

Intercropping to improve fruit productivity



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Interdisciplinary Ecology, concentration in Horticultural Science

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-fruited blackberries
- High tunnels

Also:

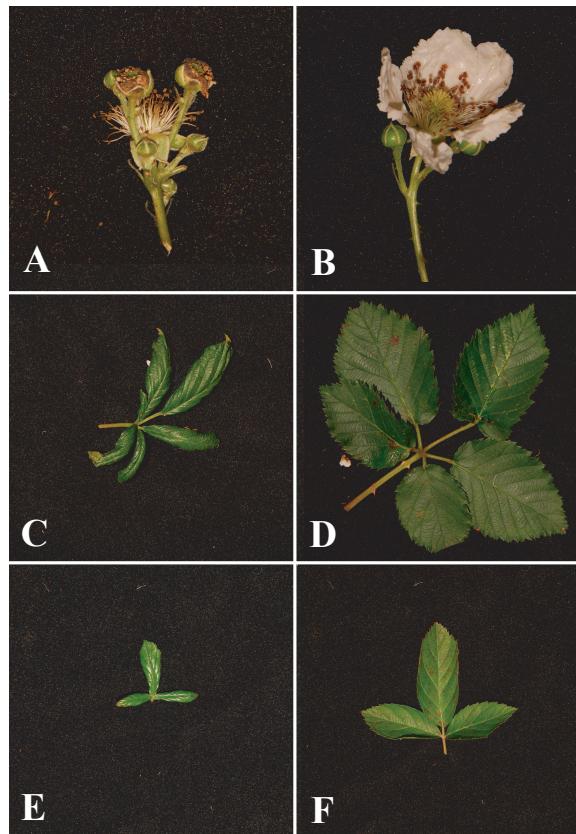
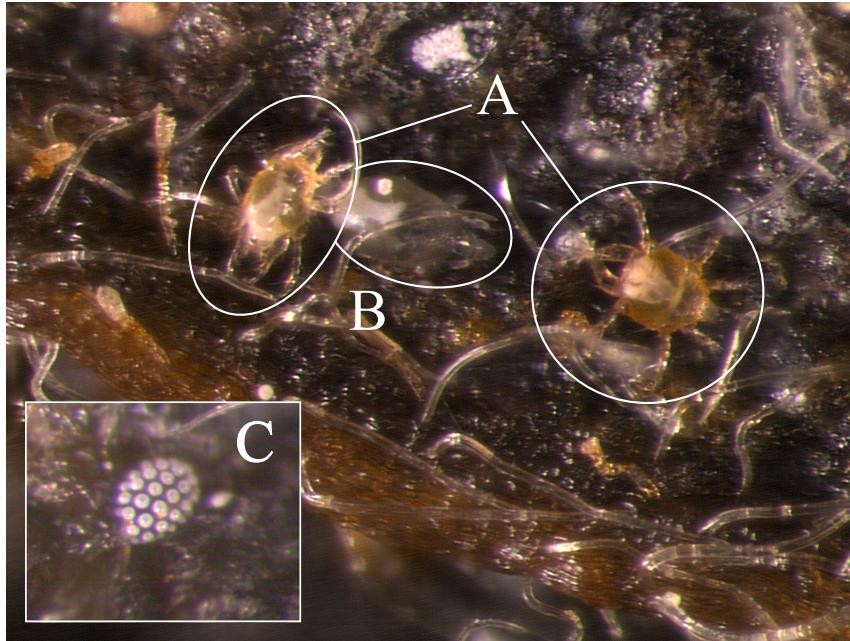
- Broad mites
- Bud phenology



Broad mite on blackberry

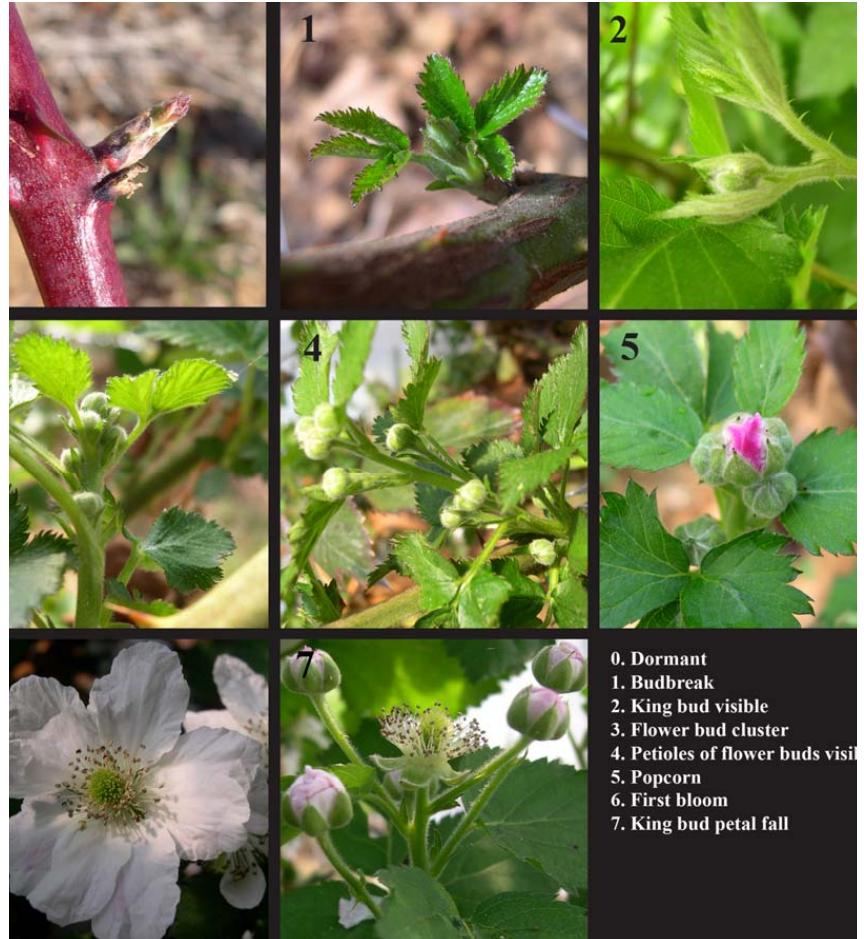
Polyphagotarsonemus latus
(Banks)

