University of Minnesota
Day-neutral Low Tunnel Strawberry Project

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Esther Jordan, Communication Specialist
Background

- Strawberries are an important part of a healthy diet
- Short MN growing season
- Newer day-neutral cultivars available to extend strawberry harvest
- Use organic production methods
- Funding provided by the North American Strawberry Growers Association (NASGA) and the MN Dept. of Ag, MN Specialty Crop Block Grant
2013-2014 Project Objectives

- Compare Portola, Monterey, Seascape, Albion, San Andreas and Evie-2 day-neutral cultivars grown on raised beds in a field vs. a low tunnel system
- Evaluate production, fruit quality, pest, weed and disease management throughout the season
- Develop more strawberry growers in the upper Midwest region
Long-term Impacts:

- Maintain or increase yield
- Contribute to improved nutrition among consumers
- Fruit available during a non-traditional time
- Improved economic and environmental sustainability for growers
Why Low Tunnels instead of High Tunnels

In high tunnels:

- Space not used efficiently due to strawberry plant stature
- Increased incidence of diseases and insects
- Wind and snow damage
- Temperature gradient high between inside and outside
What We Learned

- Skillful management required throughout entire growing season
- Fertility
- Proper installation of plastic hoop
- Organic control of insects and diseases
Harvest

- Picking starts around the 3rd week in July
- Picked fruit until mid to late October
- October, 2013: low temperature of 28 degrees F with no damage to strawberry flowers
<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Lbs./plant tunnel</th>
<th>Berry wt. (g.) tunnel</th>
<th>Lbs./A. tunnel</th>
<th>Lbs./plant no-tunnel</th>
<th>Berry wt. (g.) no-tunnel</th>
<th>Lbs./A. no-tunnel</th>
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<tbody>
<tr>
<td>Portola</td>
<td>1.63</td>
<td>19.26</td>
<td>29634</td>
<td>1.23</td>
<td>16.31</td>
<td>22357</td>
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<tr>
<td>Monterey</td>
<td>1.16</td>
<td>15.84</td>
<td>21071</td>
<td>0.84</td>
<td>15.21</td>
<td>15319</td>
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<tr>
<td>Seascape</td>
<td>1.19</td>
<td>14.11</td>
<td>21731</td>
<td>0.88</td>
<td>12.66</td>
<td>16003</td>
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<tr>
<td>Albion</td>
<td>1.05</td>
<td>16.71</td>
<td>19026</td>
<td>0.88</td>
<td>15.94</td>
<td>16055</td>
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<tr>
<td>Evie-2</td>
<td>1.16</td>
<td>15.98</td>
<td>21121</td>
<td>1.07</td>
<td>14.62</td>
<td>19516</td>
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<tr>
<td>San Andreas</td>
<td>0.99</td>
<td>16.80</td>
<td>18120</td>
<td>0.79</td>
<td>16.57</td>
<td>14315</td>
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<tr>
<td>2013 Tribute</td>
<td>1.13</td>
<td>6.62</td>
<td>20,524</td>
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## 2013-2014 Strawberry Yields: St. Paul

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>lbs./plant tunnel</th>
<th>Berry wt. (g.) tunnel</th>
<th>Lbs./A. tunnel</th>
<th>lbs./plant no-tunnel</th>
<th>Berry wt. (g.) no-tunnel</th>
<th>Lbs./A. no-tunnel</th>
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<tbody>
<tr>
<td>Portola</td>
<td>1.01</td>
<td>13.39</td>
<td>17824</td>
<td>1.0</td>
<td>13.38</td>
<td>17577</td>
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<tr>
<td>Monterey</td>
<td>1.07</td>
<td>13.27</td>
<td>18941</td>
<td>0.89</td>
<td>12.72</td>
<td>15558</td>
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<tr>
<td>Seascape</td>
<td>0.77</td>
<td>11.41</td>
<td>13378</td>
<td>0.68</td>
<td>10.42</td>
<td>11806</td>
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<tr>
<td>Albion</td>
<td>0.96</td>
<td>13.19</td>
<td>16949</td>
<td>0.75</td>
<td>12.22</td>
<td>13295</td>
</tr>
<tr>
<td>Evie-2</td>
<td>1.16</td>
<td>12.77</td>
<td>20523</td>
<td>1.1</td>
<td>11.93</td>
<td>19327</td>
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<tr>
<td>San Andreas</td>
<td>0.86</td>
<td>13.82</td>
<td>15105</td>
<td>0.75</td>
<td>13.82</td>
<td>13232</td>
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</table>
Individual Strawberry Weight

• We calculated individual fruit size

• At Morris, the average berry weight across cultivars in the low tunnel was 16.45 g while the non low tunnel was 15.22 g.

