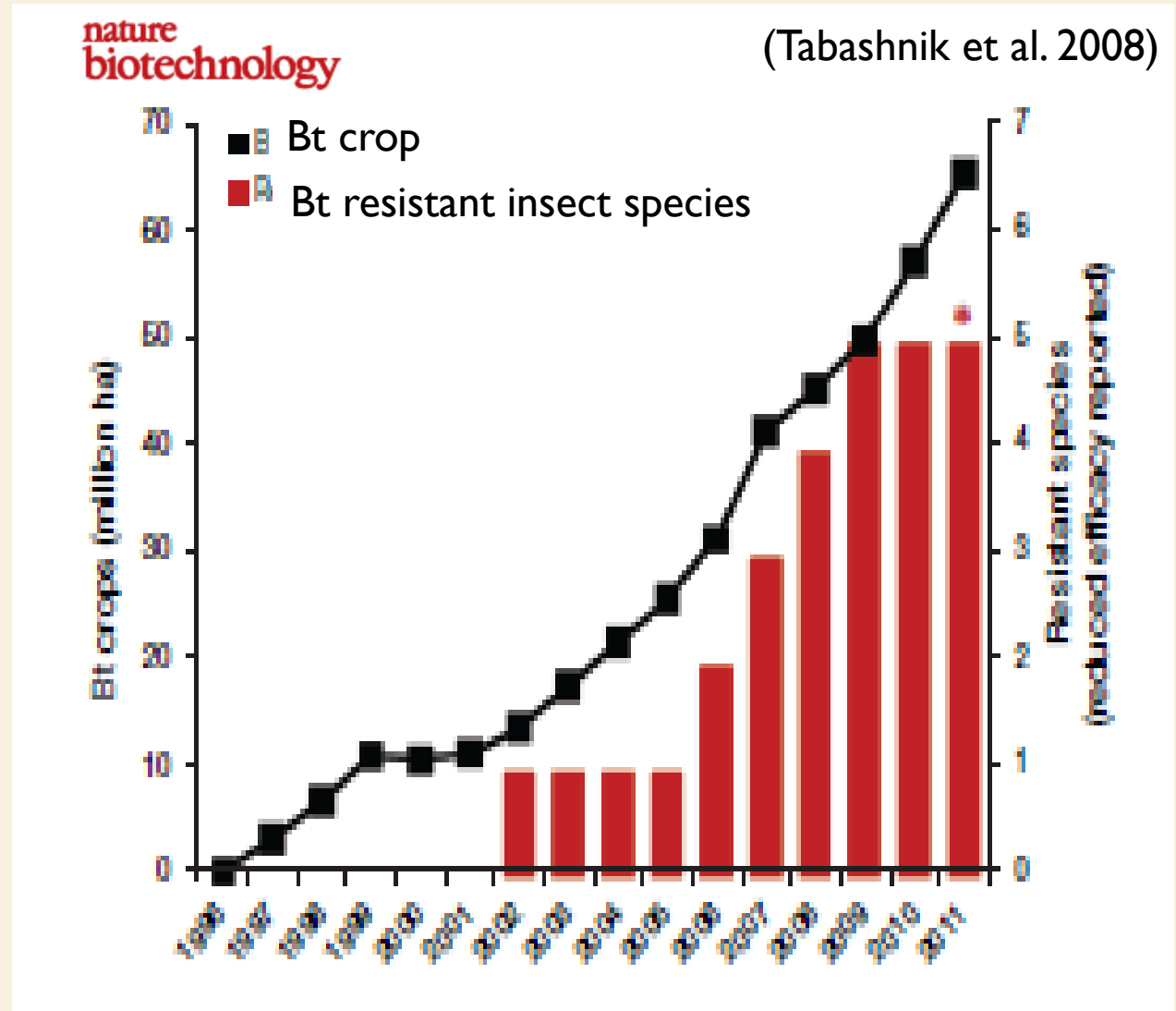


INSECTARY PLANTS & SCREENHOUSE PRODUCTION

**KOON-HUI WANG, J. SUGANO, J. UYEDA, S. CHING, J. KAM
T. RADOVICH, S. FUKUDA**

ALTERNATIVES TO INSECTICIDE ARE NEEDED

- Insecticide resistant pest populations are increasing.
 - Bt only kill 25-33% of Bt-resistant diamondback moth compare to 100% kill of the susceptible population (Tabashnik 1990).
- Some insect pests are cryptic
 - pickleworm
- Effective fruit flies management require area-wide collaboration (Vargas et al., 2008).
- For organic farmers, lack of effective OMRI certified insecticide for an effective pesticide rotation program.



ENHANCE NATURAL ENEMIES OF TARGET PESTS

INSECTARY PLANTS

Plants that attract insects, either by producing abundant flowers with pollen and nectar for beneficial insects, or by luring insect pests away from the cash crop.



Hoverflies on
buckwheat and cilantro



Sunn hemp flowers attracts
Lycaenidae butterflies that drawn
Trichogramma wasps to lay eggs on
the Lepidopteran eggs.



Lady beetles
on Aweoweo



Uhaloa attracts
wasps and bees

EXTRA-FLORAL NECTARINES

- **Extra-Floral Nectarines** = nectar glands not associated with flowers.
- Good for attracting beneficial insects when most flowers are not in bloom.



Partridge pea

HOW TO INTEGRATE INSECTARY PLANTS INTO FARMS

2. As intercrop

1. As border crop



Sunn hemp no-till (surface mulch)