- 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

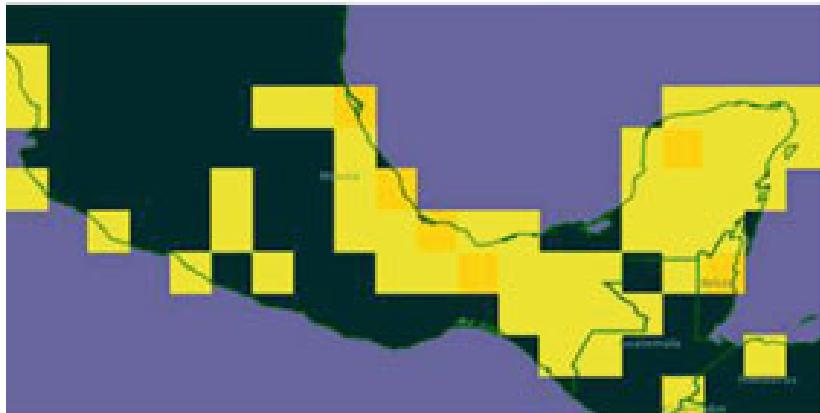
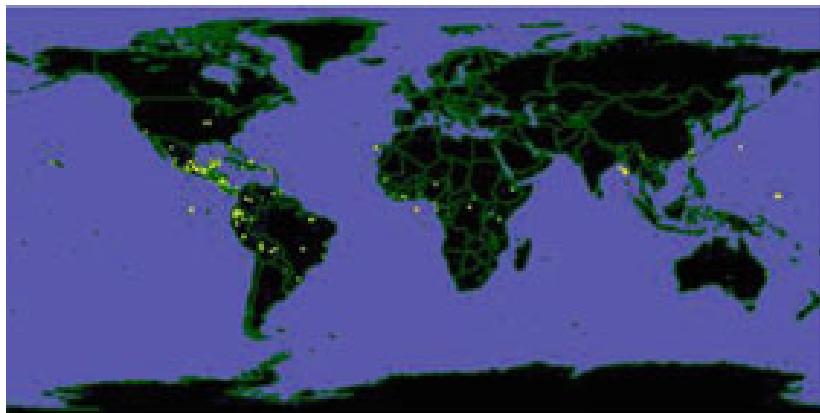
- Successful early winter and early spring production
- Day-neutral varieties best
- Some early grower adoption



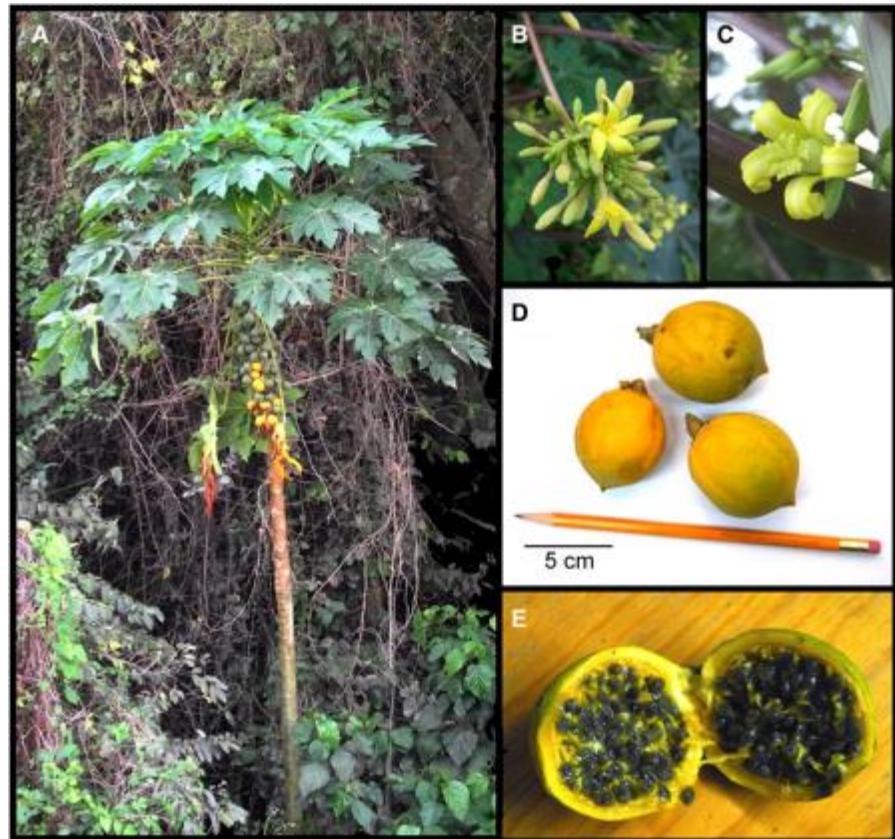
Papaya



Carica papaya L. origin



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



From: Chavez-Pesquera et al. (2014)