• By comparison, 2010, 2011 and 2013 data from the Morris June-bearing variety trial shows the average berry weight across all cultivars was 10.58 g.

The low tunnel system is proving to produce larger individual fruit size when compared to our June-bearing strawberry trials.
A Noticably Sweet Berry

• Brix levels of all six cultivars in the low tunnel and non-low tunnel treatment showed an average of 7.6
• Our 2013 June-bearing variety trial had an average brix level of 7.7
• Day-neutral cultivars are just as sweet as June-bearing varieties commonly grown in Minnesota
Temperature and Humidity

- Temperature and humidity were recorded in the low tunnel and non-low tunnel beds.
- Data loggers were suspended 12 inches above both beds.
# Temperature and Humidity

<table>
<thead>
<tr>
<th></th>
<th>Low tunnel-2013</th>
<th>Non-low tunnel-2013</th>
<th>Low tunnel-2014</th>
<th>Non-low tunnel-2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average temperature</strong></td>
<td>71.3 F</td>
<td>68.2 F</td>
<td>64.6 F</td>
<td>63.6 F</td>
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<tr>
<td><strong>Average relative humidity</strong></td>
<td>82.4%</td>
<td>74.1%</td>
<td>78.2%</td>
<td>70.7%</td>
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<tr>
<td><strong>Average due point</strong></td>
<td>63.5</td>
<td>57.8</td>
<td>56.4</td>
<td>51.8</td>
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<tr>
<td>Variable costs</td>
<td>Total low tunnel Treatment</td>
<td>per 100'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------------------------</td>
<td>----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer</td>
<td>$70</td>
<td>$11.67</td>
<td></td>
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<tr>
<td>Pesticides</td>
<td>$17</td>
<td>$2.78</td>
<td></td>
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<tr>
<td>Plants</td>
<td>$125/1000 (w/o shipping)</td>
<td>approx. 17,500 plants/acre</td>
<td>$25.00</td>
<td></td>
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<tr>
<td>Irrigation - drip tape</td>
<td>$13/acre</td>
<td></td>
<td>$2.22</td>
<td></td>
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<tr>
<td>Mulch - Plastic (white on black)</td>
<td>$112.00/9600' of row</td>
<td></td>
<td>$5.00</td>
<td></td>
</tr>
<tr>
<td>Greenhouse Film</td>
<td>$864.00</td>
<td></td>
<td>$144.00</td>
<td></td>
</tr>
<tr>
<td>Stainless Steel Rods</td>
<td>$348.00</td>
<td></td>
<td>$58.00</td>
<td></td>
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<tr>
<td>Straw (for walkways)</td>
<td>$56.00</td>
<td></td>
<td>$9.33</td>
<td></td>
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<tr>
<td>Spring tensioners, anchors, rope, stoppers</td>
<td>$126.00</td>
<td></td>
<td>$21.00</td>
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<tr>
<td>Tractor Fuel (tillage, bed prep, plastic laying)</td>
<td>approx. 1 gallon/hour,</td>
<td>approx. 20 hours per acre, $3.50/gallon</td>
<td>$3.50</td>
<td></td>
</tr>
<tr>
<td>1 lb. plastic qt. containers</td>
<td>$0.05</td>
<td>approx. 1 lb per plant &amp; 200 plants per 100' row</td>
<td>$10.00</td>
<td></td>
</tr>
<tr>
<td>Total costs (variable + fixed)</td>
<td></td>
<td></td>
<td>$292.50</td>
<td></td>
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</tbody>
</table>
Low Tunnel Construction and Planting Steps - 2013

- **Materials needed:**
  - Bed shaper
  - Mulch machine
  - 4 foot wide, 1 mil white on black plastic mulch
  - Drip tape irrigation
  - Dormant day-neutral strawberry plants
Creating a Raised Bed

- Once the bed is created, a 4 foot wide 1 mil white on black plastic mulch is placed on top of the bed.
- The dry wheel puncher makes small holes in the plastic to act as a guide for proper plant spacing.
Planting

- Row spacing was 14 inches between rows, and 12 inches between plants in a staggered row.
- Use a 1 inch x 12 inch wooden plant stake to transplant.
- Place the blunt end of the wood plant stake at the tip of the roots and insert the transplant into the ground.
Hoops and Stoppers

• Cut several 1 inch by 12 inch tubes from black poly. These will be used as a stopper; you will need two stoppers per rod

• Drill a 5/16 inch hole through the center of each stopper. The stoppers will need to insert tightly into the 3/16 steel rods

• Install the stoppers onto the steel rods, prior to installation
Hoop Rods

- Place 3/16”-10’ long stainless steel rods every 5’
- Drive rods into ground about 1 ½’ creating a “covered wagon” look
- Hoops will be about 2’ from top of bed
Installing Poly Cover

