New Developments in Field-Scale Steam Application for Flower and Strawberry

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MAW 8.24.15
The essential role for steam

- It is a non-fumigant method that kills soil pests in minutes - consistently
- Steam can be a component in a variety of non-fumigant solutions
- Steam is a stand-alone soil disinfestation treatment
- Steam application is compatible with a custom fumigant business
California Strawberry Production in Year 2025 by System
Introduction

* A description of the equipment & technology
* Soil disinfection with steam
* Roles for steam in strawberry
* Economics of field steam
* Summary
SHANK TEST

TriCal Hollister, CA 6/3/15
AUTOMATIC STEAM APPLICATION

San Juan Rd.
Watsonville, CA
9/10/12
Direct-fire Steam Generators

- Advantages
  - No steam boiler
  - Very efficient
  - Water hardness

Johnson Gas Appliance, Cedar Rapids, IA
Precision Combustion, North Haven, CT
Steam generator efficiency: Direct-fire vs. traditional

- A traditional steam generator like the Clayton Sigma is 84-87% efficient.
- A direct-fire steam generator like the Johnson Cure Pak is 93% efficient.
New Steam Applicator Plan

- Direct-fire steam technology.
Trial setup

- Conducted near Salinas & Watsonville, CA during 2011-12 & 2012-13
- Steam applied with RAC’s automatic steam applicator
- Treatments replicated 4 times
- In 2011-12 standard was Pic Clor 60,
- 2012-13 standard was MBPic
- Economic analysis conducted by R. Goodhue at UC Davis: material, labor & machine costs
Soil Temperature by Depth Ranch 1, Watsonville, Sept. 2012

Temperature (degrees C) vs. Time (min) for depths of 2 inches, 6 inches, and 10 inches.
# Weed Densities & Hand Weeding Times 2012-13

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Watsonville-Ranch 1</th>
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<th></th>
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<tbody>
<tr>
<td></td>
<td>Weeds (no./Acre)</td>
<td>Time (hr. /Acre)</td>
<td></td>
</tr>
<tr>
<td>Steam + mustard</td>
<td>6,071 b</td>
<td>21 b</td>
<td></td>
</tr>
<tr>
<td>Steam</td>
<td>2,024 b</td>
<td>12 b</td>
<td></td>
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<tr>
<td>Non-treated</td>
<td>101,175 a</td>
<td>167 a</td>
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Mean separation using Fisher’s Protected LSD P =0.05
Seasonal Fruit Yields Ranch 1

Fruit Yield lbs. Acre

<table>
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<tr>
<th>Treatment</th>
<th>Yield</th>
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<tbody>
<tr>
<td>Nontreated</td>
<td>b</td>
</tr>
<tr>
<td>Steam</td>
<td>a</td>
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<tr>
<td>Steam + MSM</td>
<td>a</td>
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</tbody>
</table>

Albion
2010-2013 Findings

- Steam controls soil pests such as *Verticillium dahliae*, *Macrophomina phaseolina*, *Pythium* spp. and weeds.
- Strawberry yields in steam treated soils are comparable to yields in fumigated soils.

Samtani et al. 2012; Fennimore et al. 2014
Steam business model

- Assumption: fumigants will continue to be used where possible
- Steam will be used where fumigants cannot
- Crop management is the same in fumigated and steamed blocks
A business role for steam

- An 80 acre farm with 72 acres cropped
- 65 acres can be fumigated, 7 acres cannot
- Fumigant cost $1,900/A or $123,426; steam costs $5,000/A or $35,000 for total treatment cost of $158,006.
- Net returns above operating costs for 7 acres $129,745

Fennimore & Goodhue 2015 in review
Steam costs – room for improvement

- Our Oct. 2014 fuel use numbers were 812.7 GPA propane (70% coverage)
- Propane cost $1.56/Gal (Oct. 2014) $1,268/A
- Comparisons indicate that natural gas cost/A would be less than 50% that of propane
- Direct-fire steam generators
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The ideal soil management system for strawberry will have many different methods. No one method will dominate. Methods of pest suppression will be rotated & used in combination. Plant breeding will play a very important role.
Collaborators

- Tom Miller
- Krishna Subbarao
- Rachael Goodhue
- Oleg Daugovish
- Frank Martin
- Jim Gerik
- Sophie Yu
- Nathan Dorn, Reiter Affiliated Cos.
- Ian Greene, Ramco Norcal
- Jenny Broome, DSA
- Mike Stangellini, TriCal
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