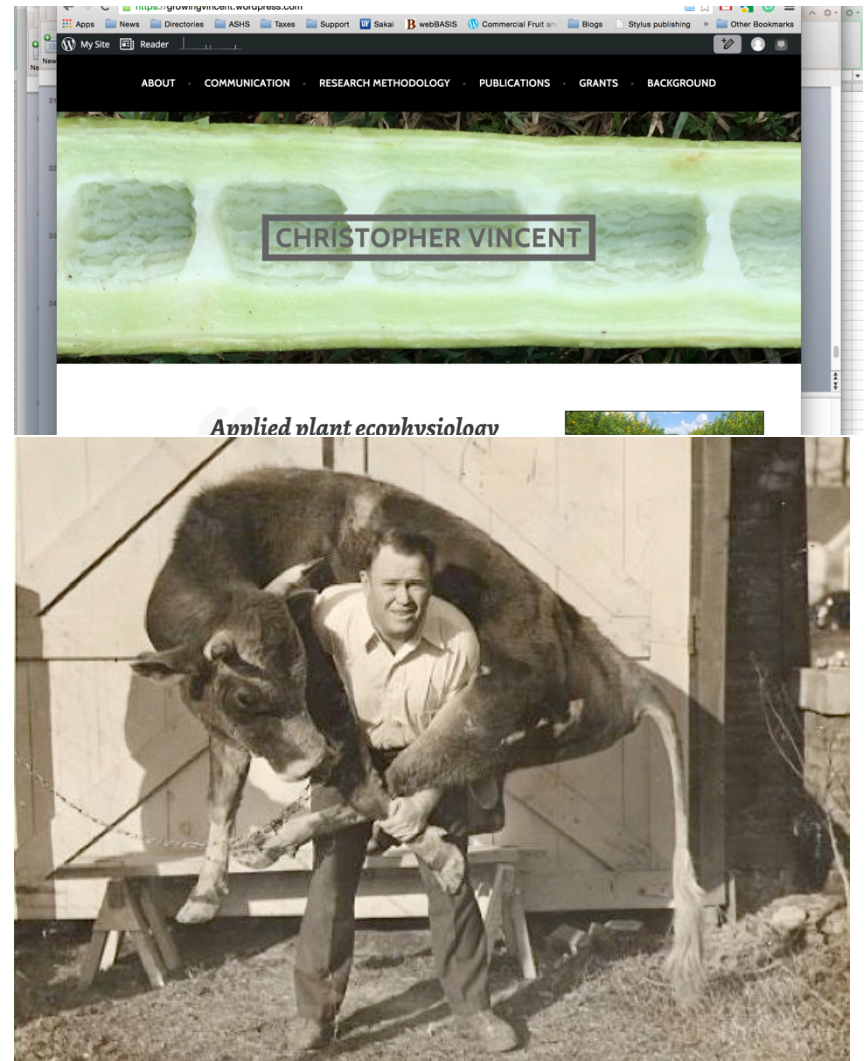
## Responses

What practices could address the challenges?



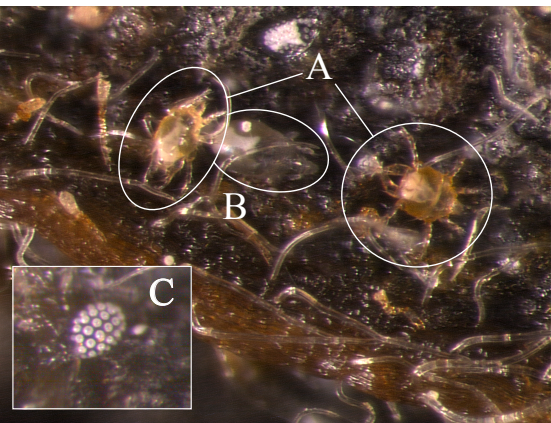
# Grower Dialogue

- What are the needs?
  - Discussion
  - Surveys of fields and growers
- Communication
  - Ongoing:
    - Focus on current growers: “New media:” Blogs, social media, video, seminars
    - Updates, commentary, discussion
    - Decision-making tools
  - Long-term:
    - Focus on new growers: long-standing training materials
    - Move toward interactive training material
    - Hand-on training



# Holistic approach

Nothing occurs  
in a vacuum



# What would\* I research here?

- Short-term
  - Spring frost protection:
    - Bloom delay
    - Fruit “rescue”
  - Thinning
- Medium-term
  - SSCD
  - Orchard ground cover mgmt
  - Cider apple varieties
- Long-term
  - Rootstock management
  - Stress management