- Need a 12 feet wide, 4 or 6 mil clear plastic poly covering
- Begin by unrolling the plastic over the hoops
Securing Poly Cover

- Gather the plastic at the end of the bed and hold tightly while securely tying
- Tie the end of rope to a spring tensioner
Rolling up Plastic Cover

- The best method for rolling up the plastic is to have two people on each side, rolling up one 5-foot section at a time.
- Roll the plastic up so it is approximately 20 inches off the ground.
- To hold this position, the black stopper is moved up on the steel rod to hold the plastic in place.
Secure the Stopper

- Using black electrical tape, secure the stopper by placing the tape above and below the stopper to secure it onto the rod.

- Tape will secure the stopper, keeping the twine tight on the plastic to help hold in case of high winds.
Secure the Twine

- With the middle of the twine secured on the one stopper, and brought over the steel hoop, you will now have the two loose ends of twine to secure at the other stopper

- Wrap the twine around the stopper twice and tie off
Secure the Twine

- Using a separate piece of twine, secure the twine that is on either side of the steel rods by tying it to the adjacent twine.
Flowers and Runners

• Need to remove flowers as well as runners from the plants
• Flowers should be removed approximately three times
• For our project, we removed flowers in early June, mid-June, and late June

• This allows the plant to establish and have leaf surface to support later fruit production
Insect Management

- Monitor for the tarnished plant bug
- This insect is prevalent throughout the entire flowering season
- Close monitoring for this pest is essential
- Applied Oxidate (OMRI Approved) for TPB control at 1 oz./1 gallon water on a weekly basis
Spotted Wing Drosophila SWD

- Throughout the 2013-2014 growing season very little if any SWD were detected in our traps at the Morris and St. Paul sites
- Applied Oxidate (OMRI Approved) for control at 1 oz./1 gallon water on a weekly basis
Spotted Wing Drosophila Traps

- Clear plastic quart-size cup, with lid
- Drilled 3/16” holes around the cup
- Wire handle inserted into the sides
- Yellow sticky traps inside the lid
- Trap cups monitored weekly
- New bait each week

Recipe for SWD trap bait:

- 12 fl oz water
- 4 T sugar
- 1 T active dry yeast
- 1 T apple cider vinegar
- 1-2 T whole wheat flour
Fertigation: 5 to 6 lbs. of N every week
Chlorosis Issue

- Farmer cooperator site
- Severe iron deficiency
- Soil pH 7.9
Rainfall Issues on Low Tunnel Plastic Hoop
Low Tunnel Wind Damage

- Farmer cooperator low tunnels became "no tunnels" on June 21 in back-to-back wicked storms
- The plants and the raised beds were the only survivors of a storm with wind speeds clocked at 85 mph
Diseases in Low Tunnel

Fruit from low tunnels-need certain wave lengths to promote botrytis, clear poly does not promote this

Botrytis fruit rot-did not see in the low tunnel
Diseases in Low Tunnel

- Expected to see powdery mildew, but in these low tunnels, there was none.
- Powdery mildew grows really well in high humidity conditions, and high tunnels are often quite humid.
Home Garden Resources

Supplies
• Growers Supply  www.growerssupply.com
• Nolt’s Midwest Produce Supplies  641-228-4496
• Johnny’s Selected Seeds  www.johnnyseeds.com
• Debois Agrinovation  www.duboisag.com

Day_neutral Strawberry Plants
• Nourse Farms  www.noursefarms.com
• Ag Resource  dgbari@tekstar.com
Tunnel Flex 1640'}
Liste des pièces
Parts list

**TUTRC1.2x500**
Rouleau de film clair 3,15 mil x 500m
Roll of Clear Film 3.15 mil x 1640'
x 1

**ELAS31G6X8NB**
Cordons élastiques 8'
8' Bungee Elastics
x 350

**BROCH28-TUNNEL**
Anneaux avec œillet
Hoops with Eyelets
x 328

**BROCH28-RANGS**
Anneaux de début et de fin de rang
Start and End Hoops
x 8

**IA TUYG1.25X2FT**
Piquets d'installation de début et de fin de rang
Start and End Anchor Stakes
x 8

**BROANCR1.8GAL**
Piquets en acier pour ancrer les anneaux
Steel Stakes to Anchor the Hoops
x 340
... this has the potential as a real production system

Special thanks to Nourse Farms for providing the plants

Portola
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Horticulture Scientist
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For more information visit our blog
http://fruit.cfans.umn.edu
(Fruit Blog, Low Tunnel Strawberry)

http://wcroc.cfans.umn.edu/

Albion