Vegetable Production using Mulches and Tunnels

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2015

Chilly spring cools crop outlook: Canadian Wheat Board

Frost warning issued for May 20 over much of Saskatchewan
CBC News

Snow in July!!! - CBC News

- Harvest behind schedule Leader-Post …

Blizzard conditions on Oct 3 close highways in South Sask

Climatic factors challenging vegetable growers on the CDN Prairies

- Limited frost free season (mid-May to mid-Sept)
- Low temperatures even in mid-summer

Growers’ Response to Limitations of Prairie Growing Conditions

- Crop selection

Major Garden Crops on the CDN Prairies

Probability of Crop Maturing in “Typical” Prairie Growing Season

<table>
<thead>
<tr>
<th>Probability</th>
<th>Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>Lettuce, carrots, beans, peas</td>
</tr>
<tr>
<td>80%</td>
<td>Sweet corn, onions, cucumbers</td>
</tr>
<tr>
<td>60%</td>
<td>Tomato, green pepper*, watermelon *</td>
</tr>
<tr>
<td>40%</td>
<td>Cantaloupe*, red peppers*</td>
</tr>
<tr>
<td>20%</td>
<td>Sweet potato *</td>
</tr>
<tr>
<td>0%</td>
<td>All * crops without microclimate modification</td>
</tr>
</tbody>
</table>
Growers’ Response to Limitations of Prairie Growing Conditions

– Cultivar selection

Grower response to limited growing season

– Microclimate modification

Soil Mulch
- material applied to soil surface to modify its properties
Mulches ...
- enhance soil temperatures

Soil warming
- Clear = IR (5C) > Black (3C) > Nothing > White = Silver (-3C) > Clippings, Leaves (-5C)
- Must be tight to work
Mulches:
- increase soil temperatures
- conserve soil moisture
- control weeds

Table 9.2: Impact of mulches and staking on marketable fruit yields of tomato in dry and wet years

<table>
<thead>
<tr>
<th>Mulch</th>
<th>Staked</th>
<th>Dry Year</th>
<th>Wet Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>No mulch</td>
<td>Yes</td>
<td>34</td>
<td>29</td>
</tr>
<tr>
<td>No mulch</td>
<td>No</td>
<td>36</td>
<td>12</td>
</tr>
<tr>
<td>Plastic</td>
<td>Yes</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Plastic</td>
<td>No</td>
<td>40</td>
<td>24</td>
</tr>
<tr>
<td>Straw</td>
<td>Yes</td>
<td>44</td>
<td>37</td>
</tr>
<tr>
<td>Straw</td>
<td>No</td>
<td>39</td>
<td>24</td>
</tr>
</tbody>
</table>
Colored Mulches
- mulch color = reflected light ... all other wavelengths absorbed
- reflected light has potential to alter crop growth

Colored Mulches
- colors tested
  - red, blue, white, yellow
- crops tested
  - cucs, corn, zucchini, transplanted onion

Mulches
- alter soil temperature
- preserve soil moisture
- weed control
- keep crop clean
- alter crop growth
- repel insect pests

Table 9.4 - Influence of mulch color on insect damage to cucumbers (Illinois)

<table>
<thead>
<tr>
<th>Mulch</th>
<th>Plants with Virus</th>
<th>Leafminers/leaf</th>
</tr>
</thead>
<tbody>
<tr>
<td>No mulch</td>
<td>60</td>
<td>7.1</td>
</tr>
<tr>
<td>Paper</td>
<td>24</td>
<td>3.4</td>
</tr>
<tr>
<td>Blue plastic</td>
<td>20</td>
<td>1.7</td>
</tr>
<tr>
<td>White plastic</td>
<td>21</td>
<td>2.6</td>
</tr>
<tr>
<td>Aluminum</td>
<td>20</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Mulches
- alter soil temperature
- preserve soil moisture
- weed control
- alter crop growth
- repel insects
- improve yields and profitability
Mulch Issues