Cowpea & buckwheat as border crop in onion plot

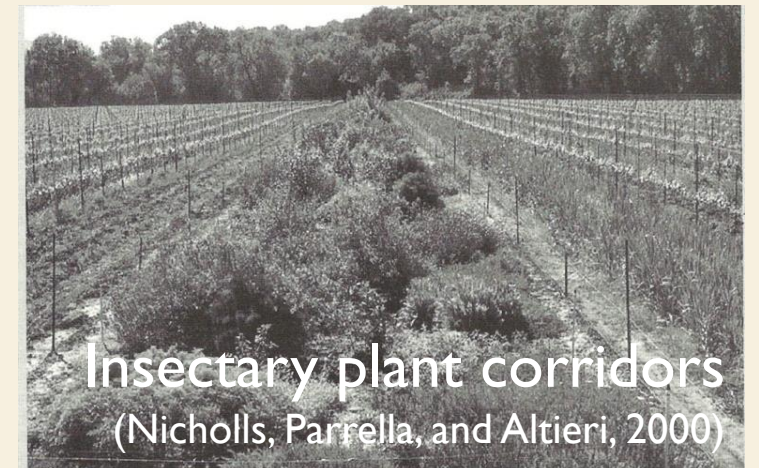


Buckwheat and zucchini



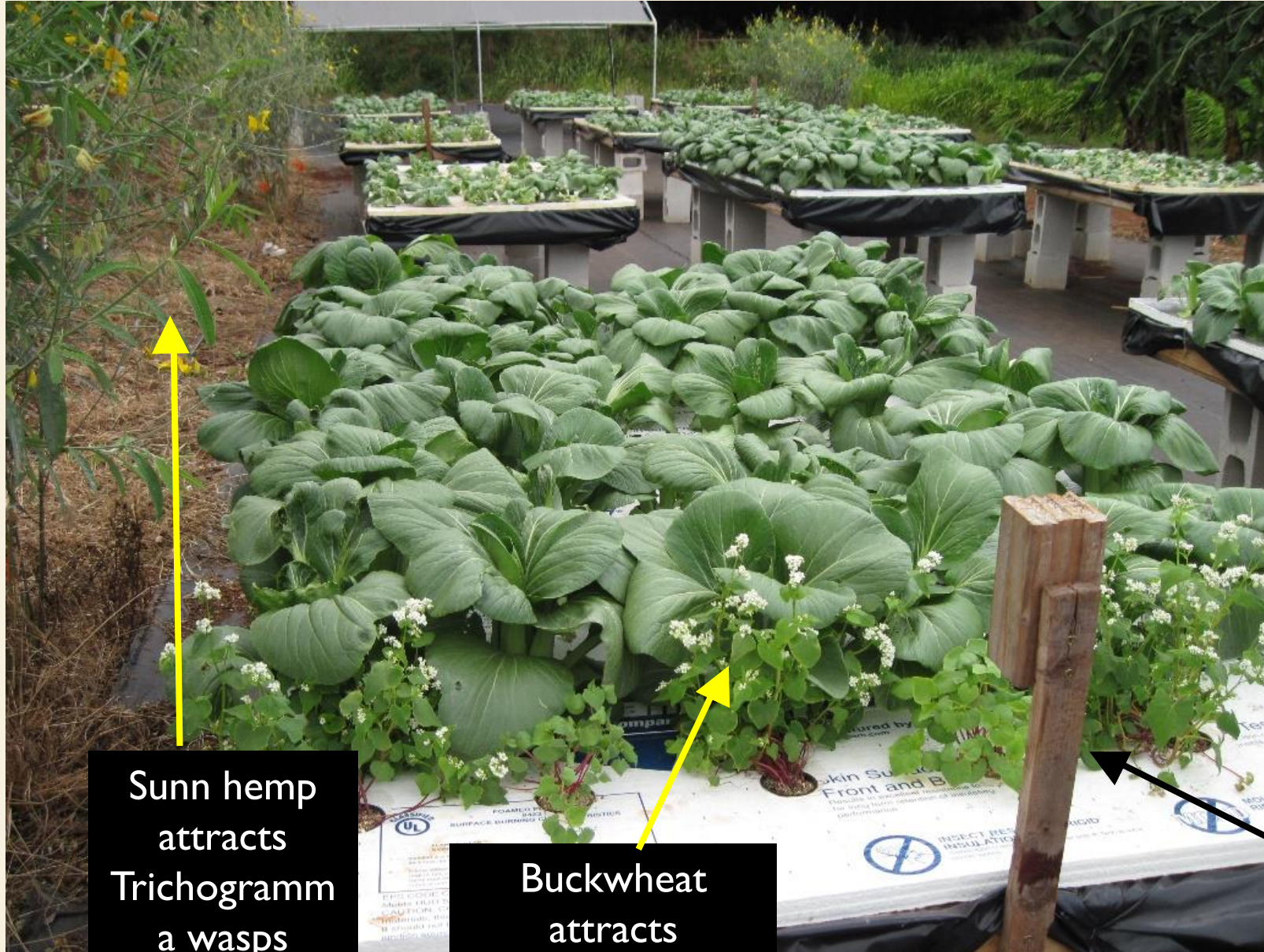
(Roshan Manandhar)

Sunn hemp and corn



Insectary plant corridors
(Nicholls, Parrella, and Altieri, 2000)

INSECTARY PLANTS FOR HYDROPONIC PRODUCTION



Sunn hemp
attracts
Trichogramma
a wasps

Buckwheat
attracts
hoverflies

Wasp
nesting
block
attracts
keyhole
wasps



WASPS NESTING BLOCK

Pollinators



Leaf cutter bee



Hylaeus bee



Untreated wood

Predators



Key-hole Wasp

<http://bugguide.net/node/view/241212>



Aphid-collecting
Wasp

COMPARING INSECTARY SETTINGS AND METALLIC REPELLANT FOR HYDROPONIC BRASSICA



Whiteflies

Aphids



Beneficial insects found in insectary treatment



Trichogramma wasp



Parasitized aphids



Hoverfly eggs
among aphids

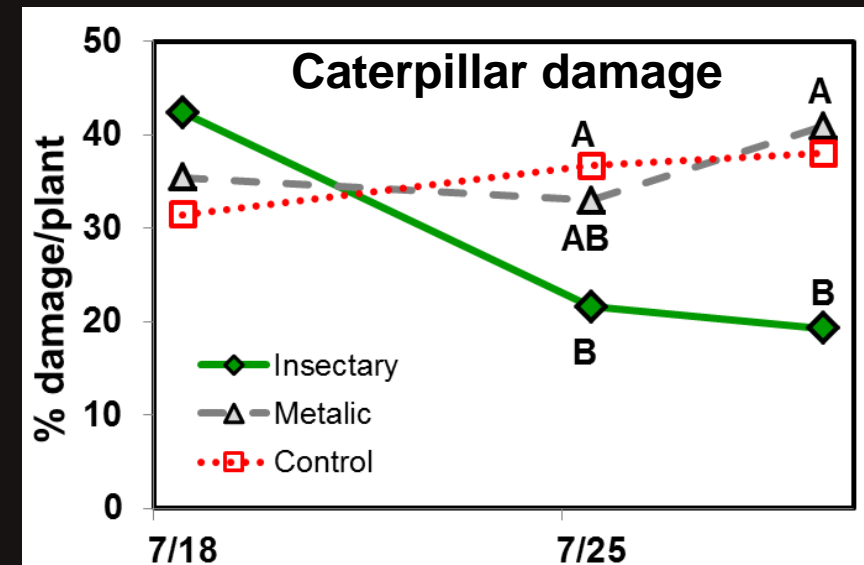
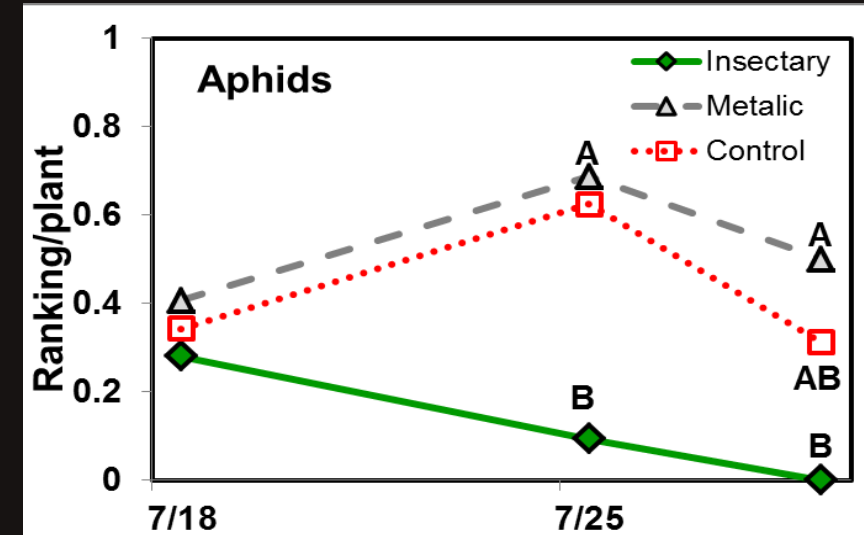


