College of Tropical Agriculture and Human Resources
University of Hawaii at Manoa

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Sustainable Agriculture Research & Education

CRATE

MANAGING INSECTS AND WEEDS IN DIY SCREENHOUSES

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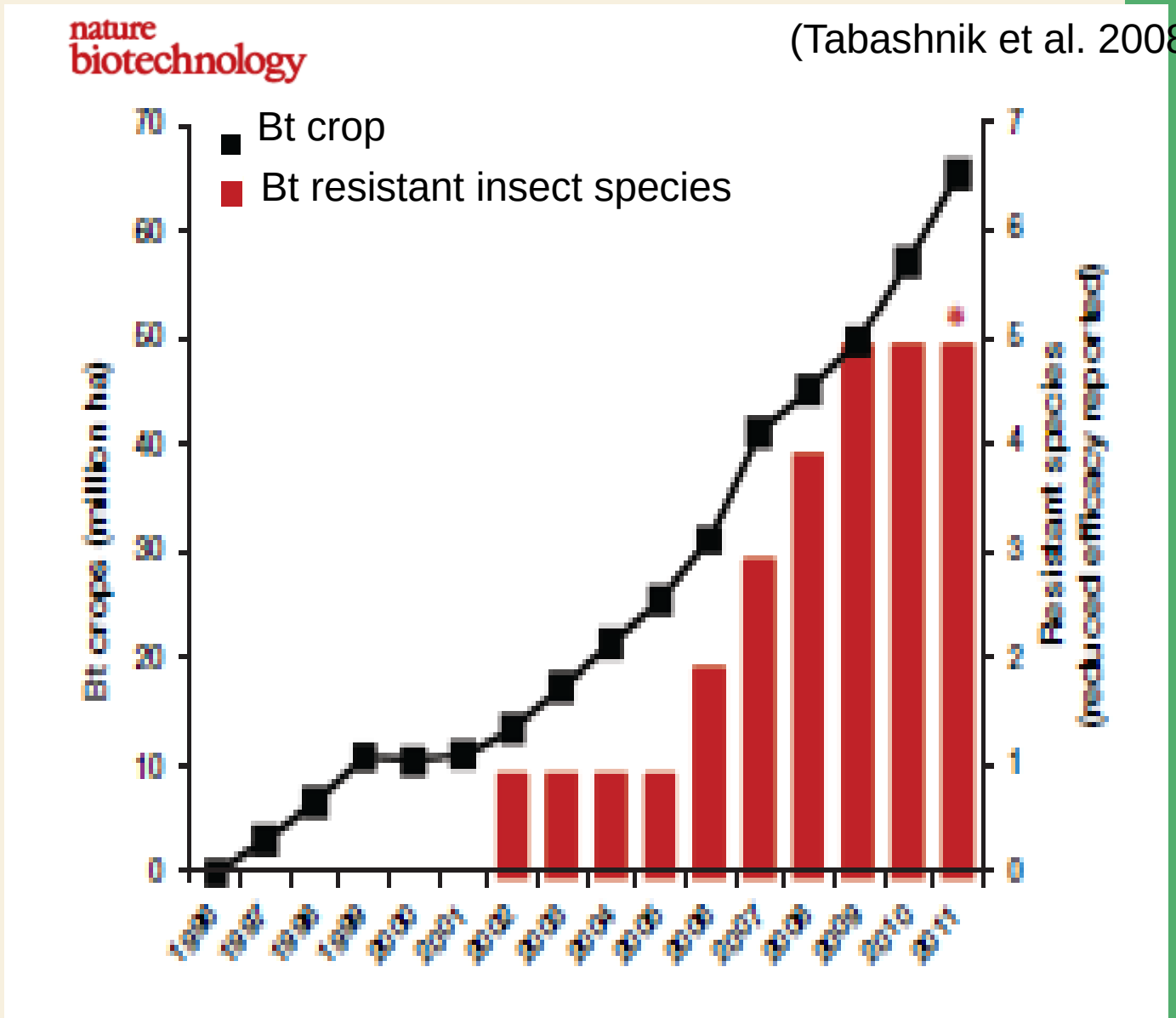
WHY SCREENHOUSE?

- Population of insecticide/Bt resistant insect pests are increasing.
- Bt only kill 25-33% of Bt-resistant diamondback moth compare to 100% kill of the susceptible population (Tabasnik 1990).
- Some insect pests like pickleworm is cryptic in nature, hard to reach by insecticides.
- 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.



INSECT EXCLUSION SCREENHOUSE

CHALLENGES OF SCREENHOUSE

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

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DIY Screenhouse for Insect Management in the Tropics: Part I

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INTRODUCTION

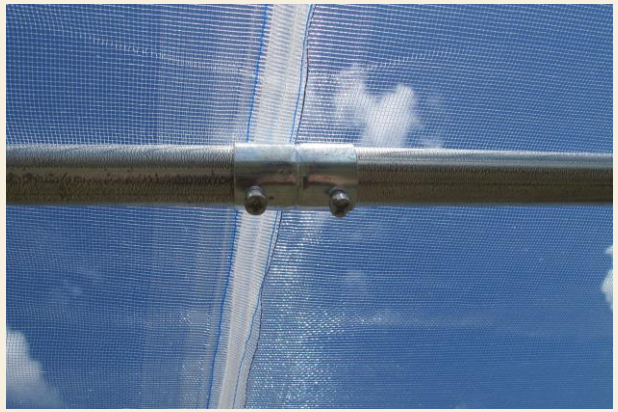
Due to growing environmental consciousness among consumers and growers, organic farming approaches are gaining popularity amongst vegetable farmers. However, organic farmers in Hawaii are concerned about the lack of effective, organic insect pest management tools (Radovich, 2009). Constructing screenhouses 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-Gámez 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 (OW15-019), and in part by the CTAHR Supplemental fund (9022H). We greatly appreciate the collaboration and support from Jay Bost, Dan Ching, Anthony Deluze, Meleana Judd and Victor Perez.

Slide thru



T-slide thru

EMT Conduit

SCREENHOUSE DESIGNS #1

With wood-base frame

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.

