Instructions for Webinar Participation

Getting Started
• The webinar will start soon
• Audio is through your computer speakers or headset – you may hear nothing until the webinar begins
• Audio check - use the Audio Settings options to do a sound check
• If you see presenters talking but do not hear audio, use the Question & Answer feature to indicate you are not getting sound

How to Ask Questions
1. Click on Questions and Answers icon found at the upper part of your screen
2. A box will open where you can type in questions, comments, indicate sound problems, etc.
3. You can use this throughout this webinar to ask questions

Technical Help
• Do your own sound check using the Audio Settings
• Telephone (800) 500-1554 for technical support.
Growing Raspberries in High Tunnels

MSU is an affirmative-action, equal-opportunity employer. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, sex, gender, gender identity, religion, age, height, weight, disability, political beliefs, sexual orientation, marital status, family status or veteran status.
Growing Raspberries in High Tunnels
Eric Hanson, Department of Horticulture, MSU

1. Raspberries – a review
2. What are high tunnels?
   Break for questions
3. Why use them for raspberries?
4. How to do it.
   Concluding questions
Raspberries

Red Raspberries
(Rubus idaeus)
‘Anne’ ‘Prelude’ ‘Heritage’

Black Raspberries
(R. occidentalis)
‘Jewel’ ‘Cumberland’

Purple Raspberries:
(R. occidentalis x R. idaeus)
‘Brandywine’ ‘Royalty’
Raspberry Fruiting Habits

Floricanes – 2\textsuperscript{nd} year cane
(fruit in July)

Primocanes – 1\textsuperscript{st} year canes
(fruit in fall)

Primocane fruiting varieties produce a crop in the fall. If canes are overwintered, they produce a second (floricanes) crop in July.
Double cropping primocane fruiting raspberries:

Canes die back during the winter to where they stopped fruiting in the fall. Lower floricane buds develop fruit in July, and new primocanes fruit in the fall.

Remnants of fall fruit

Basal floricane buds will develop fruit in July.
High tunnels are plastic covered hoop-houses that are generally:
- low cost (relatively)
- no foundation
- unheated

1. Stand-alone Tunnels
   quonset- or gothic-shaped
2. Multi-bay or “three-season” high tunnels
Nor-Easter 30 x 96 ft structure
(Heidenreich et al. www.fruit.cornell.edu/berry.html)

Initial Investment:
Package and other materials $ 7,840
Poly $ 150
Construction labor $ 1,660
$ 9,650

Annual costs:
Tunnel depreciation (10 yr) $ 970
Poly depreciation (3 yr) $ 50
Interest on frame and poly @ 7% $ 640
Monitoring and venting poly $ 150
$ 1,810 or $0.63/ ft²
One-Acre Haygrove Tunnels  
(Von Weihe et al., 2009)

Initial Investment:
- Tunnel frames: $34,000
- Poly: $8,000
- Construction labor (200 hr @ $10/hr): $2,000

$44,000

Annual costs:
- Tunnel depreciation (15 yr): $2,300
- Poly depreciation (3 yr): $2,700
- Interest on frame and poly @ 7%: $2,900
- Install, vent, and remove poly: $1,200

$9,100 or $0.21 / ft²
Tunnels??
Which kind??

Small area – small investment
Greater season extension
Grow less hardy varieties(?)

Lower cost per ft²
Management of soil salts
Greater risk of wind damage(?)

??
Optimizing Protected Culture Environments for Berry Crops
Research and Extension Project

Providing growers with the knowledge needed to select tunnel structures and plastics that optimize productivity and pest management, while increasing profits and minimizing plastic waste generation.
High Tunnels for Extended Growing Season

High Tunnels are temporary structures that provide some crop protection and environmental modification at a relatively low cost. Unlike greenhouses, high tunnels are ventilated by raising the sidewalls. Types of high tunnels include:

Hoophouse or Quonset style:
- Rounded roof profile
- Can collect snow so space arches close enough to bear the weight of snow.
- Sidewalls can be rounded or straight. Straight sidewalls provide space for taller crops.

Gothic style:
- Peaked roof, sheds snow more easily. Straight side walls.
- Higher profile for taller crops and more stable temperatures in warmer months.
- Must have braces and purlins to withstand wind.