DBM pupae
parasitized by
parasitoid wasp

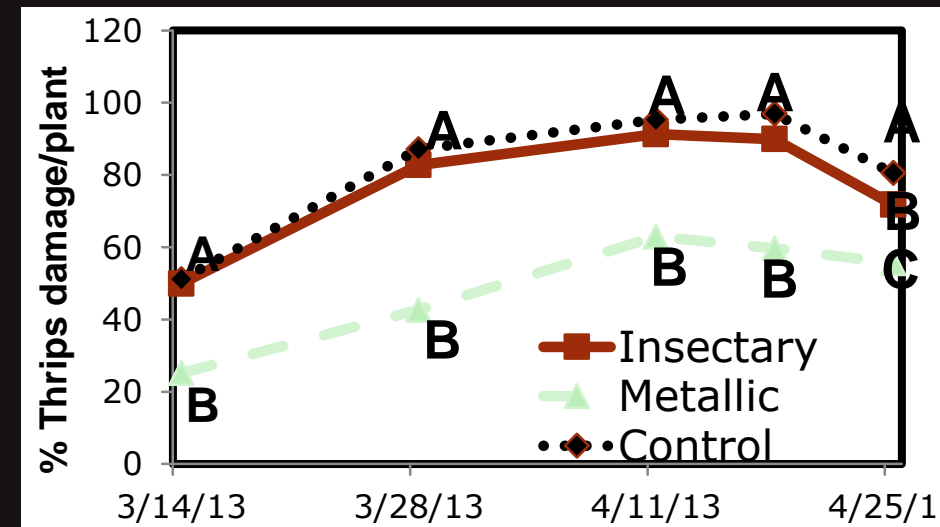
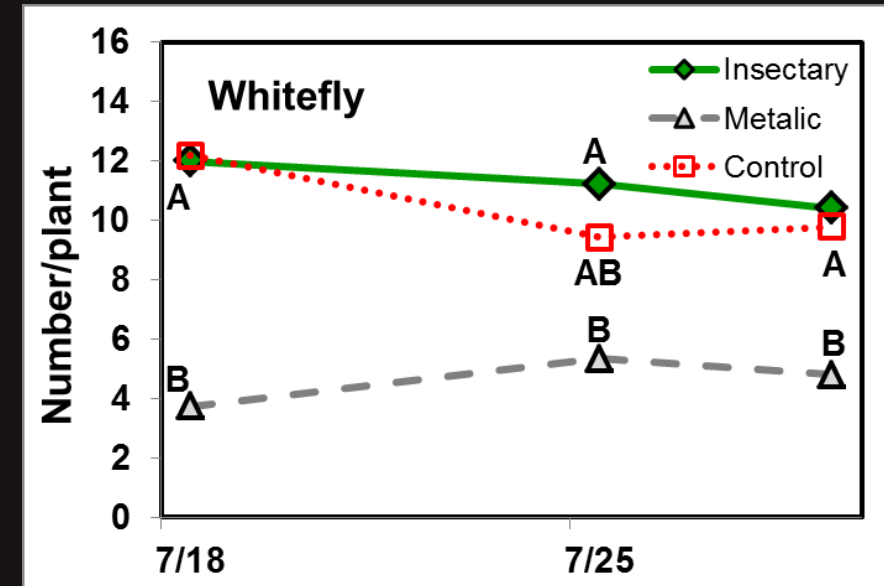
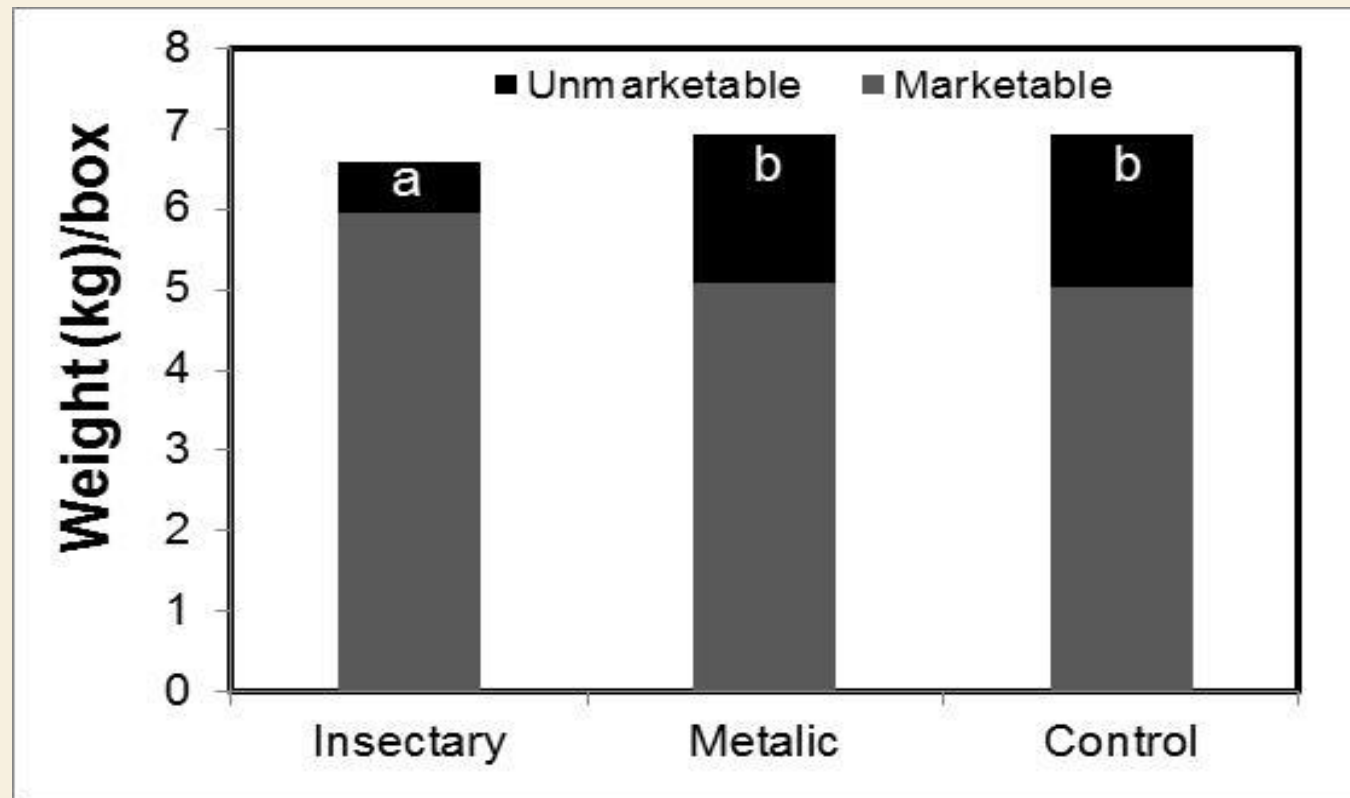