Wind damage



Photo by Kati Migliaccio

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

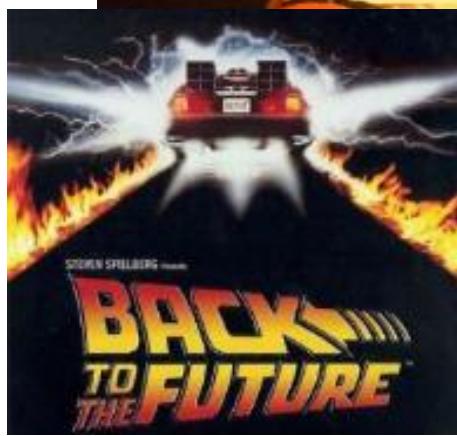
PRSV



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

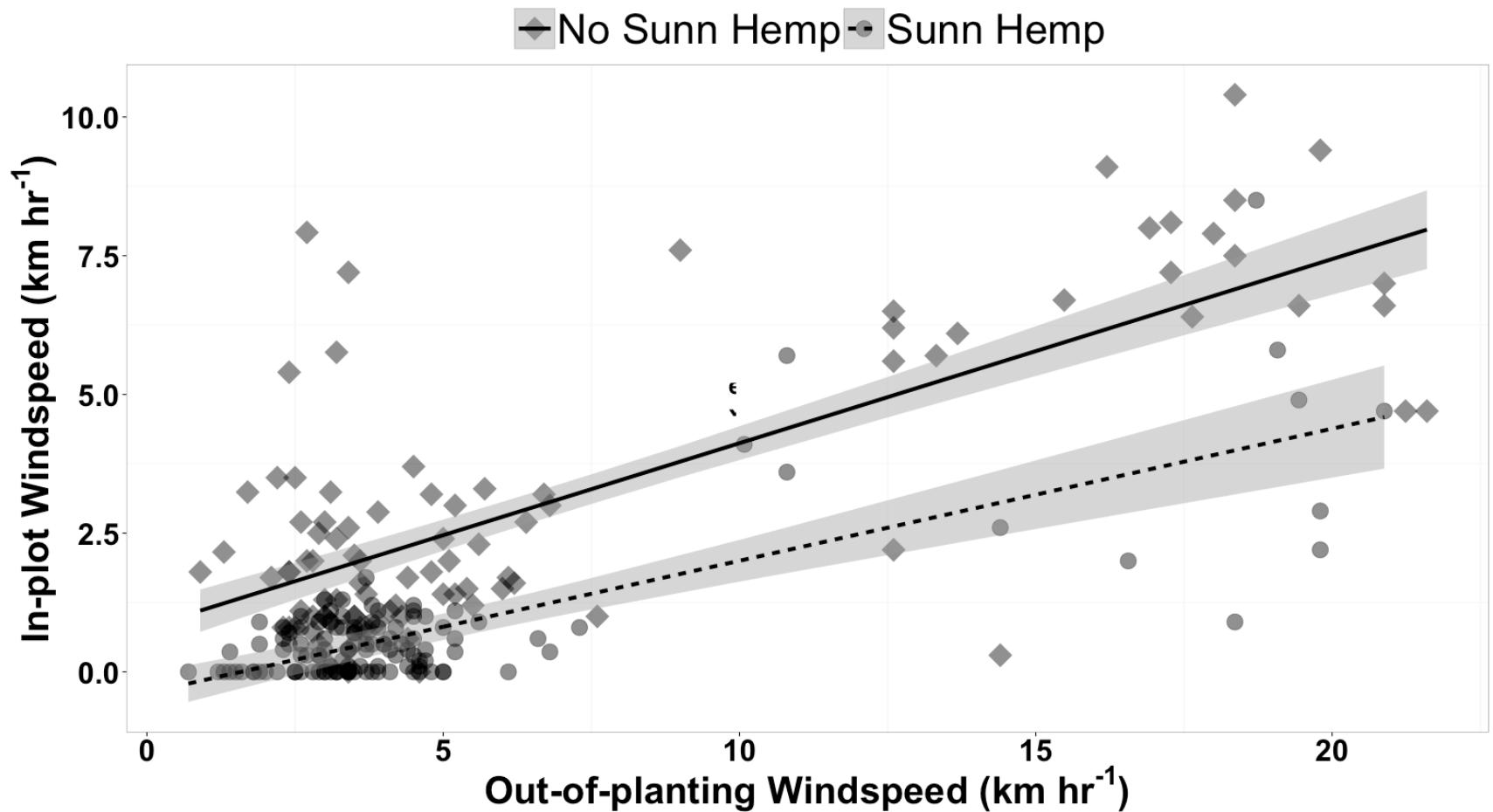
Methods

- 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



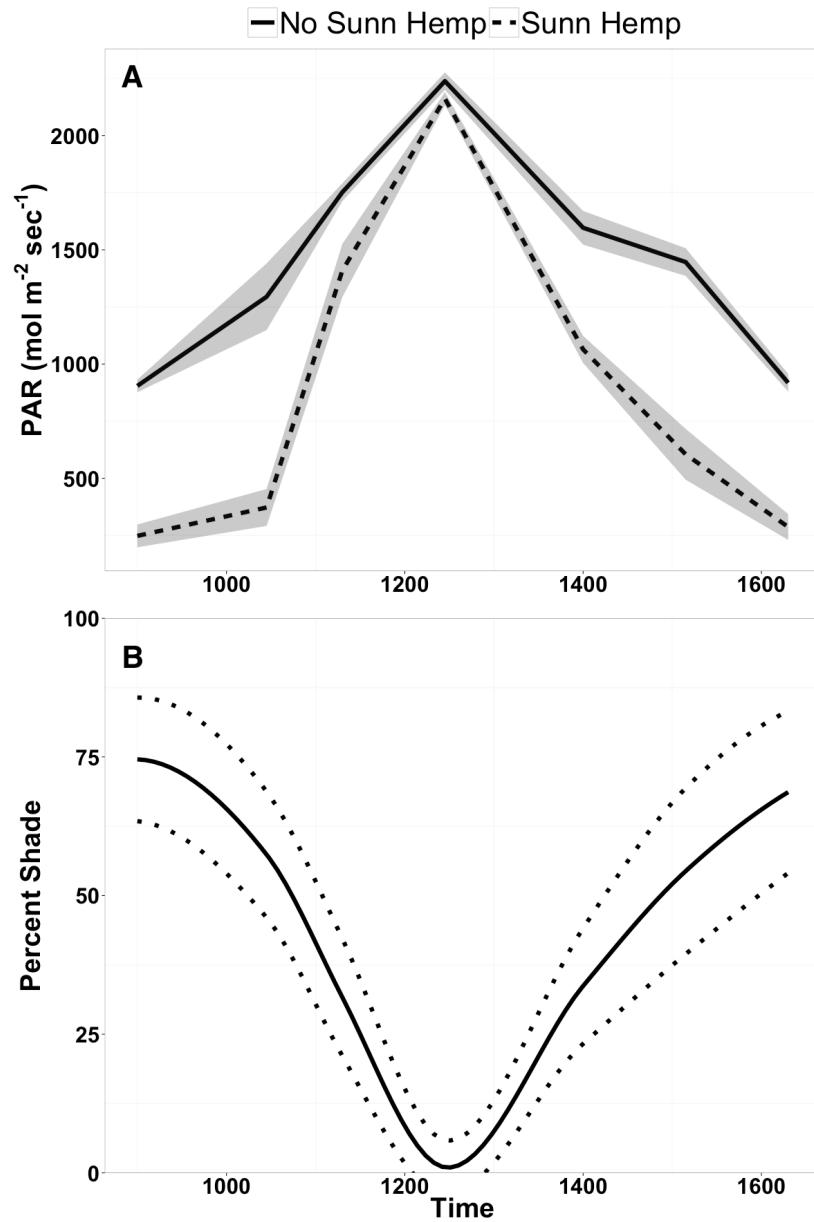
Bands represent 95% confidence intervals.

Sunn Hemp Intercrop

Shade