Multi-Bay High Tunnels:
Site Considerations

North – South orientation for best light distribution

With slopes for water and air drainage

Position for wind protection
Provide drainage to remove water from the tunnel

Gravel over drain tile
Benefits of high tunnels

1. Season extension
   - supply reliable volumes when prices are strong

2. Improved production and quality
   - protect from the weather and optimize growing conditions

3. Suppress diseases and some insect pests

Drawbacks

1. Cost

2. Management cost and learning curve
   - poly installation/removal, venting

3. Risk of damage from weather.
High tunnel raspberries and blackberries, PSU (K. Demchak)
Primocane-fruiting raspberries in stand-alone tunnels in MN:
-greater vigor, yield and berry size
-issues with temperature management, venting in summer and supplemental heat for late fall.
(Hoover and Poppe, University of MN)

June 14, 2007

June 14, 2007
Tunnel Raspberries, SW Mich.

1. Harvest begins earlier and continues later.
2. Yields were twice field yields.
4. Less anthracnose, leaf spot, Japanese beetle and leaf hoppers, but more spider mites in tunnels.
Yield (1,000 lb/acre) of primocane fruiting raspberries in a 3-season high tunnel and the open field, southwest MI.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn Britten</td>
<td>1</td>
<td>15</td>
<td>11</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Caroline</td>
<td>3</td>
<td>21</td>
<td>25</td>
<td>1</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Chinook</td>
<td>1</td>
<td>13</td>
<td>13</td>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Heritage</td>
<td>2</td>
<td>16</td>
<td>22</td>
<td>1</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>2</strong></td>
<td><strong>14</strong></td>
<td><strong>14</strong></td>
<td><strong>1</strong></td>
<td><strong>4</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

Yield (1000 lb/acre) of floricane fruiting raspberries in a 3-season tunnel and the open field, southwest MI.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canby</td>
<td>3</td>
<td>26</td>
<td>18</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Encore</td>
<td>2</td>
<td>20</td>
<td>19</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Heritage</td>
<td>1</td>
<td>5</td>
<td>8</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Nova</td>
<td>4</td>
<td>26</td>
<td>18</td>
<td>3</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>3</strong></td>
<td><strong>19</strong></td>
<td><strong>16</strong></td>
<td><strong>1</strong></td>
<td><strong>6</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>
Yields of ‘Caroline’ primocane fruiting raspberries in tunnels and the field, Benton Harbor, MI, (Hardiness Zone 6b), 2007.
Summer Raspberry Yields, Benton Harbor MI, 2008

Yield (g/plot)

Date

Encore - tunnel
Nova - field
Nova - tunnel
Encore - field

## Raspberry Picking Seasons – SW Michigan

<table>
<thead>
<tr>
<th></th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer bearers</td>
<td>In tunnels</td>
<td>In tunnels</td>
<td>In tunnels</td>
<td>In tunnels</td>
<td>In tunnels</td>
<td>In tunnels</td>
</tr>
<tr>
<td>Fall bearers</td>
<td>in field</td>
<td>in field</td>
<td>in field</td>
<td>in field</td>
<td>in field</td>
<td>in field</td>
</tr>
</tbody>
</table>

Plastic on earlier?  

Supplemental light or heat?
Cumulative yield (kg/plot) of potted raspberries in a high tunnel, Benton Harbor, MI

- Jaclyn
- Joan J
- Aut Britten
- Polka
- Himbo Top
- Caroline
- Josephine
- Anne
- Nantahala
- Joan Irene
- Crimson Giant
- No.14
### ‘Heritage’ Double Cropping Study

**NY, 2008 (M. Pritts, Cornell University)**

<table>
<thead>
<tr>
<th>Cane management</th>
<th>Crop</th>
<th>Size (g/berry)</th>
<th>Yield (g/meter)</th>
<th>Marketable (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field</strong></td>
<td>Double-cropped</td>
<td>Summer</td>
<td>1.90</td>
<td>1,637</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fall</td>
<td>2.26</td>
<td>4,761</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td>2.20</td>
<td>6,399</td>
</tr>
<tr>
<td></td>
<td>Single-cropped</td>
<td>Fall</td>
<td>2.19</td>
<td>3,510</td>
</tr>
<tr>
<td><strong>Tunnel</strong></td>
<td>Double-cropped</td>
<td>Summer</td>
<td>1.69</td>
<td>2,371</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fall</td>
<td>2.16</td>
<td>5,685</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td>2.09</td>
<td>8,056</td>
</tr>
<tr>
<td></td>
<td>Single-cropped</td>
<td>Fall</td>
<td>2.16</td>
<td>5,585</td>
</tr>
</tbody>
</table>
Cumulative summer and fall yield (lb/acre) of three raspberry cultivars under high tunnels in East Lansing, MI, 2014.

