Solid set systems as a novel method of delivering chemical inputs in apple
Goal is to help growers:

- better manage chemical inputs
  Develop systems optimized to modern orchards with fruiting walls
- improve pest and crop management
- reduce labor and fuel costs
Systems consisting of fixed microsprayers distributed throughout the orchard canopy have the potential to:

• Improve spray deposition and coverage
• Reduce application time and exposure
• Reduce on-farm use of fossil fuels
• Allow growers to make foliar applications in a tight weather window or when the orchard floor is impassable by tractors
• Improve efficacy of chemical inputs
Plumbing and Hose System to Support SSCDS

- PVC 2” lines established perpendicular to source; **buried**.
- Connected to water mains for sourcing pure water
- Option to control input and output from **water source** or **tanks** (“manifold control valves”; source and return lines)
- Hoses;
  - Suspended (3’ intervals, clips from trellis wire) 1” polytube for top (8-9’) hose and ¾” polytube for bottom (5’) hose.
  - Emitters/nozzles inserted into suspended hoses.
Canopy delivery system

- Microsprinklers
- Upper and lower lines
- Applicator
  - Compressor
  - Tank
  - Pump
4-stage spray procedure

**Charging** – fill the lines (<18 psi)

**Spraying**
– increase pressure (>30 psi)
– apply 70-100 gal/ac in (15-25 s)

**Recovery** – blow material back into applicator (<18 psi)

**Cleaning** – run air compressor to clear lines and microsprayers
Comparing SSCDS and Airblast sprayer coverage

• Amount of AI deposited
• Percent surface area coverage
• Spatial distribution in the canopy
• Parallel comparison of deposition data to insect bioassays.
Amount of AI deposited:

- tank mix of Keyacid Tartrazine dye 1000 ppm (2.5 lb per 300 gal water)
- SSCD spray for 15 sec (76 GPA) Airblast sprayer 3.5 mph (76 GPA)
- 10 leaves collected from each canopy location, placed in zip-lock bags with know amount of water
- PPMs of the tracer dye determined using BioTek Synergy HT micro plate reader.
% Surface Area Covered:

- 26 × 26 mm water sensitive paper cards
- Placed low, mid and upper canopy
- One card facing up and one facing down
- Cards scanned, % coverage calculated using Photoshop.
Amount of AI deposited - MSU

μg/g (leaf mass)

- Airblast
- SSCDS

- low
- middle
- high
% Surface Area Covered - MSU

![Graph showing percent coverage for different levels of surface area. The graph compares Airblast and SSCDS for both upper and lower surfaces.](image)

- **Upper surface**
  - Low: Airblast 80%, SSCDS 90%
  - Middle: Airblast 60%, SSCDS 70%
  - High: Airblast 50%, SSCDS 60%

- **Lower surface**
  - Low: Airblast 40%, SSCDS 50%
  - Middle: Airblast 30%, SSCDS 40%
  - High: Airblast 20%, SSCDS 30%
% Surface Area Covered - WSU

**Upper surface**

- **Bottom**: Airblast 70, SSCDS 30
- **Middle**: Airblast 60, SSCDS 40
- **Top**: Airblast 50, SSCDS 30

**Lower surface**

- **Bottom**: Airblast 70, SSCDS 30
- **Middle**: Airblast 60, SSCDS 40
- **Top**: Airblast 50, SSCDS 30
Bt Bioassay

Treat SSCDS and Airblast plots

Collect 20 leaves/zone

Expose 1-2d old larvae

Assess mortality after 4d

High
Middle
Low
Leafroller mortality

**MSU**

- **Live Larvae after 4d**
  - Bottom: Airblast (b), SSCDS (b), UTC (a)
  - Middle: Airblast (b), SSCDS (b), UTC (a)
  - Top: Airblast (b), SSCDS (b), UTC (a)

**WSU**

- **Abbott % corrected mortality**
  - Airblast: untreated (a)
  - SSCDS: untreated (b)

Legend:
- Green: Airblast
- Blue: SSCDS
- Red: UTC

Note: bars with different letters indicate significant differences.
Season-long programs