Sunn Hemp Intercrop



Shading

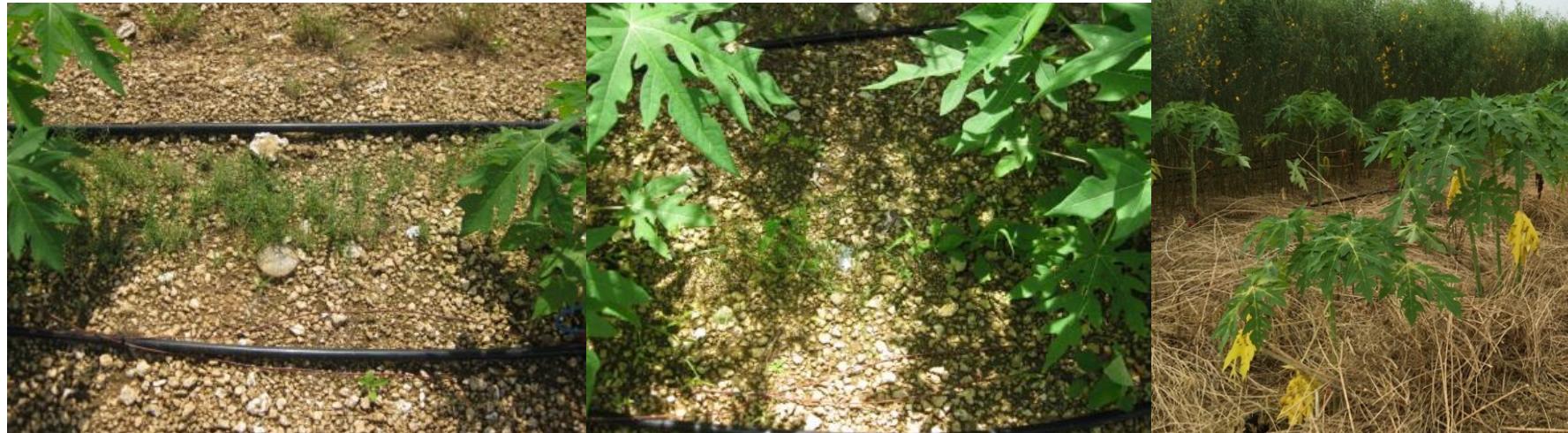


Sunn Hemp Intercrop

Horticultural Results

Planting Year	Treatment*	Weeding (hrs ha^{-1})			SH FW (Mg ha^{-1})		SH DW (Mg ha^{-1})		Flowering (DAT)	
		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	104	1.7
	SH-ML	96.9	b	11.7	23.2	4.8	8.8	a	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
	SH-ML	33.8	b	5.2	23.9	a	1.9	8.3	a	0.7