Mulch Materials
- thin plastic on rolls
- thickness
  - thinner is less expensive but less durable during installation + recovery
  - typically 1-1.5 mil thick and 4-5' wide on 1-5,000' rolls

Mulch Issues

Installation Equipment
- must be fast, tight and gentle
- raised bed = tighter fit + better for crop
- securely bury edges of plastic under soil
- works on your soil type . with your tractor and your soil prep
- lays drip tube at same time?
Mulch Issues

Planting through mulch
Mulch Issues
- Removal at end of season

Mulch Issues
- Disposal

Biodegradable mulches
- Made from corn byproducts
- Degraded with exposure to sunlight, moisture and microbes
- Available in clear, black, IRT/WLS
- Durability/performance ???
- Cost/benefit ?

Biodegradable Mulch trials
Mulches tested by U of S
- Clear, black, IRT, no mulch
- Biodegradable and photodegradable forms

Crops tested
- Corn
- Zucchini
- Melons

Biodegradable mulches

Degradable Mulches

Ideally ....
- Mulch lasts long enough to benefit crop ...
  then dissolves
- Eliminates fall clean up
Several observations:
- All crops did well on all colors.
- Biodegradable clear gave an earliness advantage but it broke down too early.
- Biodegradable black and IRT held up well.
- Biodegradable mulch minimized fall clean up.

Biodegradables cost about 15% extra.

Multiple Cropping to Reduce Mulch Costs:
- Within a season
- Over > 1 year

Challenges:
- Durability/performance of the mulch?
- Cropping issues - fertility, disease.

Potential to Multi-Crop Mulches:
- Year 1
  - IRT, black and clear (1.5 mil)
  - No mulch
  - Peppers and cucumbers
  - Drip irrigated

Potential to Multi-Crop Mulches in SK:
Fall of Year 1:
All mulches physically intact

<table>
<thead>
<tr>
<th>Mulch Type</th>
<th>New</th>
<th>Used for 1 Season</th>
<th>Used, then Cleaned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>56%</td>
<td>62%</td>
<td>63%</td>
</tr>
<tr>
<td>IRT</td>
<td>22%</td>
<td>3%</td>
<td>12%</td>
</tr>
<tr>
<td>Black</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>
Potential to Multi-Crop Mulches

Mulch Status – Over-Winter

Crop residues left in place
30 cm snow December --- March

Spring – Year 2

All mulch intact
Soil test
No changes in nutrients ...except N
N applied through drip
Crop residues removed
Glyphosate prior to transplanting

Year 2

Test crop = tomato
Lay new mulch in adjacent area for comparisons
New mulch laid one week prior to transplanting

Crop Status
Some problems with crop establishment on year old mulch
Soil compaction?
Weeds on year old clear

Comparing temperature profiles:
Black Mulch

Summary + Conclusions

Multiple cropping on mulches is feasible with minor modifications to production practices
Potential benefits
Reduces costs (materials + labor + environment)
Reduced spring work load
Earlier soil warming?
Mulch Cost
- materials
- installation
- removal
- disposal
ca $1200/ha

Row/Crop Covers
- Increase daytime air temperatures
- Some frost protection
- Wind protection
- Keep insects out
  Must be done right to work

Row/Crop Cover responses
- Most beneficial for warm season crops growing in a cool environment
- Enhance earliness and increase yields

Crop Covers
### Extending the Growing Season

#### Crop Covers

<table>
<thead>
<tr>
<th>Width (ft)</th>
<th>Weight (oz/sq yd)</th>
<th>% Light Transmission</th>
<th>Heat Build-up (°C)</th>
<th>Frost Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agryl P-17</td>
<td>6, 21, 34, 42</td>
<td>0.6</td>
<td>88</td>
<td>+ +</td>
</tr>
<tr>
<td>Agryl P-20</td>
<td>6, 21, 34</td>
<td>1.1</td>
<td>78</td>
<td>++</td>
</tr>
<tr>
<td>Reemay</td>
<td>6, 12</td>
<td>0.6</td>
<td>65</td>
<td>+ +</td>
</tr>
<tr>
<td>Clear poly</td>
<td>6</td>
<td>0.5</td>
<td>95</td>
<td>+++</td>
</tr>
</tbody>
</table>