SCREENHOUSE W/ WOOD-BASE FRAME & RETRACTABLE WALL

- Important for pollinator-dependent crops

“Adopt insectary plants” concept

Cucumber

Parthenocarpic var.

Pumpkin

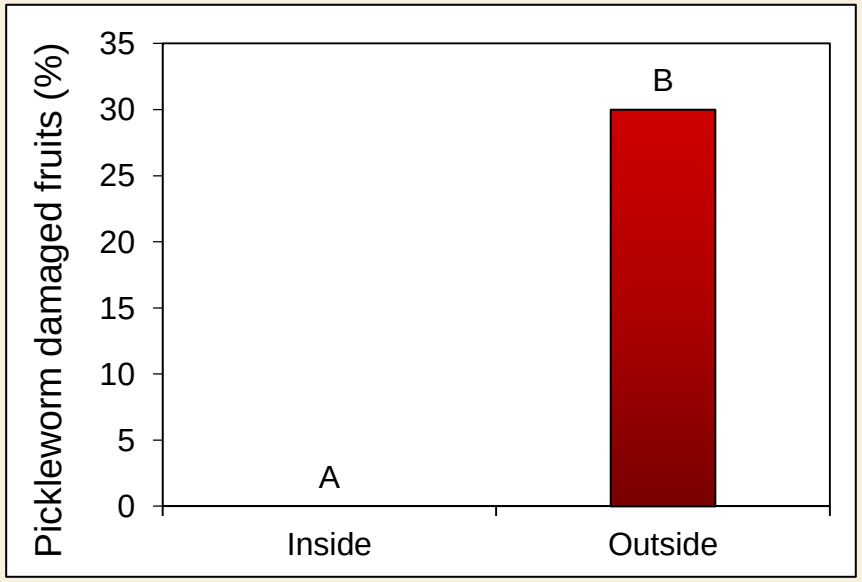
Hand pollination

SCREENHOUSE DESIGNS #2

Wood-base frame with retractable wall

Dimension: 15’ × 50’ × 6’

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



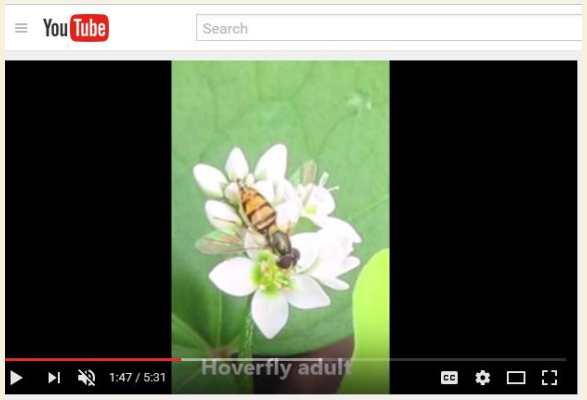
- No zucchini ‘Felix’ was harvestable when grown outside.
- Pickleworms were the main culprit.
- ‘Felix’ doesn’t seems to require pollination.

ADOPT INSECTARY PLANTS

INSECTARY PLANTS SELECTION

Insectary Videos

- Part I: https://www.youtube.com/watch?v=BsN_3lC35wg&feature=youtu.be
- Part II: https://www.youtube.com/watch?v=1stOru5I-a0&feature=youtu.be



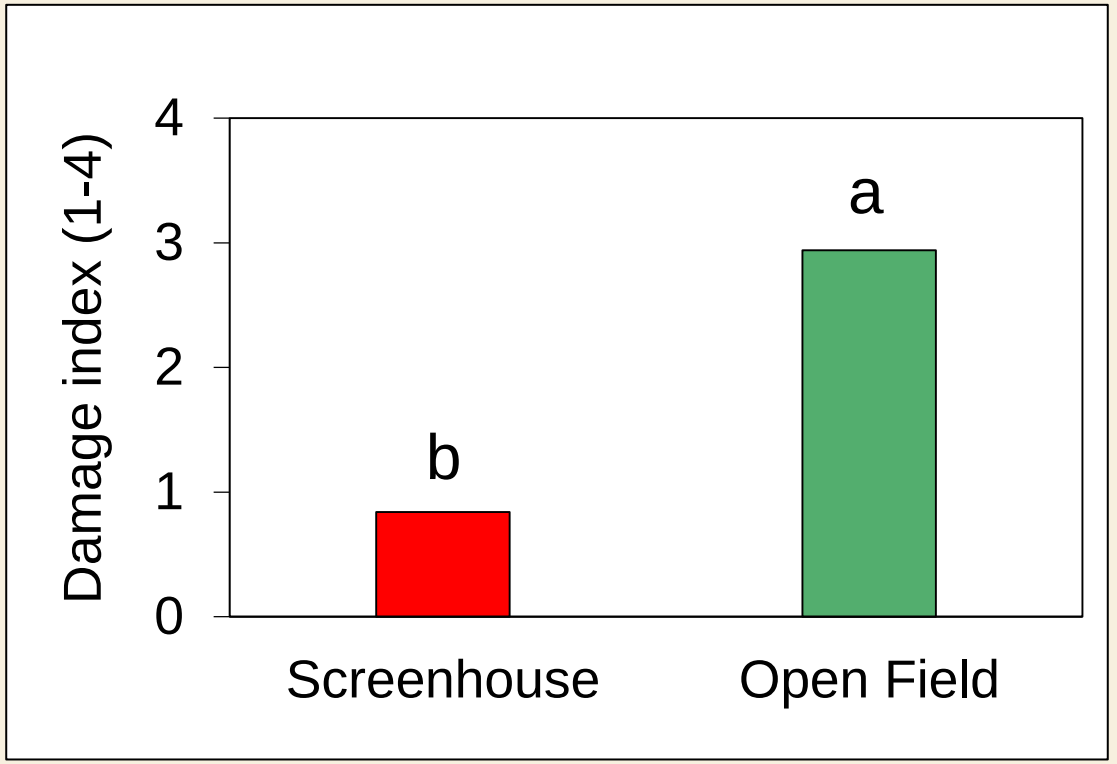
TARGET PESTS

Although the 17-mesh screen cannot block out all insect pests, the goal is to manage insect pests that are difficult to be managed with insecticides.