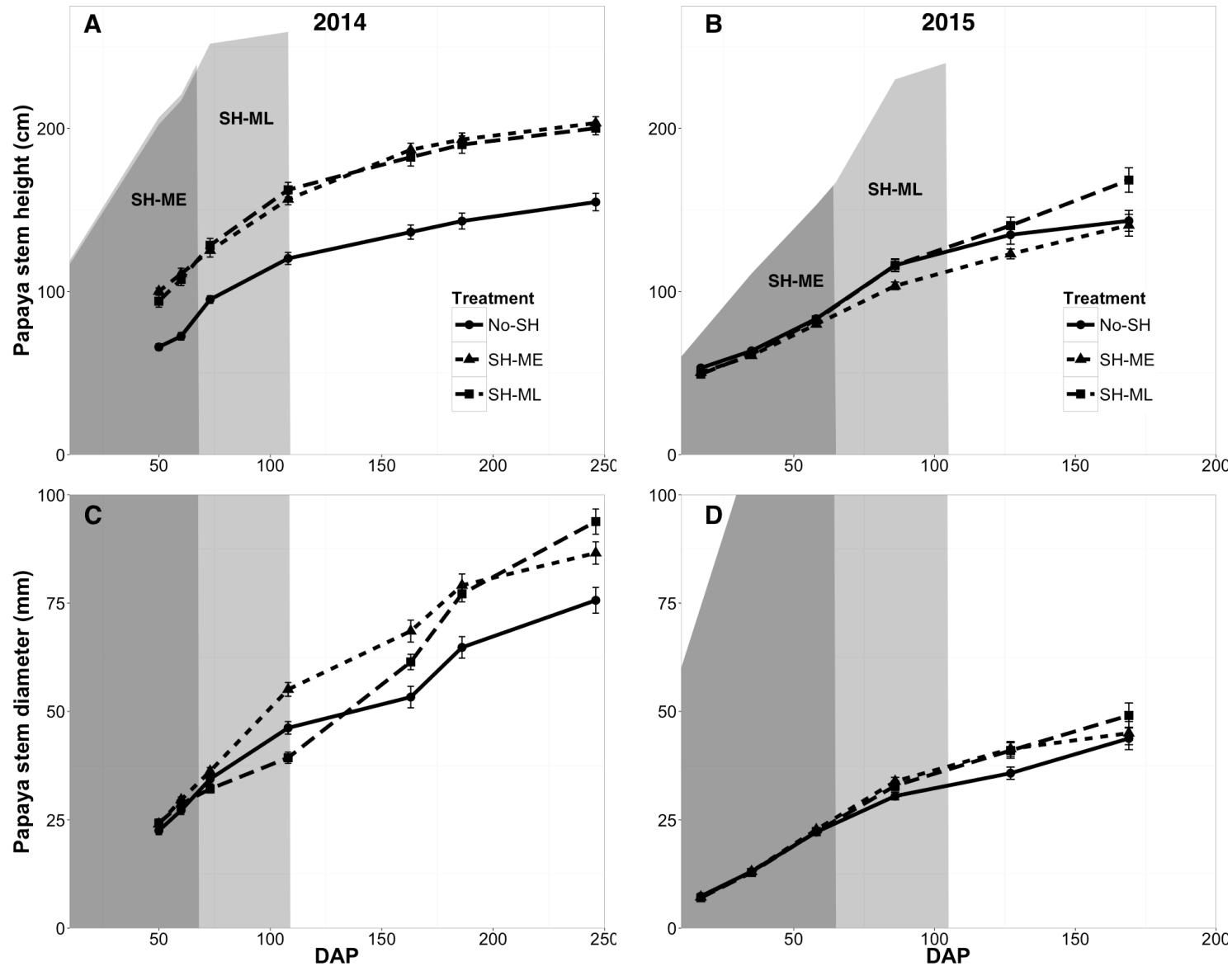
No differences in yield or irrigation water use