- SSCDS vs Airblast sprayer
- 0.1 hectare plots
- 4 replicates
- assess pest abundance and fruit injury
Fruit Injury

- 4-5 insecticide applications
- novaluron, chlorantraniliprole, acetamiprid, spinetoram

**MSU**

- **Internal**
- **External**

**WSU**

- Codling moth

- Airblast
- SSCDS
- UTC

- 0
- 2
- 4
- 6
- 8
- 10
- 12
- 14

- a
- b

- 0
- 20
- 40
- 60
- 80
Disease severity

Average % scab damage

Leaf scab

Fruit scab

Mildew severity (0-4)

Scab (MSU)

Mildew (WSU)
Solid-set delivery of sprayable pheromone

- Commercial microcapsules
- Sub microcapsules
- 0.5-2.5 gm/AI per hectare

Mazzi injector system

Tank and pumping system
Solid Set Canopy Delivery System

Cumulative Avg. OFM captures

- NO MD
- MEC

Airblast Sprayer

Cumulative Avg. OFM capture

- 92%
- 87%

OFM
Solid Set Canopy Delivery System

Cumulative Avg. CM capture

- NO MD
- MEC

Airblast Sprayer

Cumulative Avg. CM capture

CM
20 gm ai/ac
1 appl.
20 gm ai/ac
2 appl.
1 gm ai/ac
4 appl.

- Ground Spray
- High SSCDS
- Low SSCDS
- UTC

Release SIR moths

Mean CM/trap

Week 0
Week 1
Week 2
Week 3
Week 4
Progress

Operational SSCDS systems have been developed and tested.

Total amount of material applied to canopy of tree as good as with airblast sprayer.

Coverage on upper leaf surface good – variable on underside.

Efficacy of pest management inputs using SSCDS equivalent or better than that achieved using Airblast sprayer.

SSCDS shows potential for improving efficacy of sprayable pheromone.
Other potential applications: Post-Bloom Thinning

Fuji – Fruitlets/100 Blossom Clusters 2012
MaxCel + Fruiton L applied at 5 and 10mm

Airblast
SSCDS
UTC
Other potential applications: **Evaporative cooling**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Time ON</th>
<th>Time OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSCDS</td>
<td>35 sec</td>
<td>15 min</td>
</tr>
<tr>
<td>Standard EC</td>
<td>15 min</td>
<td>15 min</td>
</tr>
</tbody>
</table>

Temperature is >90F, Cooling cycles run from 12pm – 6pm
Threshold for Sunburn = 115F

![Graph showing temperature changes over time for SSCDS and Standard EC](image)
Other potential applications:

Delay bloom

Treatments

- Misting operated for ca 20 days
- Misting operated for ca 30 days
- No mist control

Results

- Delayed bloom by 7-10 d in apple
- Delayed bloom by 4-10 d in cherry
- Provided delay using 6-9 ac in. of water
- Equals 4-6x reduction in water use compared to evaporative cooling systems used in previous studies

Figure 21 Apple (top) and cherry (bottom) buds, delayed buds on left.
Future of SSCDS

ADDRESS
Spray coverage → improve consistency of coverage
Emitters → optimize emitter designs

EXPLORE
Up-scale to larger plots → 1+ acres, commercial
Application method → direct injection system rather than premixed in holding tank
Unique IPM applications → short reapplication times at reduced rates biopesticides
Economics of SSCDS

- SSCDS requires significant up-front capital investment
- Varies depending on presence or absence of trellis training system
- Estimates of SSCDS operating costs, including system installation exceed conventional systems
- However, SSCDS may provide additional value

<table>
<thead>
<tr>
<th>Application system</th>
<th>Costs per acre</th>
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<tbody>
<tr>
<td>Commercial SSCDS</td>
<td>$48</td>
</tr>
<tr>
<td>Prototype SSCDS</td>
<td>$61</td>
</tr>
<tr>
<td>Airblast Sprayer</td>
<td>$36</td>
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</tbody>
</table>
Team effort – MSU, WSU, Cornell, Private industry, Growers and others

Matt Grieshop
PI of project
Questions ?