Hoverfly larvae
eating an aphid

Insectary setting suppressed aphids and caterpillar damage

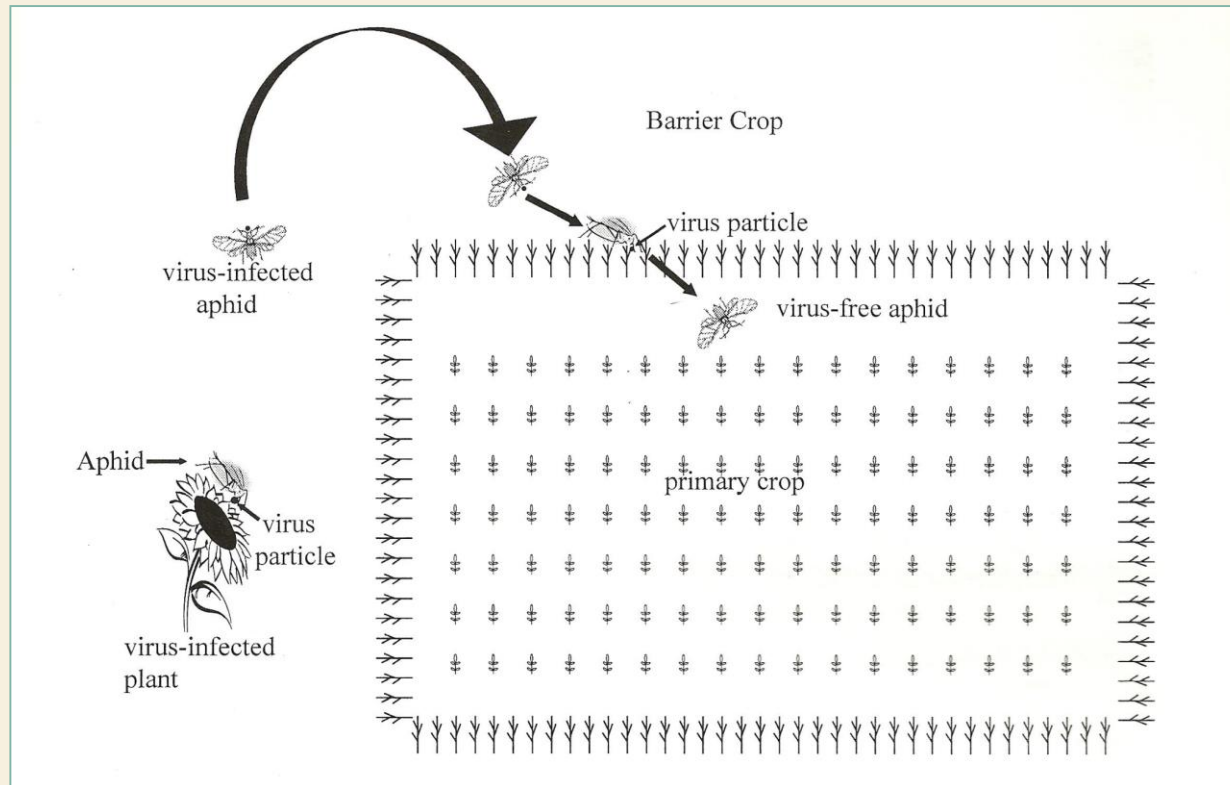


Insectary settings reduced unmarketable pak choi, but did not protect it against thrips and whiteflies