Severe winter injury to canes of each variety: less than 1 cane left per ft of row
Cumulative summer and fall yield (lb/acre) of three raspberry cultivars under high tunnels in East Lansing, MI, 2015.

Floricanes per ft of row:
- Himbo 1.5
- Joan J 1.2
- Polka 1.3

Summer crop??
Fall crop??
Questions or comments so far??
Choosing Varieties

**Primocane fruiting:**
- High quality and yield
- Season
- Double cropping?
- Market needs

**Flouricane fruiting:**
- Hardiness
- High quality and yield
- Season
- Market needs
Observations of raspberry varieties in Michigan are summarized in this publication, available on www.tunnelberries.org.

RASPBERRY VARIETY CHOICES FOR MICHIGAN
Eric Hanson, Department of Horticulture, Michigan State University and Diane Brown-Rytlewski, Fruit Educator, Michigan State University Extension

Many raspberry varieties are available today. This fact sheet reviews the strengths and weaknesses of older varieties and provides descriptions and initial observations of some new varieties. Summer-fruiting (florican-fruuting) and fall-bearing (primocane-fruuting) types are described separately.

SUMMER-FRUITING REDS

BOYNE Manitoba, Canada, 1960. (Chief X Indian Summer). This older red fruited variety has been used in colder areas due to its extreme hardiness. Berries are flavorful and ripen early, but tend to be dark, small, and soft, but flavorful. Freeze well. Plants have moderate vigor with thorny, upright canes, and some tolerance of Phytophthora root rot. Boyne is a good choice for home use or PYO in cold locations.

CANBY Oregon, 1953. (Viking X Lloyd George). This variety has been used for many years for fresh fruit in warmer Michigan locations. Berries ripen in the early midseason, with excellent flavor, a light red color, and moderate firmness. Plants have moderate vigor and resistance to aphids and some viruses. Canes are thornless, marginally hardy and susceptible to crown gall and Anthracnose.

ENCORE New York, 1998 (Canby X Cherokee). This season variety has become popular throughout Michigan and much of the Midwest because it is relatively hardy and produces large, firm fruit with very nice flavor. It is probably the best late season variety for commercial growing. Plants are vigorous and sucker freely. Encore produced numerous double berries grown as potted plants in high tunnels.

HAIDA Vancouver, BC, 1973 (Malling Promise X Creston) is a late midseason variety that has been grown to some extend in the Midwest, although it is just marginally hardy for colder sites. Fruit are, medium to large with good firmness, and are suited for fresh and processed uses. Plants produce numerous spiny, upright canes and have resistance to raspberry aphid and spur blight.
General harvest times for primocane raspberries in high tunnels in southern Michigan. Relative harvest volumes increase with bar darkness. Varieties followed by (?) are only estimated.
Floricane-fruiting varieties (early to late)

**Prelude:** hardy, high yields, good flavor, medium firmness and size (some primocane fruit)

**Nova:** very hardy, high yields, medium flavor, medium to large, very firm (some primocane fruit)

**Encore:** hardy, very high yields, exc flavor, firm and large
Primocane fruiting varieties (early to late)

**Polka:** large bright red fruit, high yields, but: attractive to leaf hoppers, Jap. beetles

**Joan J:** large, firm fruit with exc flavor, high yields but: very dark color

**Jaclyn:** large, firm fruit with exc flavor, but: modest yields, dark color, hard to pick

**Himbo Top:** large bright red fruit, high yields, but: softer
Primocane-fruiters (cont.)

Caroline: medium-large, exc flavor, v high yields
but: softer

Anne: medium-large, exc unique flavor, high yields
but: slightly more gray mold

Josephine: very large, firm fruit with exc flavor,
but: dark color, later maturing

Nantahala: firm with exc flavor, high yields,
but: later maturing
Row spacing – not closer than 7 feet
Tunnels exclude rain so irrigation is essential. Trickle systems are best.

Trickle systems can also be used to fertigate plants.
Weed Management

Between rows tilled twice per year. Within rows hand weed twice per year or managed with herbicides.
V-trellis to space and separate canes
Fence post/wood flashing, monofilament wire
Raspberries prefer mild temps (70s, low 80s). Provide for ventilation
Venting – Tunnel temperatures compared to outside temperatures at 5 ft height

Fully vented
(August 7-31)
Daily min.  Daily max.
+ 0.4 F  + 1.7 F

Closed except for ends
(Sep 8-19)
Daily min.  Daily max.
+ 0.4 F  + 5.0 F
Partly vented, 26 June

- Outside
- Plastic
- Plastic + black
- Plastic + Aluminet

Temperature (F)
Raspberries need bees for pollination

Honeybees do not like working under tunnels, but they will because they love raspberry flowers.