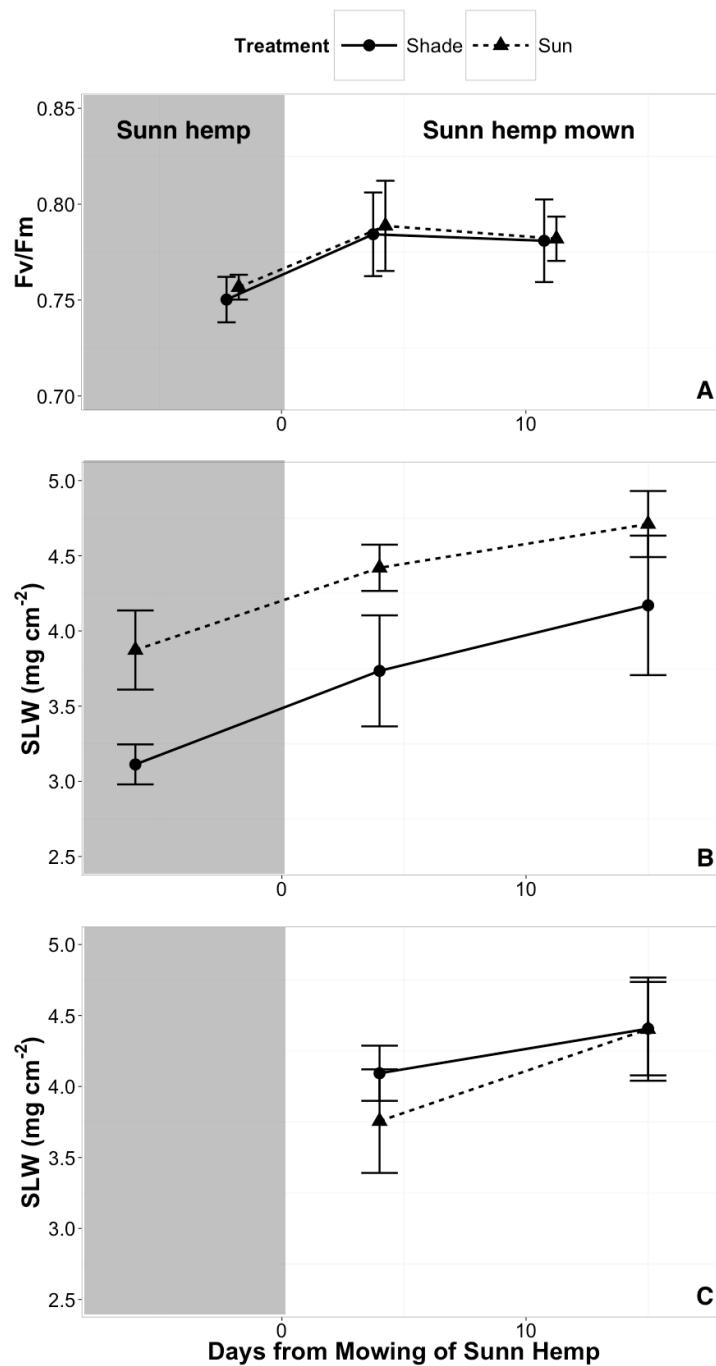
Sunn Hemp Intercrop

Papaya growth



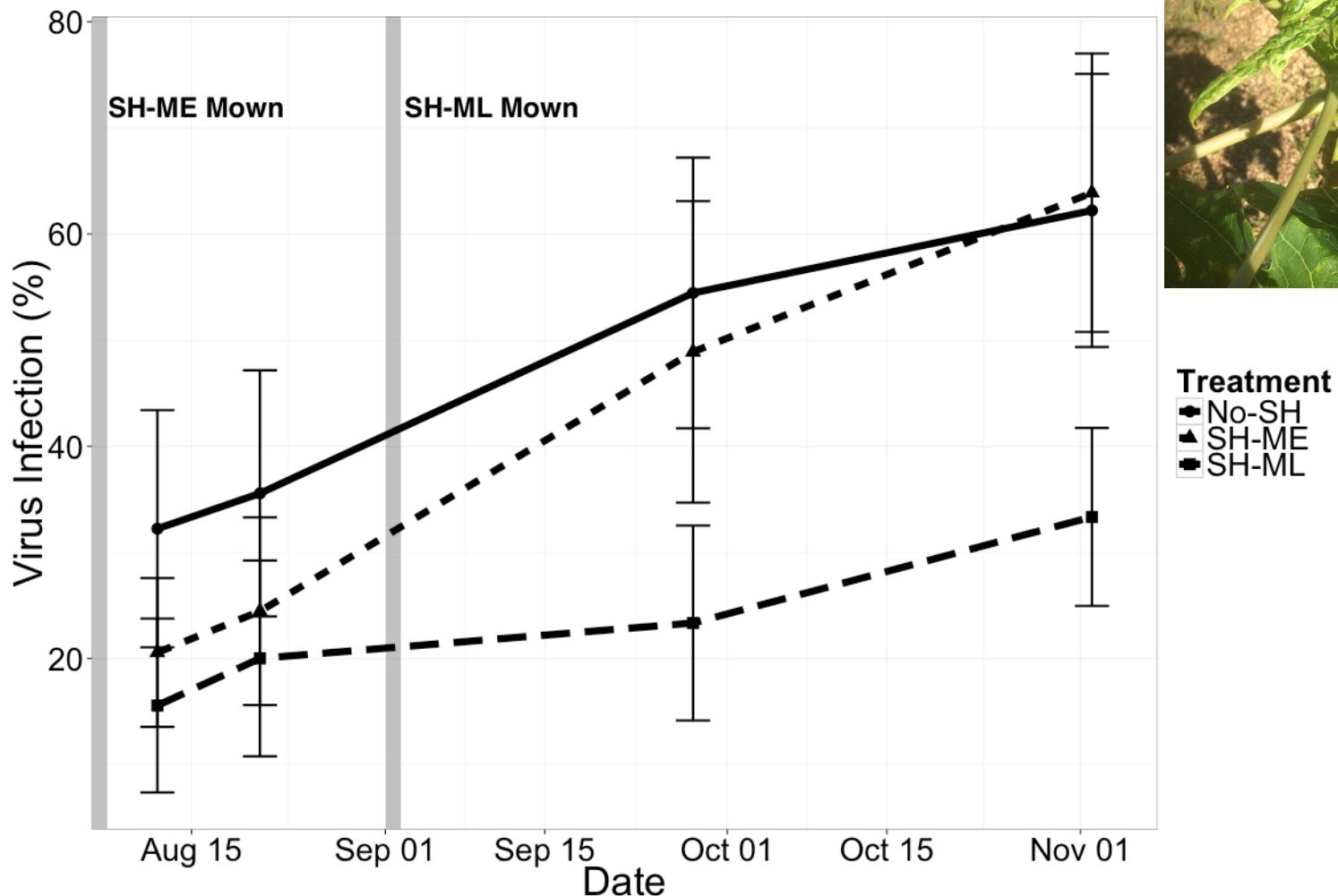
Light Stress and acclimation

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



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.