SUNN HEMP AS A TRAP CROP FOR WHITEFLIES, REDUCING SILVERLEAF & VIRAL SYMPTOMS

Trap crop / virus sink theory

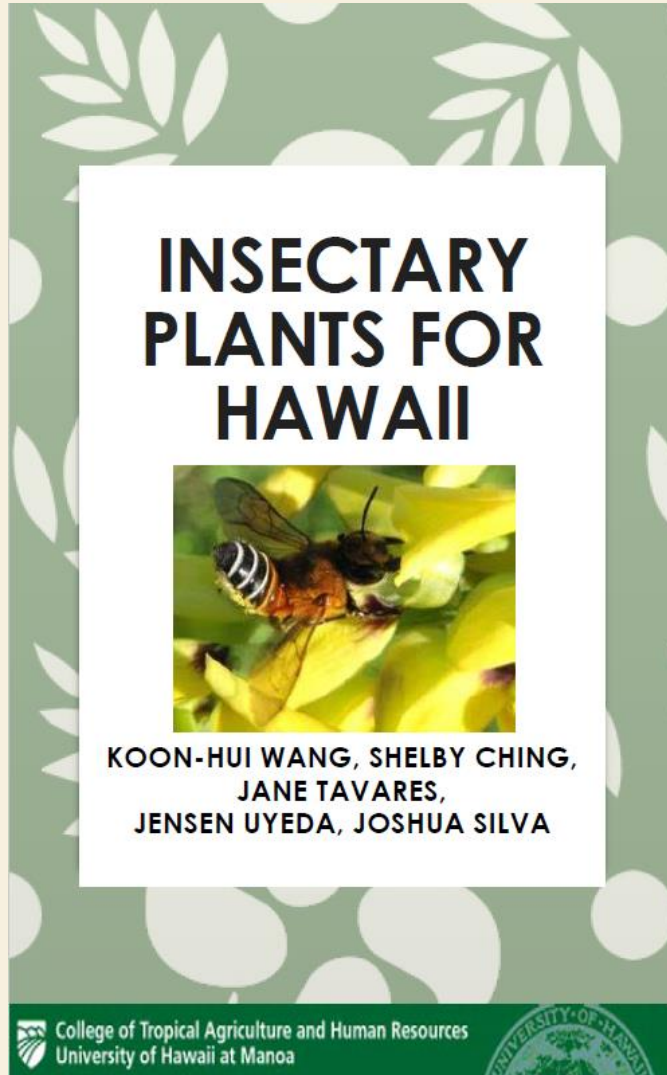


Zucchini in bare ground



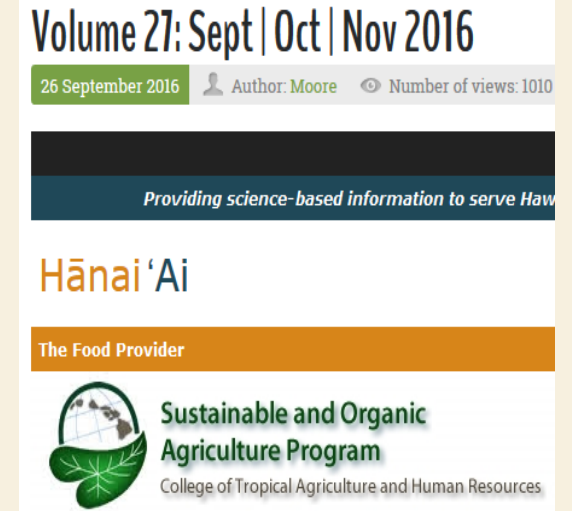
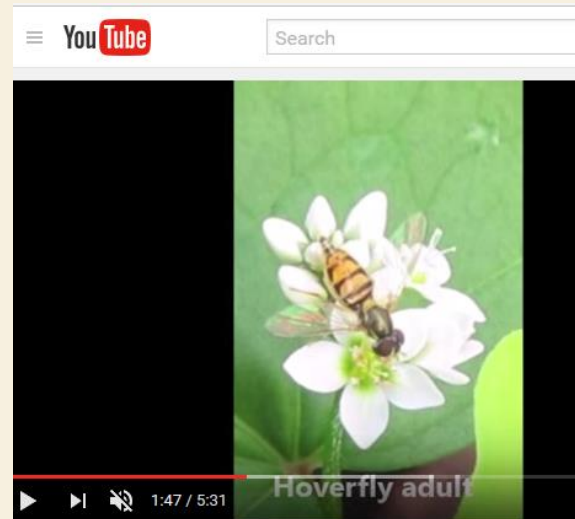
Zucchini intercropped with sunn hemp

INSECTARY PLANTS SELECTION



Videos

- Part I:
https://www.youtube.com/watch?v=BsN_3lC35wg&feature=youtu.be
- Part II:
<https://www.youtube.com/watch?v=1stOru5l-a0&feature=youtu.be>



**INTEGRATE WITH
PHYSICAL BARRIER**



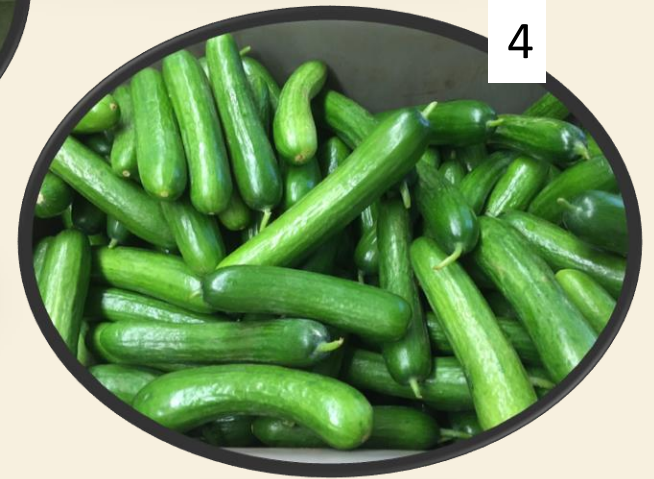
**INSECT EXCLUSIVE NET
SCREENHOUSE**

CHALLENGES OF SCREENHOUSE

1. Additional cost than open field production
2. Construct stable structure that can withstand gusty wind
3. Smaller insect pests can get in
4. Exclude pollinators
5. Rupture of screen from close contact with pipe connectors
6. Difficult to till the soil for next crop (weeds and nematodes problems)



Out break of aphids inside the screenhouse can occur.



Parthenocarpic zucchini and cucumber seeds are available, but are expensive.

Conley 1100



Utah State High Wind Tunnel



Plastic coverings (6 mil) did not hold up against tropical storms and winds in 2017, USDA NRCS considers to change the AMA criteria to allow for screen covering.



NRCS AMA Cost Share

Code	Practice	Component	Units	Unit Cost
325	High Tunnel System	Gothic style high tunnel with shade cloth	Sq ft	\$2.83
325	High Tunnel System	HU-Gothic style high tunnel with shade cloth	Sq ft	\$4.24
325	High Tunnel System	Quonset style high tunnel with shade cloth	Sq ft	\$2.25
325	High Tunnel System	HU-Quonset style high tunnel with shade cloth	Sq ft	\$3.38

Quonset Style



Gothic Style with 17 mesh screen



All screenhouses with different designs can withstand the same tropical storm.

