Berry Problematic

- Berry production season is short: 4-6 weeks
- Rain can reduce summer floricane cropping harvest
- High temperatures limit raspberry production in South
- High late summer temperatures limit flower formation and fruit set of primocane fruiting blackberry and raspberry cultivars
- Early fall freezes (20-Oct) limit fruiting of primocane cultivars
WHY High Tunnels?
Why Tunnels?

**Environmental Modification with**

A. Temperature Modification  
B. Precipitation and Moisture Modification  
C. Light modification  
D. Wind reduction

Thereby allowing the grower to

1. **Extend the growing season**  
   • Advance the Spring Season  
   • Extend the Autumn Season

2. **Minimize impacts of weather** (hail, wind, etc.)

3. **Mitigate Pest Problems**
The Opportunities and Benefits from Tunnels

• Reduced Risk of High Risk Crops
• Never a “lost day” due to rain
  • You will always have crop to sell
• Increase Value of Crops
  - Increased yields; size, total yield
  - Out-of-season production
  - Reduced costs
• Extended Season means Extended Cash-Flow for the farm
• Potential Reduced use of Pesticides
• Opportunity for Sustainable and Organically Produced
• Possible better Economics
Tunnels may extend the summer harvest season from 4-6 weeks during summer to 16-20 weeks during the year.
Opportunities

• With the combination of appropriate cultivar selection and use of high tunnels
  • Extend the season an additional 8-10 weeks per year
  • Protect the crop from inclement weather
  • Produce fruit when there are limited fresh fruit available in the market place.
    • Chance to capture high value early and late markets
A Place for Tunnels

Tunnels have a place in the production system to *compliment* field production.
Our Projects

Sustainable/Organic Berry Production in Tunnels

A. 2006-2010
Blackberries and Raspberries
1. Advancing Spring Production
   Blackberries: Navajo, Ouachita, Arapaho
   Raspberries: Dormanred, Prelude, and Encore
2. Extending Fall Production
   Blackberries: Prime-Jan, Prime-Jim, APF46
   Raspberries: Dinkum, Caroline, Autumn Bliss
3. Double-Cropping Primocane Cultivars

B. 2012-2014 Studies
1. Advancing Spring Production
   • Blueberries: Earliblue
   • Blackberries: Natchez
2. Extending Fall Production
   • Primocane Raspberries: Nantahala, Josephine, Autumn Bliss
   • Primocane Blackberries; PrimeArk 45; APF#
Overall Project Goal

The overall project goals are

1. To extend the berry production season from 4-6 weeks (June-July) to 4-5 months (May – November) with double cropping primocane fruiting genotypes
2. To allow for production of Raspberries in hot climates
3. To develop sustainable and organic production systems for southern fruit
4. To have products to capture high value markets
Hypotheses

• Extend the traditional summer seasons by advancing production of *floricane* berries in the spring with tunnels
• Establish a autumn harvest season and extend it with tunnels
• Growing fruit out-of-season reduces potential pests
• Growing fruit out-of-season in tunnels may reduce incidence of disease
• Use tunnels to improve fruit quality and marketable yield
Research Objectives

Develop production systems in order to:

I. Advance spring floricane blackberry production
   (Study 1)

II. Extend autumn primocane harvest season of blackberries and raspberries
    (Study 2)
HT Environments

- HT reduce total PAR ~17-20%
- In the spring season, HT increases Growing Degree Hour (GDH) accumulation by about 50-60GDH
  - Advanced phenology approx. 2-3 wks
  - Frost Protection Required in HT:
    - Spring averaged 4 nights frost protection
- In the autumn season, HT prevented frost and continued fall fruiting for 3 – 4 wks after field
  - Field ended between 15-Oct and 25-Oct (past 3 years) by freezes
  - HT ended 28-Oct and 18-Nov by freezes
    - Autumn averaged 2 night frost protection
- HT can “supercool” on some nights
  - Requires frost cloths for both advancing the season and protecting crop
## Do Tunnels Advance Bloom?