	Target Pests
Kale	Diamondback moth, Imported cabbage worm, leaf miner,
Zucchini	Pickle worm, Fruit fly
Pumpkin	Pickle worm, Fruit fly
Tomato	Fruit fly, pin worm, stink bugs

CATERPILLAR DAMAGE ON KALE

Screenhouse

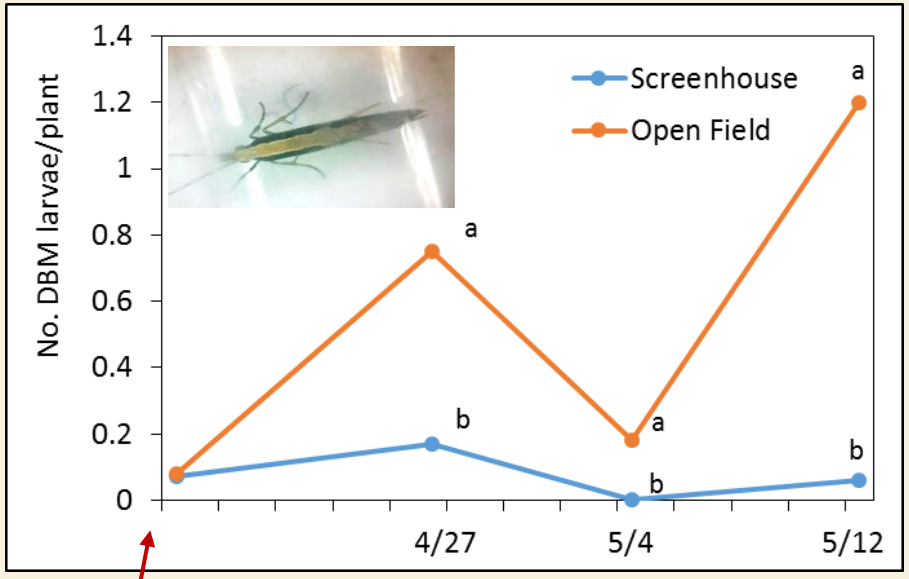


Some varieties are less preferred by the caterpillars present.