	Extension	Research
3 years	<ul style="list-style-type: none"> <li>• Dialogue</li> <li>• Ongoing needs assessment</li> <li>• Online communication</li> <li>• Targeted training</li> <li>• Begin to develop new grower training</li> </ul>	<ul style="list-style-type: none"> <li>• Bloom delay</li> <li>• Thinning models</li> </ul>
5 years	<ul style="list-style-type: none"> <li>• Decision-making tools: crop-variety selection, thinning</li> <li>• New grower training</li> <li>• Re-evaluate progress and training</li> </ul>	<ul style="list-style-type: none"> <li>• SSCD</li> <li>• Ground cover mgmt</li> <li>• Variety trials</li> </ul>
10 years	<ul style="list-style-type: none"> <li>• Set goals depending on re-evaluation</li> </ul>	<ul style="list-style-type: none"> <li>• Rootstock management/selection</li> <li>• Stress management</li> </ul>

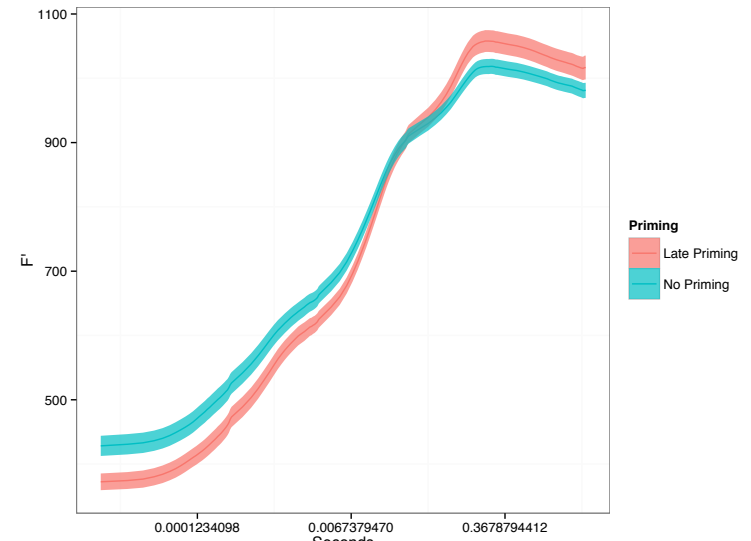
# Funding



- UA: Lead role in 4 funded proposals (\$108,000)
  - All applied and grower-focused
- UF: Edited 2 funded proposals (USDA NIFA, SSARE : \$510,000)
- Experience in applications to SFRC, USDA-NIFA, SSARE, Specialty Crop Block Grants

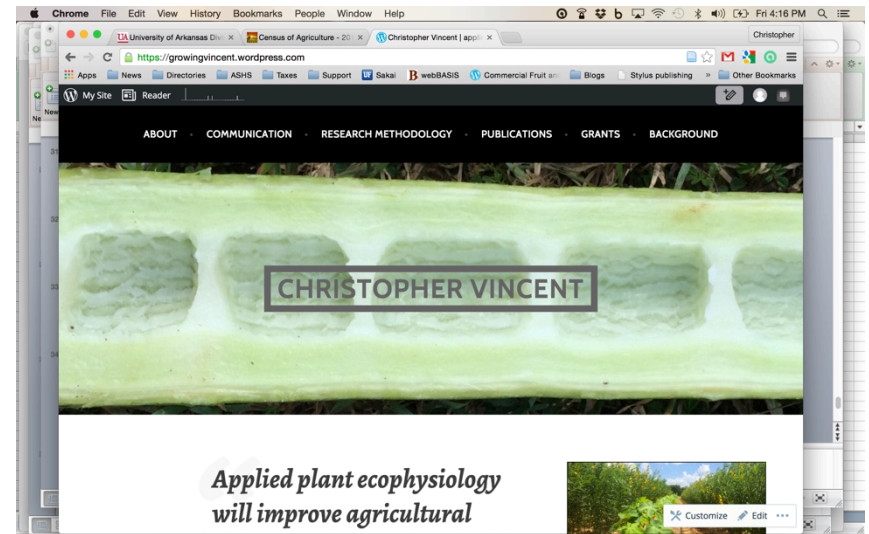
# Research

- Grower-focused
- Collaboration
  - Entomologists
  - Pathologists
  - Breeders, geneticists
  - Soil scientists
  - Ag. engineers
- Physiology and methodology
- Publications
  - 2 from MS
  - 2 last year
  - 5 currently in process



# Extension Writing & New Media

- Fruit & Nut blog
- Editing factsheets
- Driscoll's review
- Sustainable Blackberries & Raspberries
- Personal website (demonstration)
- Coordination of video production for organic training



# Thank you