Honeybees and native bees may adequately pollinate small tunnels, but bumblebee hives are good insurance for larger tunnels.
Gray mold caused by the fungus *Botrytis cinerea* is a common pre- and post-harvest fruit rot.

Control is achieved with fungicides, timely harvest, and keeping plants dry with high tunnels.
Primary Pests – Michigan High Tunnels

Japanese beetle
*Popillia japonica*

Potato leafhopper
*Empoasca fabae*

Raspberry sawfly
*Monophadnoides geniculatus*

Raspberry cane borer
*Oberea bimaculata*

Two spotted spider mite
*Tetranychus urticae*

Spotted wing drosophila
*Drosophila suzukii*
Two spotted spider mites 
(*Tetranychus urticae*)

Can be very severe in hot, dry conditions

Some pesticides (pyrethrum) increase populations

Management:
Vent to cool tunnels
Release predatory mites:
- *Phytoseiulus persimilis*
- *Amblyseius californicus*
Avoid pyrethrum sprays
Spotted wing drosophila
New pest of raspberries and other fruits.
Flies lay eggs in ripening berries.
Larvae feed on and destroy berries.
Juice and stained caps indicate infestation.
Populations grow rapidly.

Management:
Thorough, frequent harvest.
Proper pruning/training
Timely pesticide use.
Spotted wing drosophila numbers escalate after summer crop is harvested.

Cumulative yield (lb/acre) vs. date in East Lansing, 2013.
Primocane and floricane raspberry harvest times, E.L.

Cumulative yield (kg/ha)

Series4
Series5
Series6

2014

Himbo Top
Joan J
Polka

1st SWD trapped 7 Aug

Cumulative summer and fall yield (lb/acre) of three raspberry cultivars under high tunnels in East Lansing, MI, 2015.

1st SWD trapped 9 July
Physical exclusion of SWD

Rufus Isaacs and Heather Leach, Entomology, MSU

- Organic tunnel and two commercial tunnels
- Side walls and end doors
- ProtekNet netting (Dubois Agrinovation)
  
  1 mm x 0.6 mm mesh
  90% light transmission, 80% porosity
Exclusion Netting for SWD Control
Heather Leach and Rufus Isaacs, Entomology, MSU

- Netting significantly delays and reduces SWD infestation
- Overall insect abundance decreased
- Netting may increase tunnel temperatures some
- No effect on fruit quality

Assumes 1 acre: 5 adjacent 400 x 25 ft tunnels
Door and side netting = Tek-Knit 80 gram (Berry Protection Solutions)
Cumulative captures of male and female *Drosophila suzukii* flies in open and netted areas of high tunnel raspberries, 2014.

Fruit infestation rates were low and similar in netted and open areas.
Tunnels may facilitate organic production

1. Improved production and fruit quality
2. Suppressed fungal diseases (most)
3. Less weed competition??
4. Extend market season

Organic Raspberry Production in Three-Season High Tunnels

by Eric Hanson¹, Vicki Morrone², Rufus Isaacs³, Michigan State University Extension
¹MSU Department of Horticulture, ²MSU Department of Community Sustainability, ³MSU Department of Entomology

Extension Bulletin E3235
Can tunnel raspberries be profitable in Michigan? Yes, but........

Competing with California or Mexican berries at wholesale prices would be challenging.

Growers can be profitable if they can gain price premiums for “locally produced” or “organically grown”, or by retail marketing.

Thank you!! Any final questions?
Yield of potted raspberry varieties pruned to retain 2 floricanes or none. Grown under high tunnels, Benton Harbor MI, 2014.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Floricanes</th>
<th>Summer</th>
<th>Fall</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Josephine</td>
<td>yes</td>
<td>267</td>
<td>319</td>
<td>586</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>0</td>
<td>798</td>
<td>798</td>
</tr>
<tr>
<td>Joan Irene</td>
<td>yes</td>
<td>438</td>
<td>545</td>
<td>983</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>0</td>
<td>798</td>
<td>798</td>
</tr>
<tr>
<td>Crimson Giant</td>
<td>yes</td>
<td>387</td>
<td>311</td>
<td>698</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>0</td>
<td>444</td>
<td>444</td>
</tr>
</tbody>
</table>