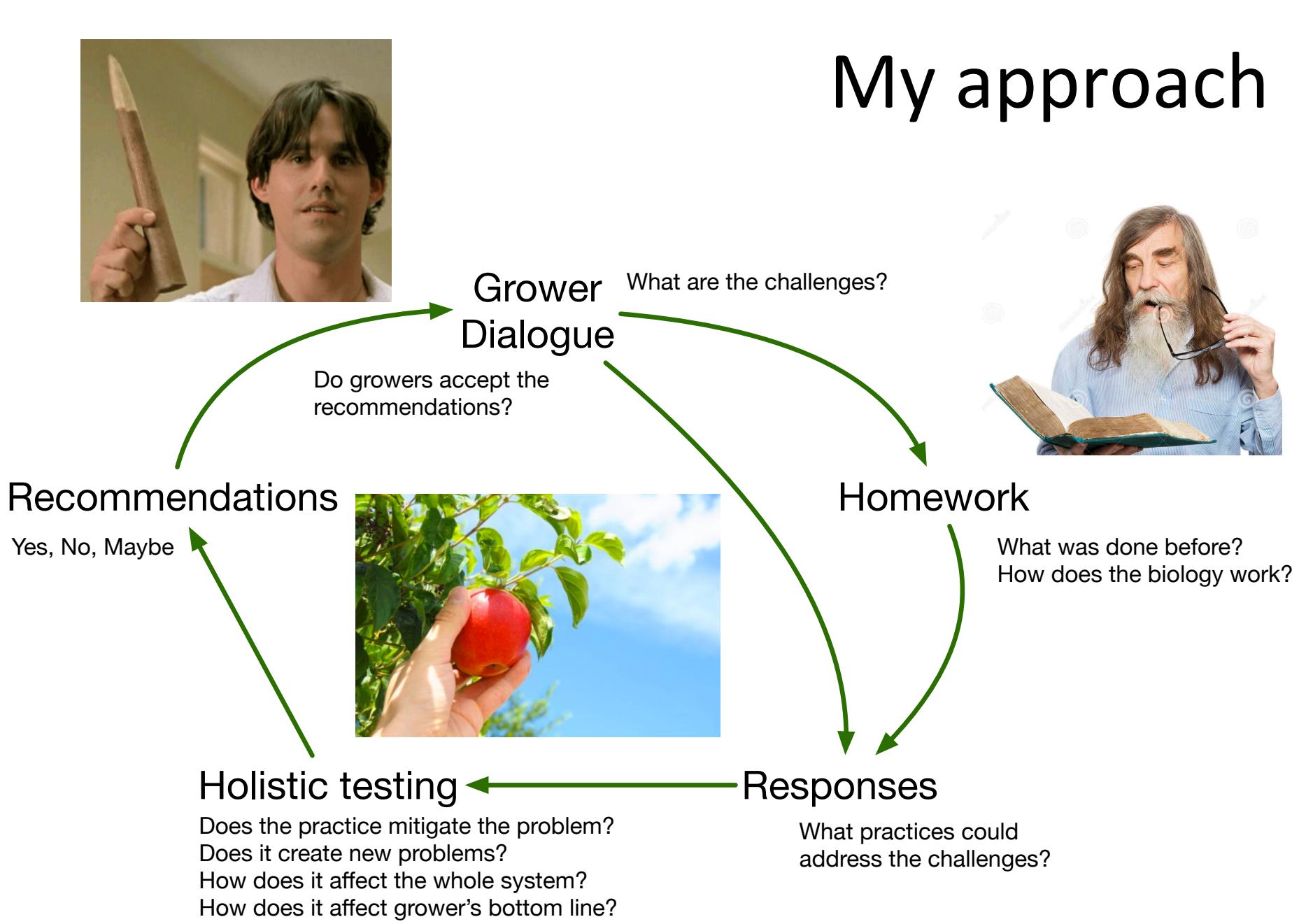
Study Conclusions

- 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?

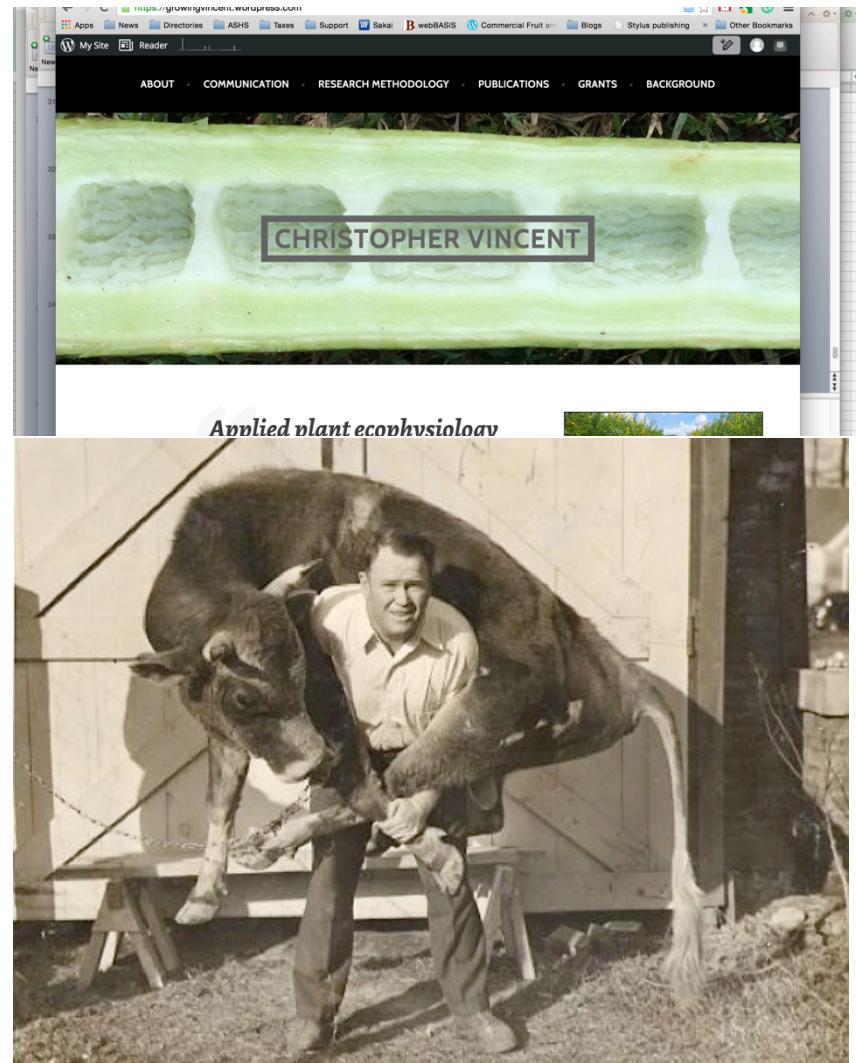
- Consider unintended consequences
- Think about the whole system
- Unique uses of cover crops may lead to win-win scenarios
 - Benefits of diversity or conservation without sacrificing yield