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**Slitted Row Cover**

- Side by side, short row
- For ventilation
- 1 inch long
- ¾ inch apart
- Wire loops
- 4 x 4 galvanized wire
- 6 inch long
- 1½ to 2½ inches
- 5 foot between loops
Row Covers

- **Row Cover materials**
  - clear (perforated) – warm
  - clear (non-perforated) – hot
  - white (perforated) – cool
  - green (perforated) – cool
  - woven – cool

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**Extension of the Growing Season**

- **Row/Crop Cover issues**...

  **Frost Protection**
  - Limited potential in both spring and fall
  - Protection increases with thickness of cover
  - Works well in conjunction with overhead irrigation

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**Insect control**

Covers may protect crop from insect pests that fly into plots.
Extending the Growing Season

Crop Covers

Duration of Coverage?
- as long as cover still beneficial
- too long = over heating + no pollination
- row covers difficult to remove: then re-install
- field covers easier to remove and re-install
- 6 weeks for peppers, melons
- 2 weeks for corn and tomatoes

Impact of mulches and row covers on yield, and returns for peppers and melons

<table>
<thead>
<tr>
<th>Crop</th>
<th>Treatment</th>
<th>Yield (kg/ha)</th>
<th>Price ($/kg)</th>
<th>Gross ($/ha)</th>
<th>Input ($/ha)</th>
<th>Net ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peppers</td>
<td>Bare ground</td>
<td>5,000</td>
<td>1.16</td>
<td>5,800</td>
<td>2,800</td>
<td>3,000</td>
</tr>
<tr>
<td></td>
<td>Mulch</td>
<td>6,700</td>
<td>7,772</td>
<td>3,300</td>
<td>4,472</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mulch + Cover</td>
<td>15,200</td>
<td>17,864</td>
<td>5,400</td>
<td>12,464</td>
<td></td>
</tr>
<tr>
<td>Melons</td>
<td>Bare ground</td>
<td>20,000</td>
<td>0.51</td>
<td>10,200</td>
<td>2,200</td>
<td>8,000</td>
</tr>
<tr>
<td></td>
<td>Mulch</td>
<td>32,000</td>
<td>16,320</td>
<td>2,700</td>
<td>13,620</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mulch + Cover</td>
<td>60,000</td>
<td>30,600</td>
<td>4,800</td>
<td>25,000</td>
<td></td>
</tr>
</tbody>
</table>

Bottom Line for Mulches/Crop coverings

- Although microclimate modification systems are widely used in major vegetable crop prod'n areas (CA, MX), local growers have been slow to adopt these materials, despite an obvious need and repeated demonstration projects.
What’s the Hold Up ...?

When using mulches/rowcovers ....

- 1 year in 5 (1998 and 2011) - growing season is so good ... really don’t see any benefit = ................................
- 1 year in 5 (2004 and 2010) - growing season is so awful that don’t see any benefit = ...................................
- 1 year in 5 (2005 and 2009) - only crops grown with microclimate modification make it = opportunity for big returns

- cv. Earligold

- cv. Roadside Red

- cv. Spitfire
Temperature Management

High Tunnel Costs
- Materials: $2795
- Labor: $500
- Total: $3295

Low Tunnel Costs
- Materials: $59
- Labor: $20
- Total: $79

High Tunnels = $13.00 / linear m of row
Standard Tunnels = $0.46/linear m of row

Cost Benefit Analysis
Step 1. Calculate yield/unit linear space
Step 2. Multiply yield * Price (Wholesale) = Gross/unit row length
Step 3. Cost/Benefit = (Cost High Tunnel - Low Tunnel) / (Return High Tunnel - Low Tunnel)

Fertility Management

Space Management

High Tunnels .... ?