PVC Hoop House



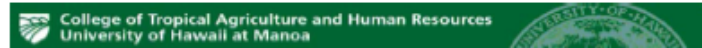
Row Cover



HANAI'AI VOL 28

DEC, JAN, FEB 2017

DIY Screenhouse



DIY Screenhouse for Insect Management in the Tropics:

Part I

Koon-Hui Wang, Jari Sugano, Steve Fukuda, Jensen Uyeda, Donna Meyer,
Shelby Ching, CTAHR, University of Hawaii at Manoa

INTRODUCTION

Due to growing environmental consciousness among consumers and growers, organic farming approaches are gaining popularity amongst vegetable farmers. However, organic farmers in Hawaii are concerned about the lack of effective, organic insect pest management tools (Radovich, 2009). Constructing screenhouses with insect exclusion nets for crop production has been practiced elsewhere and proven to reduce pesticide applications and increase crop yields compared to open field production (Romeo-Gómez et al., 2011). Purchasing fabricated screenhouses is extremely costly for farmers in Hawaii as it involves expensive shipping costs. Sugano et al. (2014) had developed protocols to construct affordable screenhouses using home improvement store supplies (<http://www.ctahr.hawaii.edu/WangKH/Downloads/P-DIY-screenhouse.pdf>). Costs can be reduced for farmers if materials are procured from local hardware stores. Screening material can be sewn with UV resistant thread to meet the appropriate dimensions of the screenhouse. There is a reduced cost to farmers with materials from home improvement stores and screen material that can be sewn with UV resistant thread to get the desired width. Strong gusty winds during certain times of the year create a challenge for these structures to hold their shape and stay in place. This article modifies screenhouse designs from Sugano's et al. (2014) publication to improve performance.

Unlike some of our U.S. mainland counter parts that had been using screenhouses or hoop houses to extend the crop-growing season into the winter, the main objective of the CTAHR screenhouse designs is for managing insect pests that are difficult to be managed with insecticides. Some pest examples include, pickle worm and melon fly on cucurbit crops, imported cabbage worm or other Lepidopteran pests on cabbage or other brassica crops, flea beetle on eggplant, rose beetle on strawberry, taro and many other crops. We used 17-mesh screen material that excludes larger size insect pests like listed above but not smaller soft body insects such as aphids, whiteflies, and thrips. Although mesh size can be substituted for a 60 mesh to exclude smaller insects, ventilation in the house will be significantly decreased and heat related stress can increase.



Western Sustainable and Agriculture Research and Education Professional and Producer (WSARE P&P) program and the CTAHR Supplemental Fund funded a 2-year project for our team to develop and promote the use of screenhouses for small-scale vegetable crop producers. This report summarizes what we have developed in collaboration with three groups of participating farmers.

Acknowledgement: This project is supported in part by the WSARE P&P (OW13-019), and in part by the CTAHR Supplemental fund (9022H). We greatly appreciate the collaboration and support from Jay Bost, Dan Ching, Anthony Deluze, Meleane Judd and Victor Perez.



EMT Conduit

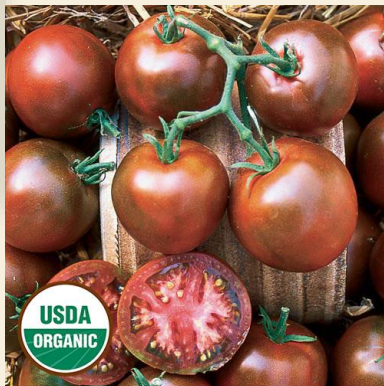


PVC

SCREENHOUSE WITH WOOD-BASED FRAME



TYLC



Dimension: 15' × 50' × 6'

	Price (\$)
Insect netting (17 mesh)	137
Wooden door	86
Total	713
per sq ft	0.95

Screenhouse did not protect peach tomatoes from *Tomato yellow leaf curl virus* transmitted by whiteflies.

- 'Nyagous' is resistant to TYLC virus, yield inside the screen house was higher than that in the open field.
- Attribute to reduction in bird damage and fruit flies infestation.

CHALLENGES OF SCREENHOUSE WITHOUT RETRACTABLE WALL

Pest outbreak due to lack of natural enemies inside the screenhouse.



aAphids outbreak



Aphids in the screenhouse with open wall were parasitized (mummified).

Some crops are pollinator-dependent.

Cucumber



Poor pollination



Parthenocarpic cucumber and zucchini varieties are available but expensive.

SCREENHOUSE WITH WOOD-BASED FRAME AND RETRACTABLE WALL



Dimension: 15' × 50' × 6'

	Price (\$)
Insect netting	137
Wooden door	86
Total	820
per sq ft	1.09



(2016)

ADOPT INSECTARY PLANTS INTO SCREENHOUSE

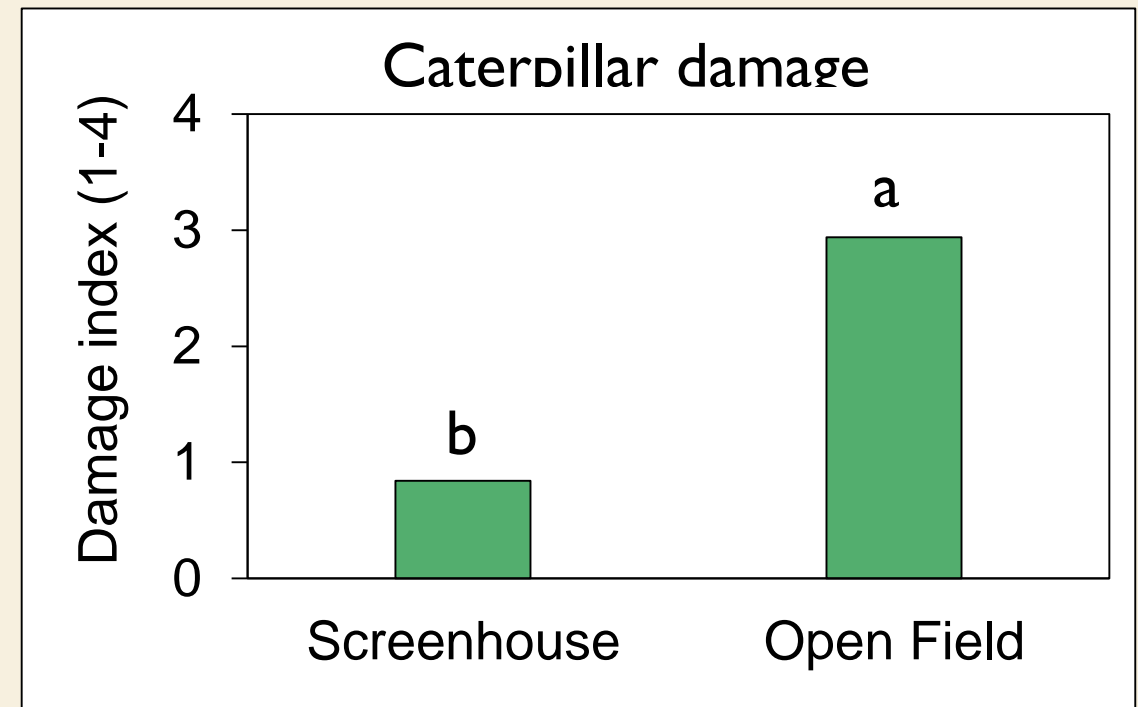


Roll up the wall in the day for pollinators and predators to come in. Roll down the wall in the afternoon to block pickle worms and fruit flies adults (nocturnal) from getting in.