Open Field

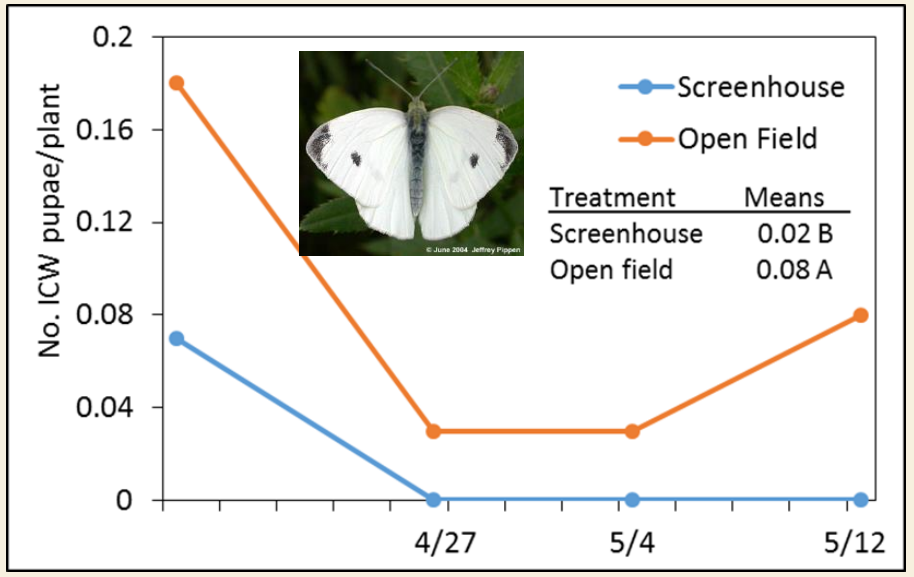
SCREENHOUSE FOR KALE PESTS MANAGEMENT

Diamondback moth

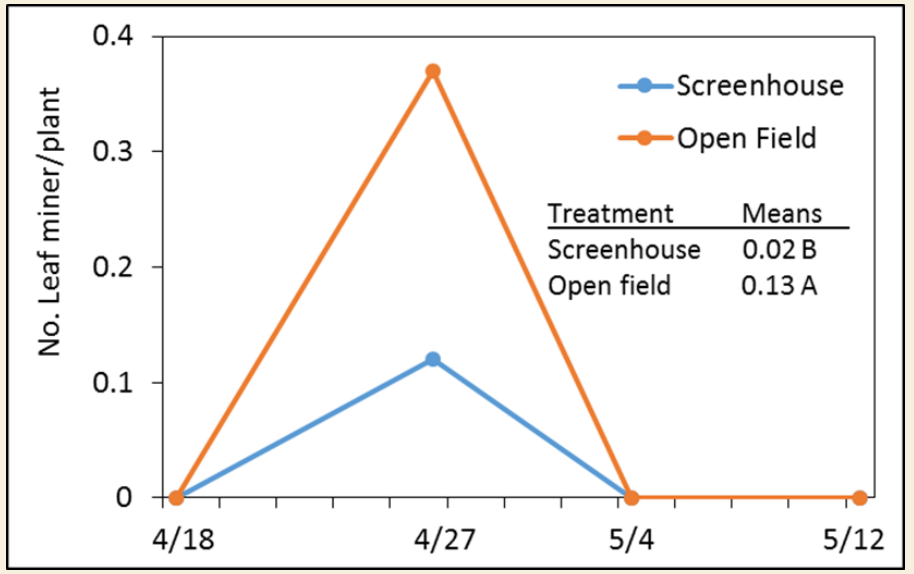


Planted end of March, 2016

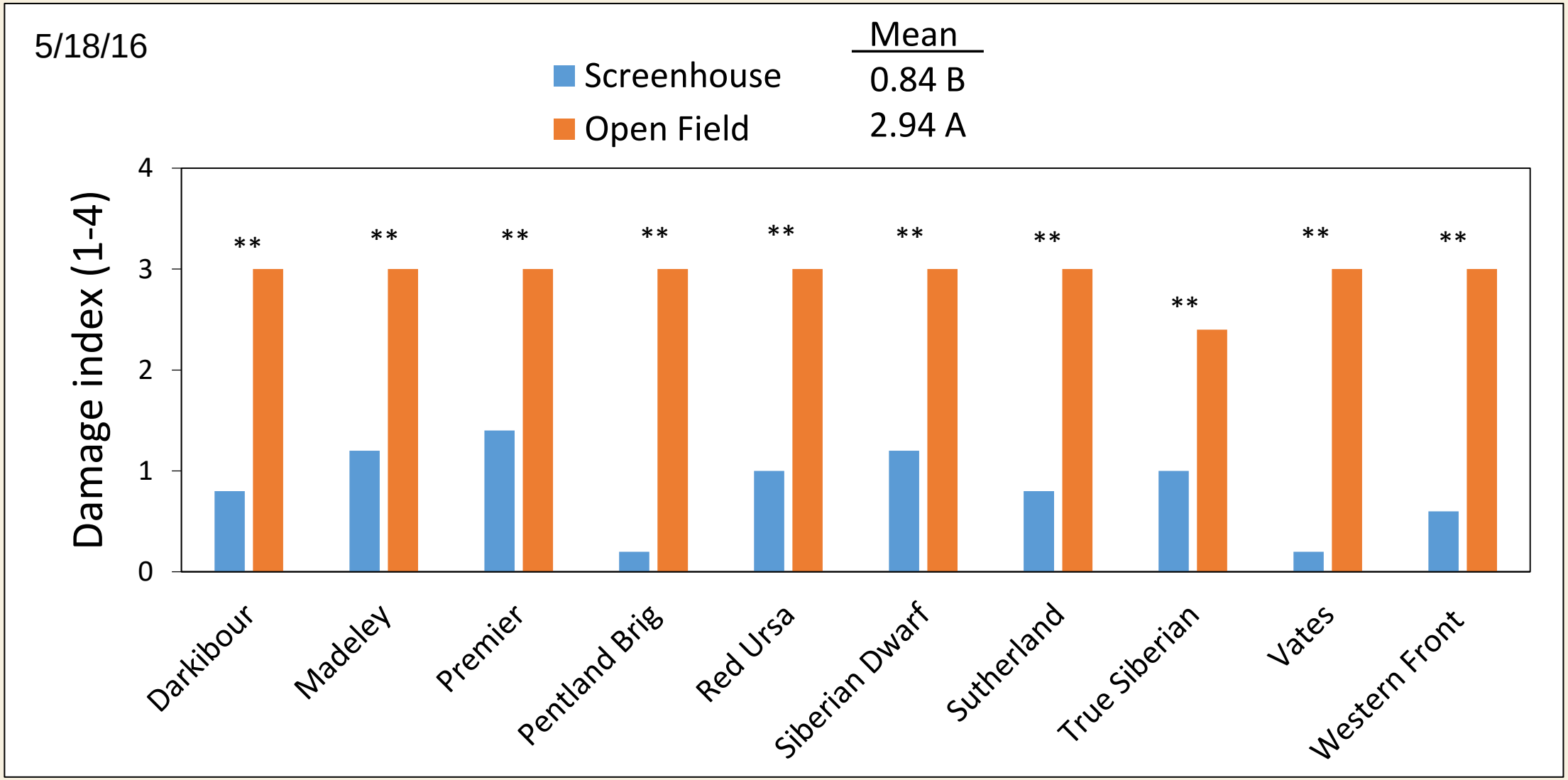
Imported Cabbage Worm



Leaf miner



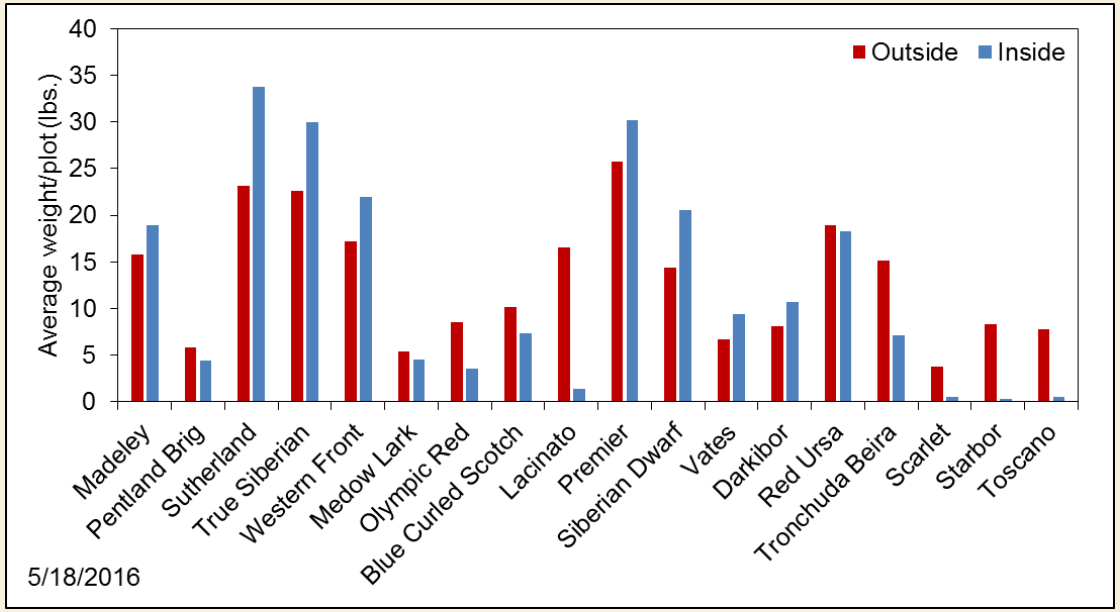
DIFFERENCE IN KALE VARIETIES TO CATERPILLAR DAMAGE



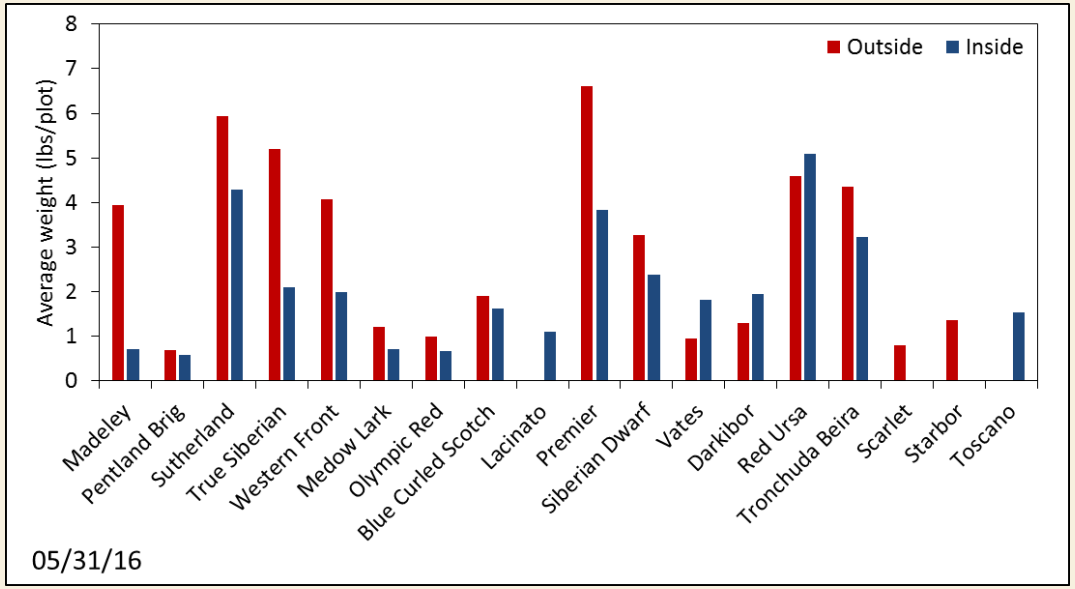
0 = 0 damage, 1 ≤ 25% leaves w/ damage, 2 (26-50% leaves w/ damage), 3 (51-75% leaves w/ damage), 4 (75-100% damage)

KALE YIELD BY DATE

Initia`l harvest was good inside the screenhouse.

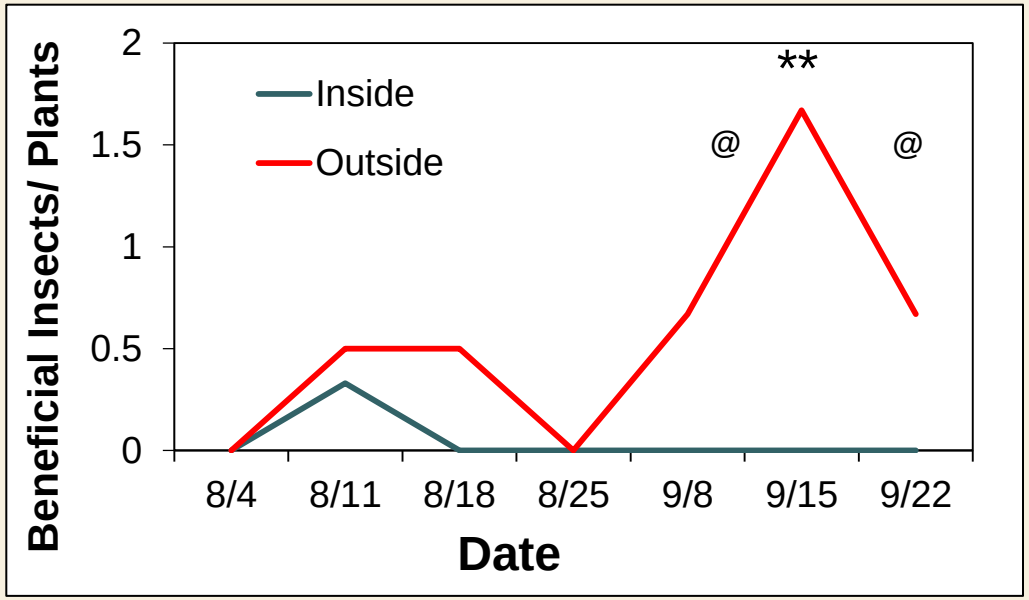


Major outbreak of whiteflies and thrips two weeks after initial kale harvest, resulted in poorer yield inside the screenhouse.



Integrate with insecticide spray program for soft body insects.

DILEMMA OF 17-MESH SCREENHOUSE



Out break of aphids also can be more severe inside the screenhouse than outside

Beneficial insects were more abundant in open field than inside the screenh

Adopt insectary plants into screenhouse

Insecticide rotation against soft body insects

What if we use finer mesh?

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

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EFFECTS OF SCREENHOUSES WITH DIFFERENT MESH SIZES

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

Open field

EMT conduits to support PVC pipes.

17 mesh ($0.09-0.125/sq ft)

Reflective shade ($0.35/sq ft)