Conclusions from studies using small, stand-alone high tunnels

- High Tunnels make sense ($) ....but could be even better with ....
- Experience
- Crop specific management
- New crops
Next Generation High Tunnels ....
Wider, Longer, Taller

Evaluation of “Next Generation” High Tunnels ....
Next Generation High Tunnels
Observations from 2011 + 2012

Next Generation High Tunnels …
- easier to work in than smaller structures
- create more “moderate” conditions
- pleasant place to work in

95 km winds – June 22, 2012
This Winter …

“Fall” 2012 …

For Sale
No Reasonable Offer Refused

Some wind/snow damage
50% usable arches
50% salvage

FUTILITY
## Tunnel Build

<table>
<thead>
<tr>
<th>Build Steps</th>
<th>Person Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Read instructions (and talk to experts)</td>
<td>2</td>
</tr>
<tr>
<td>2) Unpack and check materials</td>
<td>2</td>
</tr>
<tr>
<td>3) Staked out the perimeter of tunnels</td>
<td>0.5</td>
</tr>
<tr>
<td>4) Laid landscape cloth along edges to control weeds</td>
<td>2</td>
</tr>
<tr>
<td>5) Installed anchors for the arches using motorized post-hole auger</td>
<td>3</td>
</tr>
<tr>
<td>6) Assembled arches</td>
<td>2 people * 1.5 days</td>
</tr>
<tr>
<td>7) Installed arches into soil anchors</td>
<td>2</td>
</tr>
<tr>
<td>8) Drilled holes and installed anchor bolts at base of arches</td>
<td>8 (B)</td>
</tr>
<tr>
<td>9) Installed horizontal cross struts on arches</td>
<td>3 (C)</td>
</tr>
<tr>
<td>10) Installed end bracing struts</td>
<td>1.5</td>
</tr>
<tr>
<td>11) Installed purlin along peak</td>
<td>4</td>
</tr>
<tr>
<td>12) Install V wire at ends</td>
<td>1</td>
</tr>
</tbody>
</table>

Sub-total: 49 h

It took 49 hours to complete the basic construction of both tunnels. Each tunnel took about the same amount of time to build.

## Installed plastic cover and the end doors on the Gothic in 2013

<table>
<thead>
<tr>
<th>Build Steps</th>
<th>Person Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>13) Install plastic</td>
<td>4 (D)</td>
</tr>
<tr>
<td>14) Install and tighten ropes over the plastic</td>
<td>4</td>
</tr>
<tr>
<td>15) Built the doors ... and then built them again ... and again</td>
<td>8 (E)</td>
</tr>
</tbody>
</table>

Sub-total: 16

Total for Gothic (24.5+16) = 40.5 h

## Fall Crops in High Tunnel - 2013

- **Spinach**: grew well until early Nov. No problems with bolting. Flavor good.
- **Radish**: grew rapidly - crop ready within 3 weeks of planting. “Fewer root maggots than in field”
- **Peas**: grew slowly in the cool, short days of fall. No problems with mildew.
- **Lettuce**: multiple crops of lettuce grown – from transplants or seed. Quality was excellent.

Need to figure out an overhead watering system that works inside tunnels.

## Gothic after 108 km/h winds (Jan 2014)

Thanks to Professional Gardener for excellent service when an emergency plastic replacement is required.
2014 Tunnel Trials

- Gothic (100” 25’)

- Supersolo (200” 25’)

Enlist
Heat Issues in the High Tunnels

Humidity Issues in the High Tunnels

No Late Blight in Tunnels

Combination of High Tunnel + Field Cover protects tomatoes through -6C + wind
2014 High Tunnels vs Low Tunnels

- Day neutral strawberries and primocane raspberries in the high tunnel continue to fruit through until November.
Thanks to …