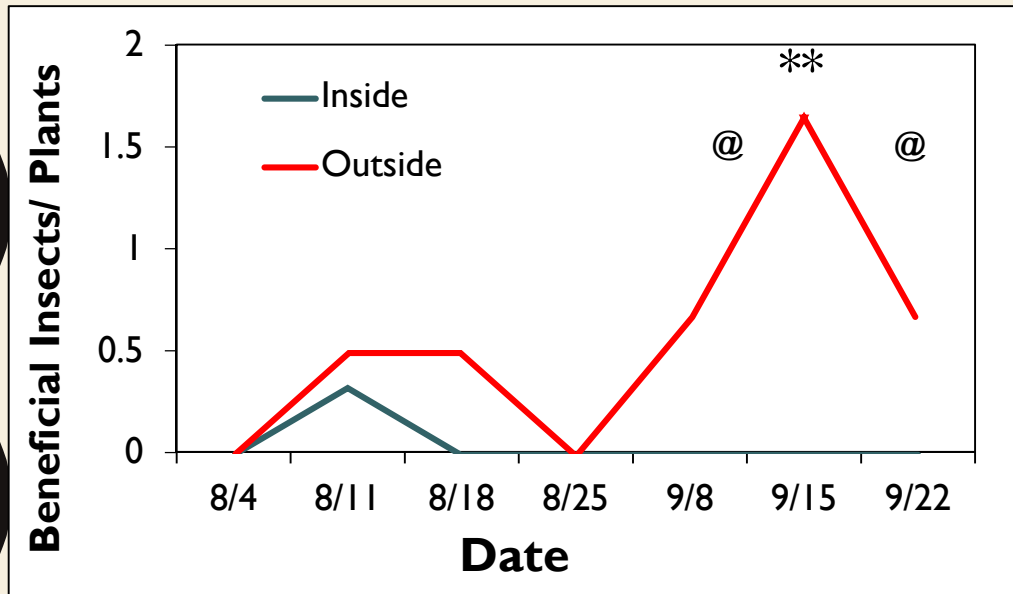


SCREENHOUSE ON KALE

Screenhouse reduced diamond back moth (DBM), imported cabbage worms, leaf miners on kale



SUMMARY: DILEMMA OF 17-MESH SCREENHOUSE



Beneficial insects were more abundant in open field than inside the screenhouse.



Adopt insectary plants into screenhouse

Insecticide rotation against soft body insects

What if we use finer mesh?

What if we don't use wood frame (to cut cost)?

EFFECTS OF SCREENHOUSES WITH DIFFERENT MESH SIZES



Hoop house



EMT conduits to support PVC pipes.

15'× 50'× 6'	Price (\$)
Insect netting (17 mesh)	137
Structure (with door)	330
Total	467
Price per sq ft	0.62

Open field (OF)



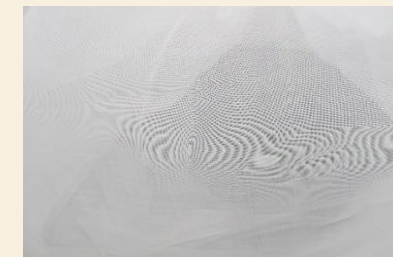
17 mesh (\$0.125/sq ft)



Reflective shade (\$0.35/sq ft)



Anti-insect netting
40 Mesh (\$0.22/sq ft)



No thrips insect screen
75 Mesh (0.85/sq ft)

SCREENHOUSE ON ZUCCHINI



Melon aphids

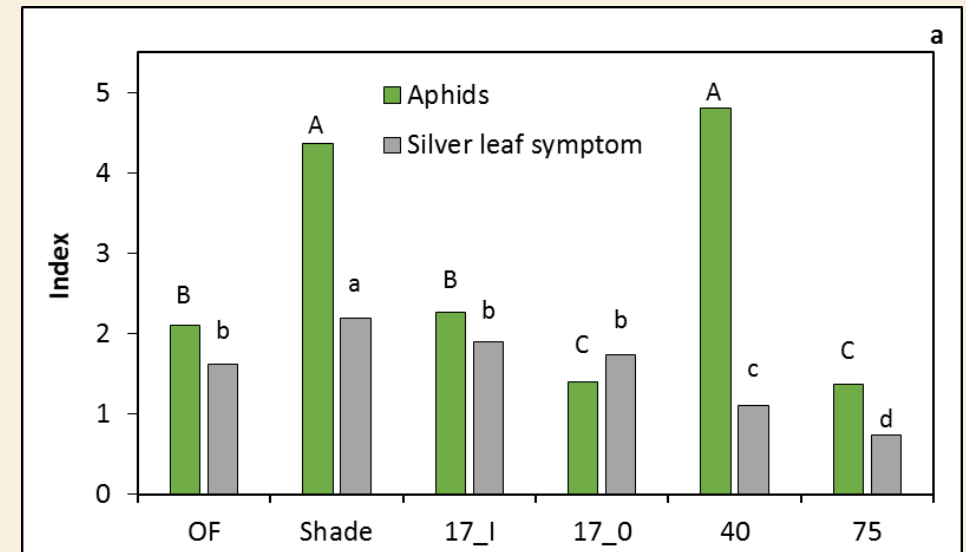
Zucchini mosaic virus



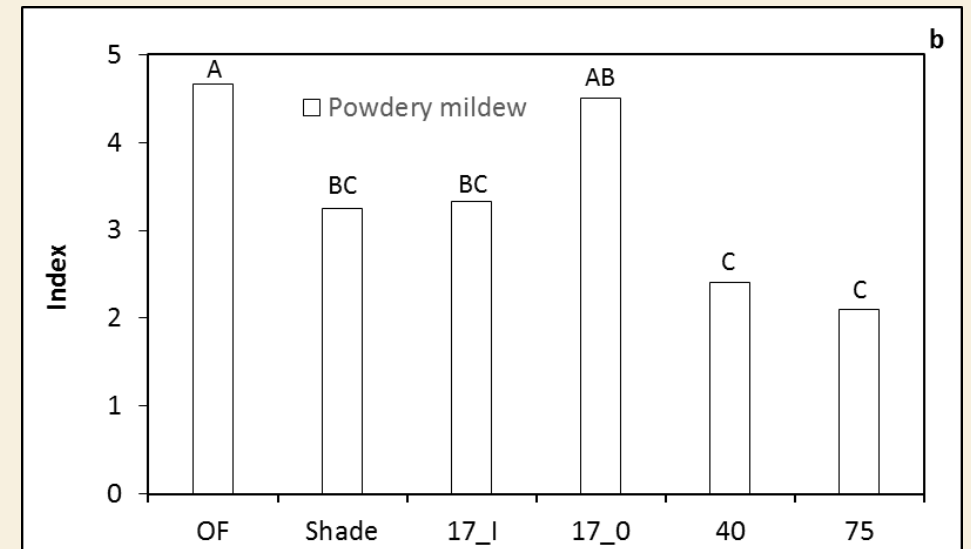
Silverleaf symptom caused by whiteflies



Powdery mildew



- 40 and 75 mesh reduce silverleaf symptomatic plants but did not reduce aphids numbers.



