MANAGING INSECTS AND WEEDS IN DIY SCREENHOUSES

Koon-Hui Wang, Shelby Ching, Jonathan Kam Jari Sugano, Steve Fukuda, Jensen Uyeda, Donna Meyer
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.

(Tabashnik et al. 2008)

![Graph showing the increase in Bt crops and Bt resistant insect species from 1990 to 2011.](nature biotechnology)
INSECT EXCLUSION SCREENHOUSE

17 mesh screen
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)
SCREENHOUSE DESIGNS #1

With wood-base frame

Dimension: 15’ × 50’ × 6’

<table>
<thead>
<tr>
<th>Item</th>
<th>Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect netting (17 mesh)</td>
<td>137</td>
</tr>
<tr>
<td>Wooden door</td>
<td>86</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>713</strong></td>
</tr>
<tr>
<td>per sq ft</td>
<td><strong>0.95</strong></td>
</tr>
</tbody>
</table>

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.
“Adopt insectary plants” concept

- Important for pollinator-dependent crops

SCREENHOUSE W/ WOOD-BASE FRAME & RETRACTABLE WALL

Cucumber

Pumpkin

Parthenocarpic var.

Hand pollination
**SCREENHOUSE DESIGNS #2**

Wood-base frame with retractable wall

<table>
<thead>
<tr>
<th>Insect netting</th>
<th>137</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden door</td>
<td>86</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>820</strong></td>
</tr>
<tr>
<td>per sq ft</td>
<td>1.09</td>
</tr>
</tbody>
</table>

**Dimension:** $15' \times 50' \times 6'$

- No zucchini ‘Felix’ was harvestable when grown outside.
- Pickleworms were the main culprit.
- ‘Felix’ doesn’t seem to require pollination.
ADOPT INSECTARY PLANTS
INSECTARY PLANTS SELECTION

Video

- https://www.youtube.com/watch?v=BsN_3IC35wg&feature=youtu.be
- 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.

<table>
<thead>
<tr>
<th>Target Pests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kale</td>
</tr>
<tr>
<td>✓ Zucchini</td>
</tr>
<tr>
<td>✓ Pumpkin</td>
</tr>
<tr>
<td>Tomato</td>
</tr>
</tbody>
</table>
CATERPILLAR DAMAGE ON KALE

Some varieties are less preferred by the caterpillars present.

Insect frass

Worms can be a post harvest problem

‘Madeley’ kale

‘Vates’

‘Pentland Brig’

Damage index (1-4)

0 1 2 3 4

Screenhouse

Open Field

‘Madeley’ kale

Screenhouse

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

<table>
<thead>
<tr>
<th>Variety</th>
<th>Screenhouse Mean</th>
<th>Open Field Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darkibour</td>
<td>0.84 B</td>
<td>2.94 A</td>
</tr>
<tr>
<td>Madeley</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Premier</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Pentland Brig</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Red Ursa</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Siberian Dwarf</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Sutherland</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>True Siberian</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Vates</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>Western Front</td>
<td></td>
<td>**</td>
</tr>
</tbody>
</table>

Damage index (1-4): 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

Initial 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 screenhouse.

What if we use finer mesh?
What if we don’t use weed frame (to cut cost)?

Adopt insectary plants into screenhouse

Insecticide rotation against soft body insects
EFFECTS OF SCREENHOUSES WITH DIFFERENT MESH SIZES

<table>
<thead>
<tr>
<th>15’x 50’x 6’</th>
<th>Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect netting (17 mesh)</td>
<td>137</td>
</tr>
<tr>
<td>Structure (with door)</td>
<td>330</td>
</tr>
<tr>
<td>Total</td>
<td>467</td>
</tr>
<tr>
<td>Price per sq ft</td>
<td>0.62</td>
</tr>
</tbody>
</table>

EMT conduits to support PVC pipes.

Hoop house

Open field

- Insect netting (17 mesh): $0.09 - $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
### EFFECTS OF SCREEN MATERIALS ON ZUCCHINI GROWTH

<table>
<thead>
<tr>
<th>Screen materials</th>
<th>Light (μmol m⁻²s⁻¹)</th>
<th>Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open field</td>
<td>979.6</td>
<td>28.6</td>
</tr>
<tr>
<td>Reflective shade</td>
<td>446.4</td>
<td>26.7</td>
</tr>
<tr>
<td>17-1 mesh</td>
<td>802.5</td>
<td>28.4</td>
</tr>
<tr>
<td>17-0 mesh</td>
<td>662.5</td>
<td>27.3</td>
</tr>
<tr>
<td>40-mesh</td>
<td>766.9</td>
<td>29.1</td>
</tr>
<tr>
<td>75-mesh</td>
<td>563.5</td>
<td>28.8</td>
</tr>
</tbody>
</table>

- 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).
PUMPKIN

Pumpkin grown under the protection of a screen can increase marketability, but hand pollination or parthenocarpic seeds is necessary.
Early infestation of fruits by PW or MF resulted in no fruit development.
- Pickle worms bored into stem tissues can cause entire stem die back.
- Late infestation of fruits by PW or MF caused unmarketable fruits.
INSECT PESTS ON FLOWERS

![Graph showing the number of fruit flies per flower over time.](image-url)
PUMPKIN YIELD

The bar chart shows the pumpkin yield comparison between inside and outside. The inside pumpkin weight is 2.5 pounds, significantly higher than the outside weight, which is 0 pounds.
Screenhouse for Tomato at Waimanalo

Inside

Outside

PARTICIPATING FARM COACH: JAY BOST

Tomato cultivars:
- ‘Rojita’
- ‘Taiwan’
- ‘Felicity’ (TYLCV resistant)
Target Pests of Tomato at Waimanalo

- Stinkbug on Taiwan AA
- Bird damage
- Tomato pinworm
- Mite damage
Insect Damage on Plants

**Rojita**

<table>
<thead>
<tr>
<th>Date</th>
<th>Inside</th>
<th>Outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/30</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>9/6</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>9/13</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>9/20</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>9/27</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**Taiwan-AA**

<table>
<thead>
<tr>
<th>Date</th>
<th>Inside</th>
<th>Outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/30</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>9/6</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>9/13</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>9/20</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>9/27</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Stinkbug Damage (%)**

- Inside: Red line
- Outside: Blue line

**Pinworm Damage (%)**

- Inside: Red line
- Outside: Blue line

**Date**

- 8/30
- 9/6
- 9/13
- 9/20
- 9/27

**Notes:**
- **Rojita:** Inside and outside damage are approximately equal throughout the period.
- **Taiwan-AA:** No significant damage observed inside or outside.
FARMER TESTIMONY

JAY:

• “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 should try parthenocarpic varieties.”

• “Larger slice tomatoes had decent yield from inside the screenhouse something we have never been able to do in field due to fruit fly.”

• “The pepper in the screen has no fruit fly or pepper weevil, both of which infect nearly 100% in the field.”
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 aphids numbers.

- Most screens can reduce powdery mildew, but effect of 17-mesh is not consistent.
• 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 higher in screenhouses 17, 40 and 75, but not in the reflective shade.
MARKETABLE VS UNMARKETABLE FRUITS
ACKNOWLEDGEMENT

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

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