Hoop house

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

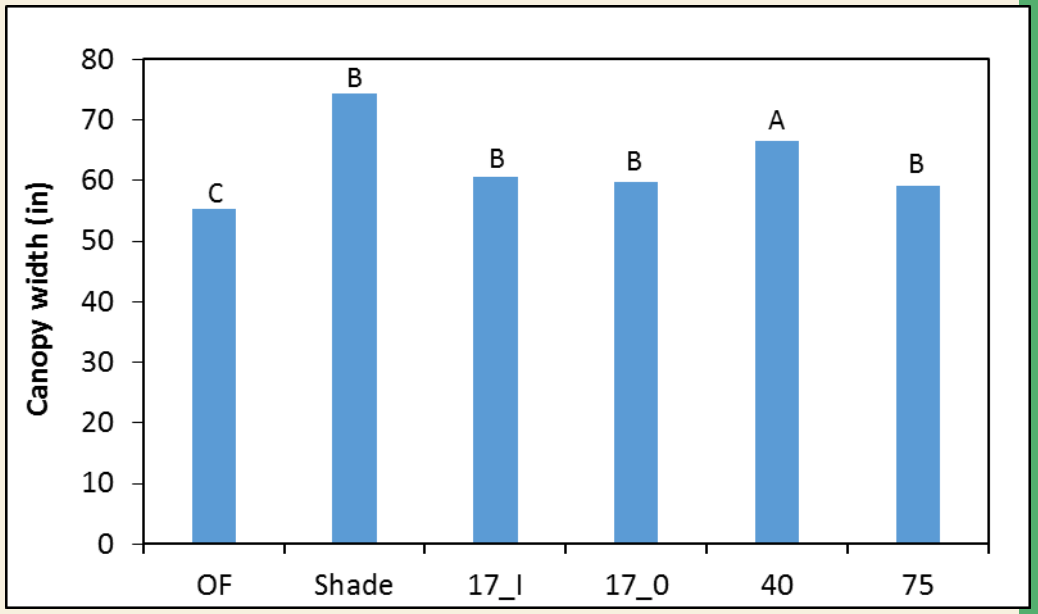
No thrips insect screen

EFFECTS OF SCREEN MATERIALS ON ZUCCHINI GROWTH

Screen materials	Light (μmol $m^{-2}s^{-1}$)	Temp (°C)
Open field (OF)	979.6	28.6
Reflective shade	446.4	26.7
17-I mesh	802.5	28.4
17-0 mesh	662.5	27.3
40-mesh	766.9	29.1
75-mesh	563.5	28.8

17-I = 17 mesh with insecticides rotation (Entrust/Trilogy)
17-0 = 17 mesh without insecticide

- Screen materials reduced light intensity to some extent compared to the open field.
- But zucchini growth was improved in all screenhouses especially 40-mesh house than the open field (OF).