- Most screens can reduce powdery mildew, but effect of 17-mesh is not consistent.

PICKLEWORMS & FRUITFLIES DAMAGE



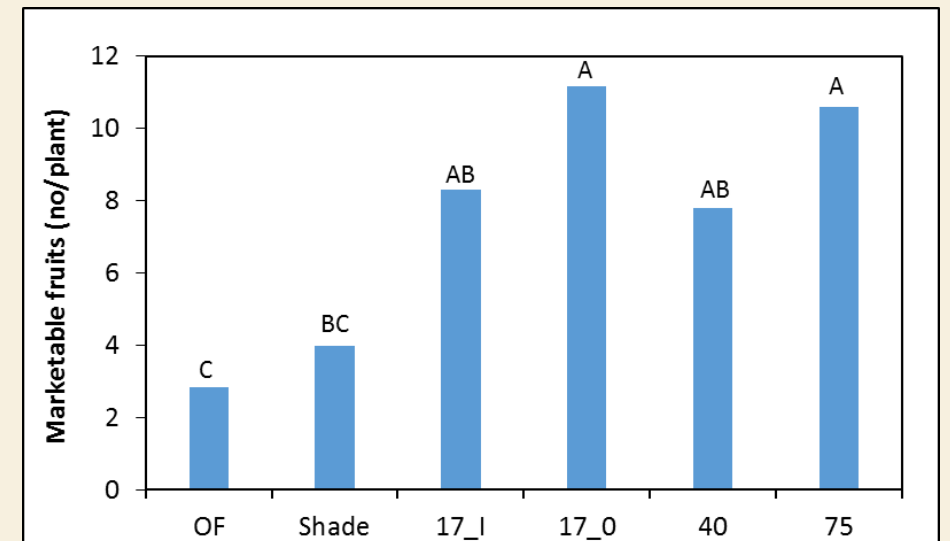
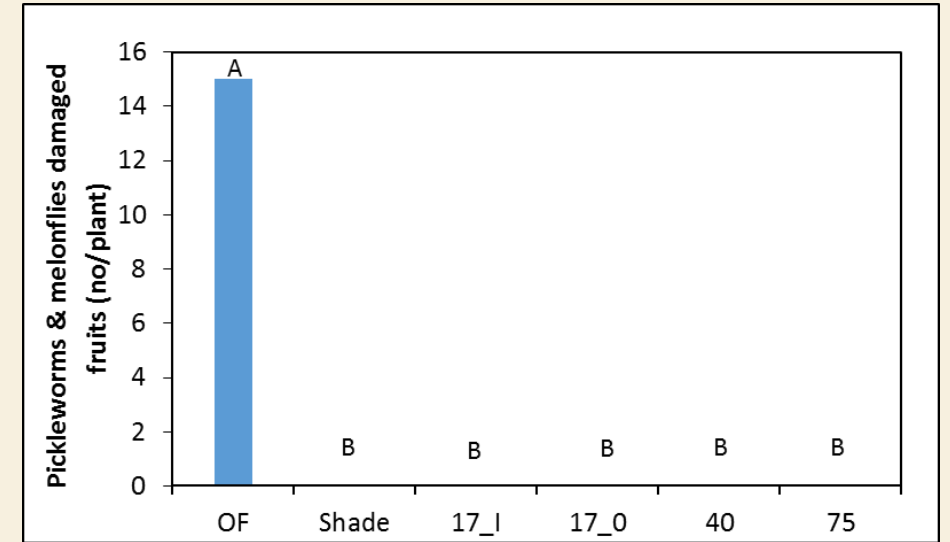
- All fruits in open field suffered from pickleworms or fruitflies damages, but no damage from thrips. Open field was detected in all the screenhouses.
- Yield was higher in screenhouses with 17, 40 and 75 mesh, but not in the reflective shade.



Screenhouse



Open field



HOOP HOUSE WITH PREMADE DOOR AND OPEN WALL

AMA Cost Share

(2018)



Code	Practice	Component	Units	Unit Cost
325	High Tunnel System	Gothic style high tunnel with shade cloth	Sq ft	\$2.83
325	High Tunnel System	HU-Gothic style high tunnel with shade cloth	Sq ft	\$4.24
325	High Tunnel System	Quonset style high tunnel with shade cloth	Sq ft	\$2.25
325	High Tunnel System	HU-Quonset style high tunnel with shade cloth	Sq ft	\$3.38

14'x 50'x 7'	Price (\$)
Insect netting (17 mesh)	150
Structure	249
Door	70
Total	469
Price per sq ft	1.12

SUMMARY: BENEFITS OF SCREEN SYSTEMS

- Non-Chemical, Physical Barrier to Pest Control
 - ✓ Lepidoptera (worm type with resistance issues)
 - ✓ Birds
 - ✓ Fruit flies (resistance issues)
 - ✓ Chinese rose beetles
- Do It Yourself or Commercial Kit Systems
 - ✓ USDA NRCS AMA cost share program
- Reduction of light intensity
 - ✓ Good for lettuce in summer



ACKNOWLEDGEMENT

- Donna Meyer, Philip Waisen, Rose Mathew, Jon Kam, Shelby Ching, Shova Mishra, Josiah Marquez, Gareth Nagai, Brayn Janura, Kaori Suda, Caio Sousa.
- Farm Crews from Poamoho and Waimanalo.



This project is supported in part by NIFA CRATE program (project number 2013-04774), WSARE P&P (OW15-019), and in part by CTAHR Supplement fund (9022H, 9034).

Uyeda's Video collection related to SPM

- <https://youtu.be/cBP52egYG9s>
- <https://vimeo.com/166306170>
- <https://vimeo.com/166306088>

Websites

<https://cms.ctahr.hawaii.edu/wangkh/>

