Economic and Environmental Benefits of Compact Bed Geometry for Plasticulture

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The Idea

Conventional

4-8 in.

30-36 in.

Short and Wide

Compact

16-24 in

10-12 in

Taller and Narrower
Motivation

Can *compact beds* make plasticulture more efficient?

**Input**
- Water
- Nutrients
- Cost
- Fumigant

**Output**
- Yield
Study Background: Tomato

**Beds**

**Conventional**
- 30 in.
- 8 in.

**Compact**
- 24 in.
- 10 in.
- 18 in.
- 12 in.
- 12 in.
- 16 in.

**2 Seasons**
- S1: 2012-2013
- S2: 2013-2014

**Water and Nutrients**
- Same rates
- One drip tape
- Preplant + liquid fertilizer
Experimental Area

Commercial Farm

- ≈ 2 acres, 36 beds

Statistical Setup

- Incomplete randomized block design (C)

T1-6: Treatment 1 – Replication 6

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Monitoring

Hydrologic

Climate

- Rainfall, wind speed, solar radiation, temperature, and humidity

Data Collection and Storage

- Real-time data (15 min.) throughout seasons
Monitoring

**Plant**

**Growth**
- Leaf-Area-Index (Bi-weekly)
- Plant Height

**Leaf Tissue**
- N, P, and K (Bi-weekly)

**Yield**
- Three harvests (USDA grade)

**Soil**

**Solution**
- NH$_4$-N and NO$_x$-N (Bi-weekly)
- In and below root zone

**Bed Firmness**
- Bulk Density

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- Differences in yield not significant with improved bed firmness
- Treatments were not water or nutrient limited
- No measured differences in growth (LAI and Plant Height)
Economic Benefits

$62-$182/acre

- Fumigant
- Plastic Mulch
- Conservative

Potential Additional Savings

- Lease Costs (6 ft vs 5 ft centers)
- Fuel and Labor
- Fertilizer
Environmental Benefits

1. Flooding
2. Disease
3. Leaching
4. Drainage
5. Runoff
6. Plastic

Reduction Factors
11. Bed Height
22. Impervious Area

Bedded Area: 42%

Potential Runoff

Field Runoff (in.)

30 in. x 8 in. 24 in. x 10 in. 18 in. x 12 in. 16 in. x 12 in.

3.5 ft. -11% 4.7 ft. -23% 6 ft. -26%

6-ft Centers
Seeing the Benefit

- Immokalee Fine Sand
- 1 hour, 0.34 GPM/100 ft.

- Wetted Width: 11 in.
- Wetted Depth: 9.5 in.

Leaching

37% in 30 in. x 8 in.
46% in 24 in. x 10 in.
61% in 18 in. x 12 in.
69% in 16 in. x 12 in.
Eggplant

Beds

24 in x 10 in  36 in x 6 in  18 in x 12 in
1 Tape  2 Tapes  1 Tape

51 Days After Transplant

24 in x 10 in  36 in x 6 in  18 in x 12 in

73 Days After Transplant

Reductions

- 50% Irrigation
- 14% Nitrogen
- 11% Phosphorus
Soil Moisture

2 tapes

36” x 6”: 13.2%, 24” x 10”: 11.7%, 18” x 12”: 10.4%

1 tape

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Eggplant Results

<table>
<thead>
<tr>
<th></th>
<th>36 in x 6 in</th>
<th>24 in x 10 in</th>
<th>18 in x 12 in</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drip Tape ($/acre)</strong></td>
<td>$255</td>
<td>$128</td>
<td>$128</td>
</tr>
<tr>
<td><strong>Fuel Cost ($/acre)</strong></td>
<td>$27</td>
<td>$14</td>
<td>$14</td>
</tr>
<tr>
<td><strong>Cost of Fumigant ($/acre)</strong></td>
<td>$260</td>
<td>$174</td>
<td>$129</td>
</tr>
<tr>
<td><strong>Net Production Cost Savings ($/acre)</strong></td>
<td>-</td>
<td>$227</td>
<td>$273</td>
</tr>
</tbody>
</table>

*Conservative (Additional Potential Savings: Liquid Fertilizer, Labor, Lease)
What We Know

More Crop per “Drop”

System

Efficiency

Economic

Environment
What We Are Doing Now

- **Single-Row Crop: Tomato**
  - ![Tomato Crop Image]

- **Double-Row Crop: Pepper**
  - ![Pepper Crop Image]

- **Hydrological Impact Study**

- **Other Crops: Melons, Squash, Herbs**

- **Applicability Across United States?, Implemented in FL, GA, and SC**
Improvements

Pans

New Bedder

New Plastic Machine
Then  
Tomato Season 1

Improvements

Now
What We Are Looking For

Drip Fumigation

Full-Scale Costs

Hydrology (Current and Future)

Disease

Dufault (UF-IFAS)
Tomato Experiment

Beds

Conventional

- 30 in.
- 8 in.

Compact

- 26 in.
- 10 in.
- 18 in.
- 12 in.

- 24 in.
- 10 in.
- 16 in.
- 12 in.

- 2 Seasons
  - 2015, 2016
- Fall
- Transplant:
  - October 7, 2015
Pepper Experiment

- **2 Seasons**
  - 2015, 2016
- **Fall**
- **Transplant:**
  - October 2, 2015

**Conventional**
- 32 in.
- 9 in.
- 2 Tapes, 1 Band

**Compact**
- 24 in.
- 10 in.
- 1 Tape, 2 Bands

**Standard Tie** vs. **Loose Tie**
Pepper Yield Preliminary Results

- **First Harvest**
  - November 30, 2015
- **Grades and Weight**
- **No Statistical Differences Between Bed Geometries**
Watermelon

Conventional

- 32 in.
- 8 in.

Compact

- 26 in.
- 10 in.

- 18 in.
- 12 in.

- 16 in.
- 12 in.

• More suited than tomato? vine vs staked
• Narrower than 16 in?
• Reduced cost, water, nutrient, and disease risk
• More plants/ac, reduced leasing cost
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