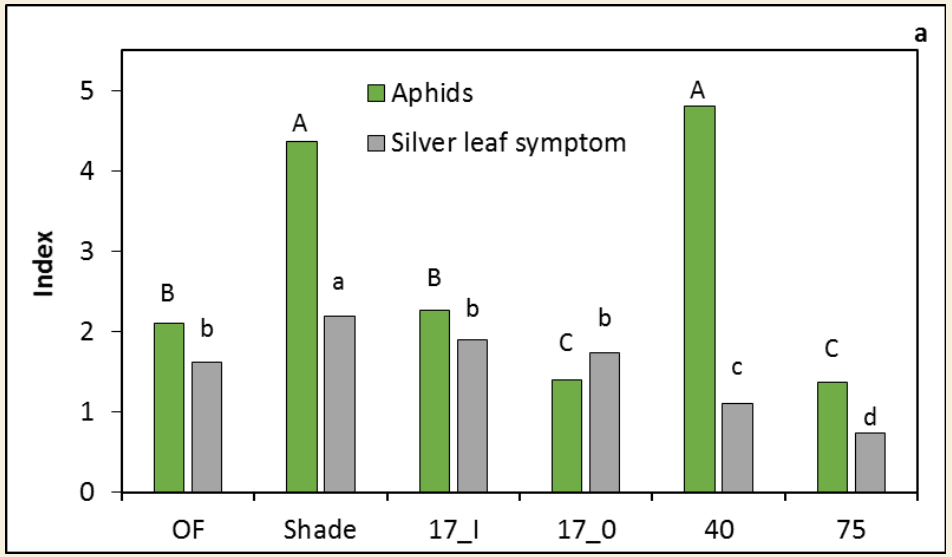
PESTS ON ZUCCHINI

Melon aphids

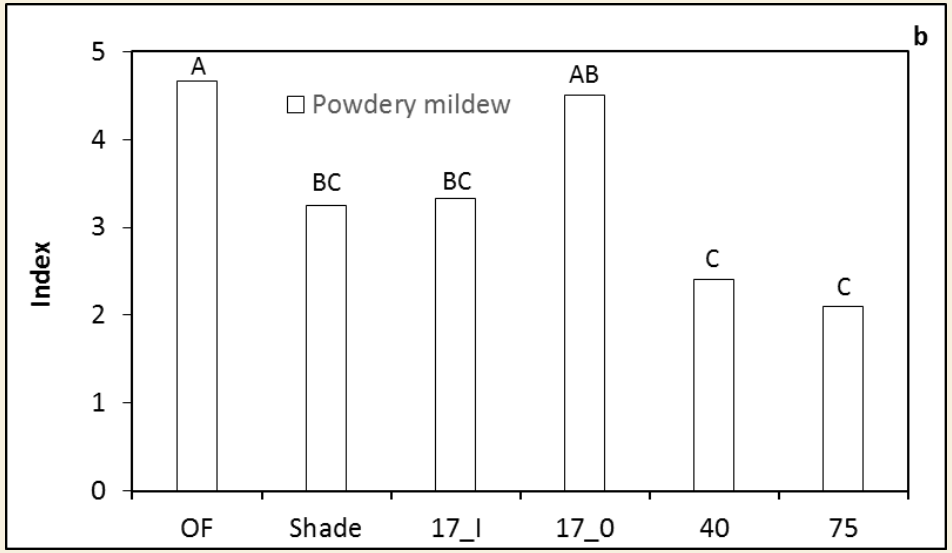
Zucchini mosaic virus

Silverleaf symptom caused by whiteflies

Powdery mildew



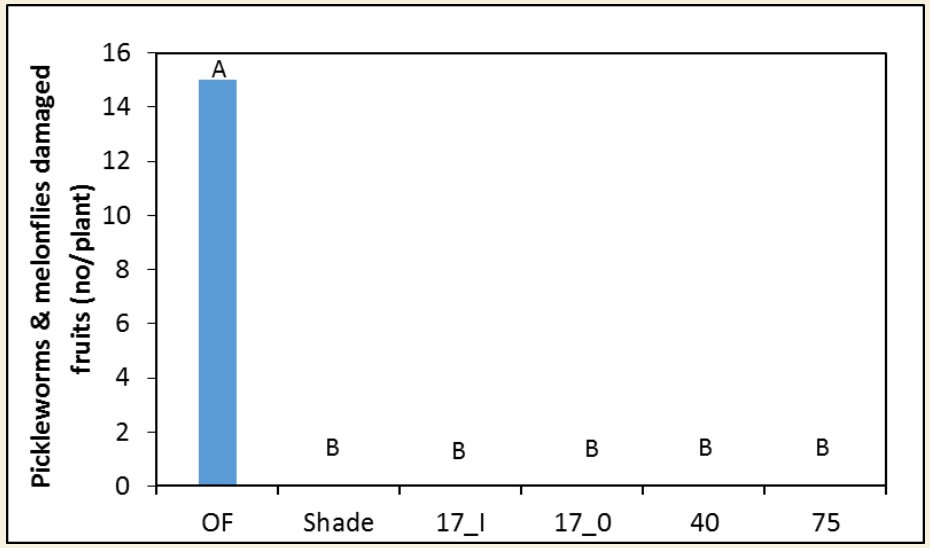
- 40 and 75 mesh reduce silverleaf symptomatic plants but did not reduce

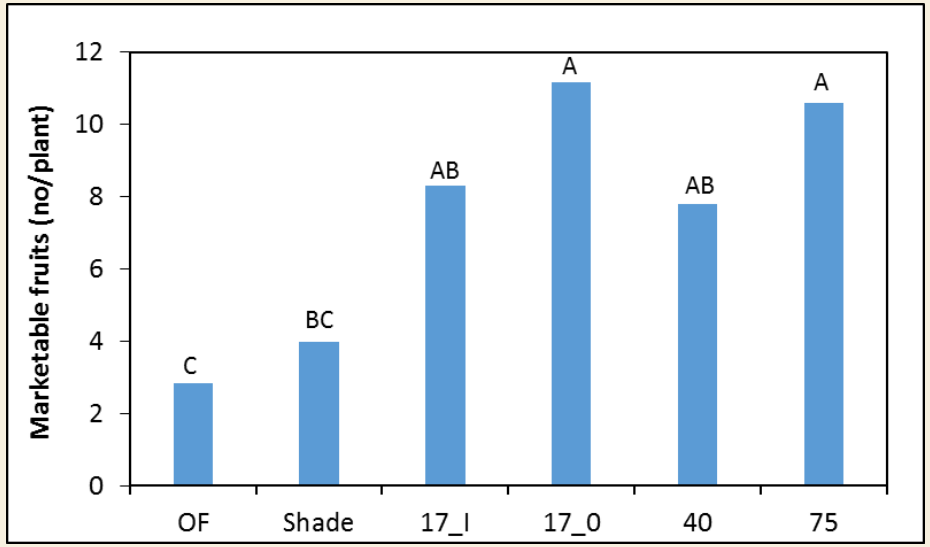


- Most screens can reduce powdery mildew, but effect of 17-mesh is not consistent.

PICKLEWORMS & FRUITFLIES DAMAGE

- All fruits in open field suffered from pickleworms or fruitflies damages, but no damage from these pests was detected in all the screenhouses.
- Yield was higer in screenhouses 17, 40 and 75, but not in the reflective shade.





MARKETABLE VS UNMARKETABLE FRUITS

Zucchini harvested from shade, 17,- 40- and 75-mesh screenhouses,

Zucchini from open field.

TARGET PESTS

Although the 17-mesh screen cannot block out all insect pests, the goal is to manage insect pests that are difficult to be managed with insecticides.

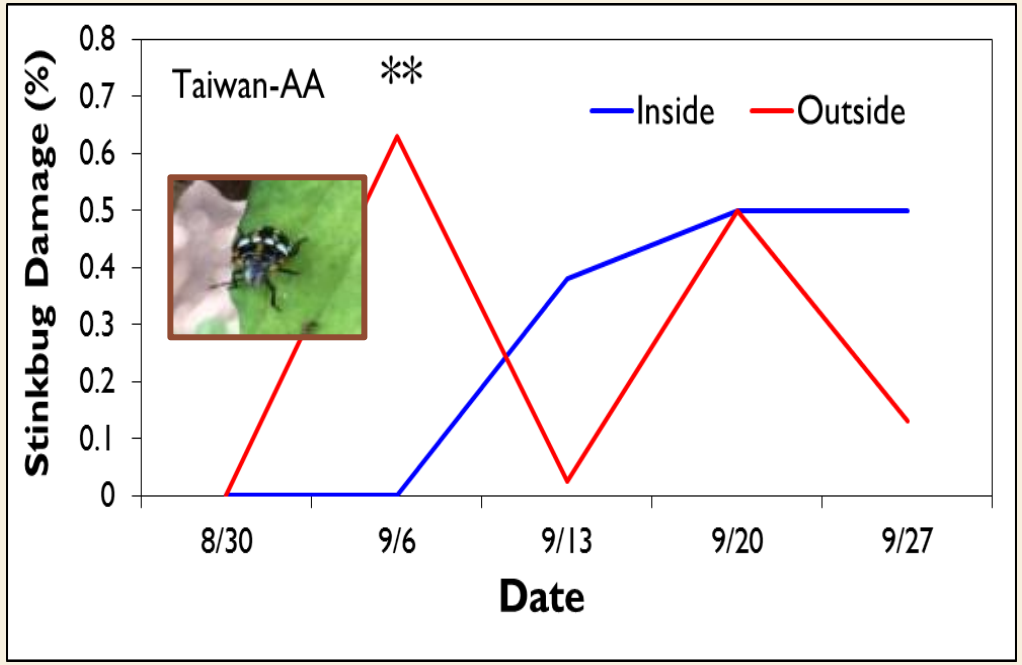
	Target Pests
✓ Kale	Diamondback moth, Imported cabbage worm, leaf miner,
✓ Zucchini	Pickle worm, Fruit fly
✓ Pumpkin	Pickle worm, Fruit fly
➢ Tomato	Fruit fly, pin worm, stink bugs