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Date of Full Bloom</th>
<th>Days Advance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2013</td>
<td>2014</td>
</tr>
<tr>
<td>Field</td>
<td>1-May</td>
<td>6-May</td>
</tr>
<tr>
<td>High Tunnel</td>
<td>18-April</td>
<td>14-April</td>
</tr>
<tr>
<td>HT+ Tunnel in Tunnel</td>
<td>12-April</td>
<td>8-April</td>
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CV: Natchez
# Do Tunnels Continue Harvest?

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2013</th>
<th>2014</th>
<th>AVG</th>
<th>Days Extension</th>
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</thead>
<tbody>
<tr>
<td><strong>Field</strong></td>
<td>15-Nov</td>
<td>1-Nov</td>
<td>8-Nov</td>
<td>0</td>
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<tr>
<td><strong>High Tunnel</strong></td>
<td>15-Nov</td>
<td>12-Nov</td>
<td>13-Nov</td>
<td>5</td>
</tr>
<tr>
<td><strong>HT+ Tunnel in Tunnel</strong></td>
<td>27-Nov</td>
<td>14-Nov</td>
<td>21-Nov</td>
<td>13</td>
</tr>
</tbody>
</table>

CV: PrimeArk 45
Field vs Tunnel Yield

Yield increase result of fall pruning management

NOTE: Pollination Problem

CV: Natchez

*lbs/A calculated at 8 ft row spacing

FD  HT

*Error bars represent standard error from the mean.
39% Increase

NOTE: Pollination Problem

CV: Natchez
Field vs Tunnel Daily Yield
2014

Daily Yield (grams per 10 ft plot)

FD
HT

Late frost

*Error bars represent standard error from the mean.

CV: Natchez
Field vs Tunnel Cumulative Yield

2014 Natchez Blackberry Cumulative Yield

Cumulative Yield (grams)

Date of 50% of Harvest

Last HT harvest 7/11

*Error bars represent standard error from the mean.

CV: Natchez
Field vs Tunnel Yield PrimeArk 45

*lbs/A calculated at 8 ft row spacing

*Error bars represent standard error from the mean.

CV: PrimeArk45
CV: PrimeArk45
Field vs Tunnel Daily Yield

Daily Yield (grams per 10 ft plot)

FD  HT

CV: PrimeArk45  2014

*Error bars represent standard error from the mean.
Field vs Tunnel Cumulative Yield

*Error bars represent standard error from the mean.

Yield (grams)

FD Tot  HT Tot

CV: PrimeArk45  2014
Field vs Tunnel Raspberry Yield

Total Yield (grams per 10 ft plot)

- Autumn Bliss FD
- Autumn Bliss HT
- Josephine FD
- Josephine HT
- Nantahala FD
- Nantahala HT

*Error bars represent standard error from the mean.

*lbs/A calculated at 8 ft row spacing

2013
Field vs Tunnel Raspberry Yield

Average Yield (lbs/acre)

137% Increase

*lbs/A calculated at 8 ft row spacing

2013
Field vs Tunnel Daily Yield

Daily Yield (grams per 10 ft plot)

- Autumn Bliss FD
- Autumn Bliss HT

Error bars represent standard error from the mean.

CV: Autumn Bliss    2013
**Field vs Tunnel Cumulative Yield**

![Graph showing cumulative yield comparison between Autumn Bliss FD and Autumn Bliss HT over time. Error bars represent standard error from the mean.](image)

- **Cumulative Yield (grams per 10 ft plot)**
- **Autumn Bliss FD**
- **Autumn Bliss HT**

*Error bars represent standard error from the mean.*

CV: Autumn Bliss 2013
Conclusions

- **Spring Tunnels advanced yield 2-3 weeks**
  - Greatest benefit was with TNT
  - Need to manage pollination and frost control

- **Spring Tunnels increased cumulative yield ~200%**
  - Some problems pollination in TNT
  - TNT had significantly better frost protection

- **Fall Tunnels extended yields 2-3 weeks**
- **Fall Tunnels increased cumulative yields ~200%**
- **Fall Tunnels increased raspberry yields ~135%**
Other Observations

• Screening tunnels reduced SWD significantly (~95%)
• Screening increased tunnel temperatures
• Screening increased severity of mite problems on raspberries