My approach



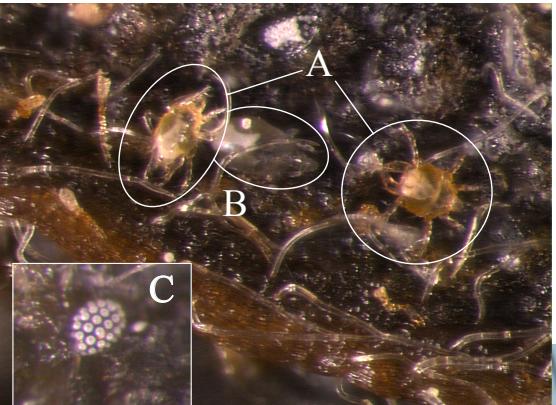
Grower Dialogue

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

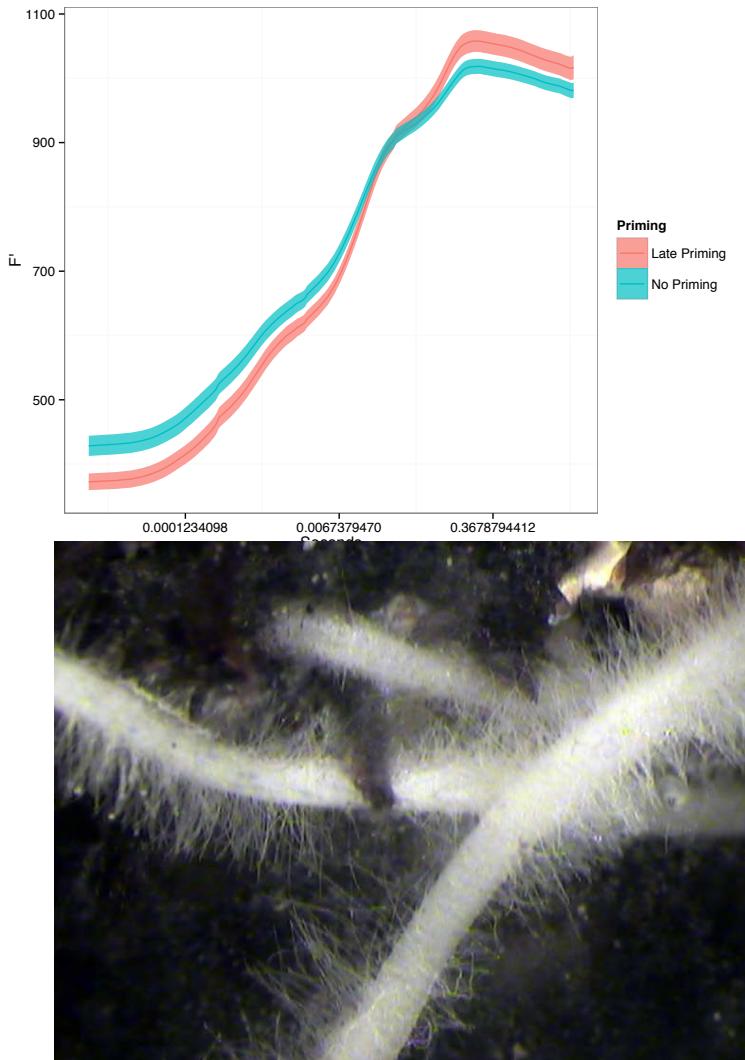
Funding



- 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

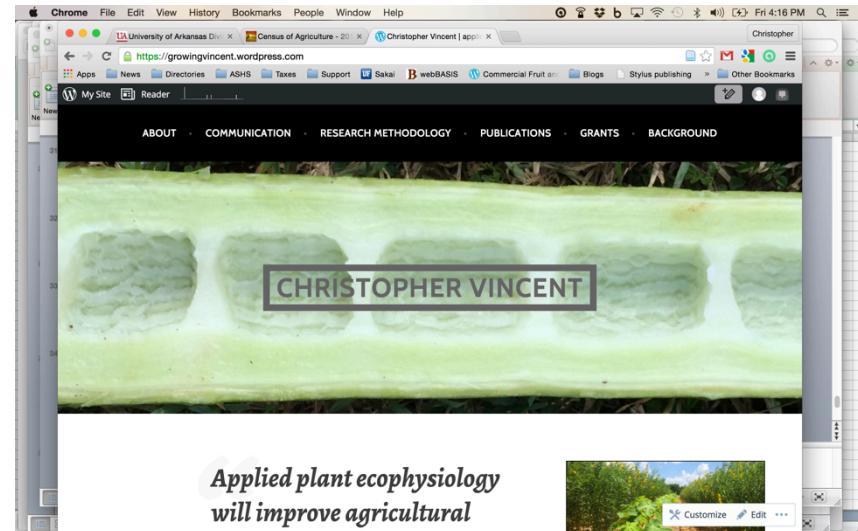
Research

- 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