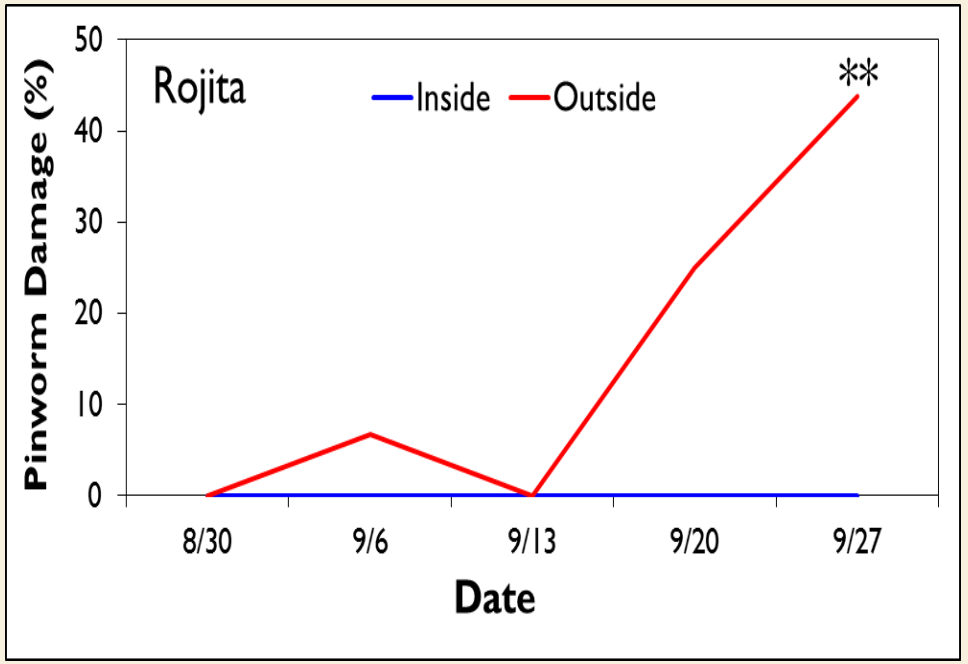
Target Pests of Tomato at Waimanalo

Stinkbug on ‘Taiwan AA’

Bird damage

Tomato pinworm





FARMER TESTIMONY

JAY BOST:

- “LOVED the screenhouse, zucchini and tomato fruit were pest free, but there was heavy aphid pressure.”
- “Cucumbers did not work out probably due to lack of pollinators, but would try parthenocarpic varieties.”
- “Larger slice tomatoes had decent yield from inside the screenhouse some things we have never been able to do in field due to fruitflies.”
- “The pepper in the screen has no fruit fly or pepper weevil, both of which infect nearly 100% in the field.”

- Considered planting tomato varieties with resistance against multiple viruses such as ‘Felicity’

CHALLENGES OF SCREENHOUSE

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

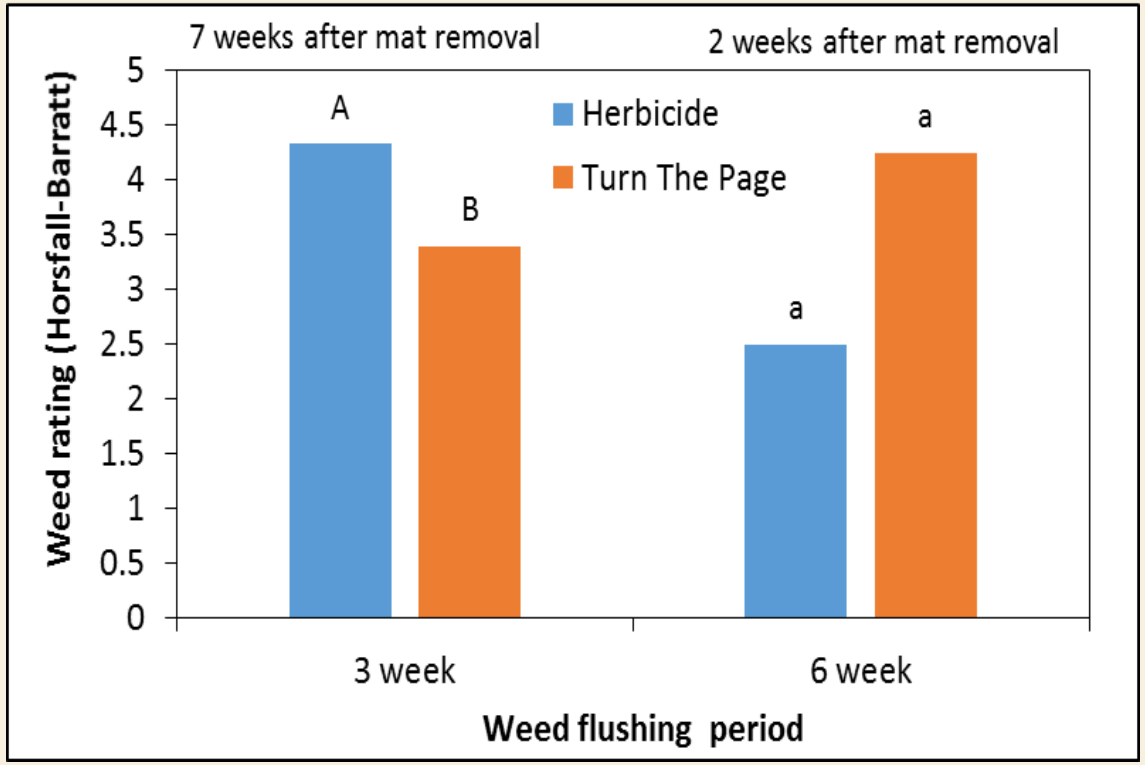
Turn-the-page Weed Management

= killing existing weeds in a portion of the field by covering the weeds with a light exclusion tarp (woven weed mat) for 1 to 6 weeks depending on weed densities and types (DeFrank, 2014).

TTP NO-TILL WEED MANAGEMENT IN THE SCREENHOUSE

3-week flushing

6-week flushing



- Flushing weeds for 3 weeks suppressed weeds better in TTP than glyphosate treatment.
- Flushing weeds for 6 weeks followed by herbicide treatment is a more effective weed suppression method (stale seedbed technique) than TTP

ACKNOWLEDGEMENT

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- Anthony Deluze, Jay Bost, Mele Judd-Cox.

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Website

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