Influence of fungicides and cultivar on development of cavity spot of carrot.

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Muck Crops Research Station, Ontario, Canada
44° 5’ N, 79° 35’ W
Pasco, Washington 46° 15’ N, 119° 10’ W
Vegetable Production in Ontario and Canada (2008 data, acres)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Ontario</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
<td>8,300</td>
<td>20,690</td>
</tr>
<tr>
<td>Onions</td>
<td>5,890</td>
<td>13,875</td>
</tr>
<tr>
<td>Lettuce</td>
<td>1,540</td>
<td>9,115</td>
</tr>
<tr>
<td>Celery</td>
<td>520</td>
<td>1,965</td>
</tr>
</tbody>
</table>

- Carrots in Ontario worth $18 million
Ontario production of carrots

About 50% of carrots (4000 acres) on muck soils
(Approx 14,000 acres of muck soil in the province)

Seeded from late April until late June,
harvested from July to November,
Kept in cold storage for 6-8 months
Cavity spot in carrots in Ontario

Field trials on muck soils each year

*Pythium* spp. isolated from cavities in 2009:

*P. violae*, 5/30

*P. ultimum* 4/30 and

*P. irregulare* 1/30

*P. sulcatum* has been isolated in the past
Field Trials

- Plots- Holland Marsh, near Muck Station Soil: 39 – 60% organic matter pH 6.7- 7.0
- Carrots seeded on raised beds 86 cm apart, 70-80 seeds/m. Plots 2 beds, 6 m long
- Seeded 29 May – 2 June
- First assessment- early harvest 11-12 weeks after seeding (August- Sept), 25 carrots
- Harvest assessment- main harvest 17-22 weeks after seeding (Oct-Nov) 50 carrots
- Cultivars: Dominion, Envy, various colours
Fungicide Trials

• **Ridomil Gold (metalaxyl-M 1.0%)**
  – 735 g/ha
  – standard fungicide, applied 14 das

• **Ranman 400SC (cyazofamid 34.5%) + Sylgard**
  – 440 ml/ha product
  – recently registered in Canada

• **Sylgard 309 (polysiloxane 80%)**
  – Surfactant
  – 150 ml/ha

Applied as a band 3 and 14 days after seeding, followed by irrigation
Fungicides and timing for control of cavity spot of carrot: harvest assessment- 2008

Percent disease

- Untreated
- Ridomil 14
- Ranman+Sylgard 14
- Sylgard 14
- Ranman+Sylgard 3
- Sylgard 3

Legend:
- b
- ab
- a
Fungicides and timing for control of cavity spot of carrot, 2 sample dates - 2008

No differences among treatments on 9 Sept, no differences between the two assessment dates. No differences in severity (11-19, 14-22 DSI).
Fungicides and timing for control of cavity spot of carrot, 2 sample dates - 2009

Very high incidence of cavity spot. No differences among treatments at either assessment, sig differences between the two assessment dates.
Fungicides and timing for control of cavity spot of carrot, 2 sample dates - 2009

High cavity spot severity. No differences among treatments at either assessment, differences between the two assessment dates.
Marketable yield in relation to fungicides and timing, 2009

Tonnes/ha

- Untreated
- Ridomil 3
- Ranman+Sylgard 14
- Ranman+Sylgard 3

Levels: a, b
Summary: Fungicides for cavity spot

Ranman plus Sylgard was effective under moderate to high disease pressure, but not under very high disease pressure.

Time of application 3 days after seeding might be best

Fungicides increased yield

Disease incidence and severity increased from Sept to Oct (6 weeks) when disease pressure was high (2009)
There is continued interest in carrots with different pigments
Carrots with different pigments

Breeding lines from ARS/USDA, Univ. of Wisconsin: 2002-2009, except 2007

<table>
<thead>
<tr>
<th>Color</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>W105-7</td>
</tr>
<tr>
<td>Yellow</td>
<td>W102-1</td>
</tr>
<tr>
<td>Dark Orange</td>
<td>W101-23</td>
</tr>
<tr>
<td>Red</td>
<td>W104-3</td>
</tr>
<tr>
<td>Purple</td>
<td>W106-3</td>
</tr>
</tbody>
</table>
## Carrots 2005-2008

<table>
<thead>
<tr>
<th>Variety</th>
<th>Color</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian</td>
<td>red</td>
<td>India</td>
</tr>
<tr>
<td>Atomic red</td>
<td>red</td>
<td>Johnny’s</td>
</tr>
<tr>
<td>Dragon</td>
<td>red</td>
<td>Garden City Seeds</td>
</tr>
<tr>
<td>Cellobunch</td>
<td>orange</td>
<td>Seminis</td>
</tr>
<tr>
<td>Envy</td>
<td>orange</td>
<td>Seminis</td>
</tr>
<tr>
<td>Ya Ya</td>
<td>orange</td>
<td>Seminis</td>
</tr>
<tr>
<td>Alpha</td>
<td>orange</td>
<td>Alpha Seeds S.A.</td>
</tr>
</tbody>
</table>

(Resistant?)
<table>
<thead>
<tr>
<th>Carrot Variety</th>
<th>Color</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mello Yello</td>
<td>yellow</td>
<td>Bejo</td>
</tr>
<tr>
<td>Amarillo Yellow</td>
<td>yellow</td>
<td>Bountiful Gardens</td>
</tr>
<tr>
<td>White Satin</td>
<td>white</td>
<td>Bejo</td>
</tr>
<tr>
<td>Crème de Lite</td>
<td>white</td>
<td>Nunhems</td>
</tr>
<tr>
<td>Cosmic Purple</td>
<td>purple</td>
<td>Johnny’s Select S</td>
</tr>
<tr>
<td>Purple Rain</td>
<td>purple</td>
<td>Bejo</td>
</tr>
<tr>
<td>Purple Haze</td>
<td>purple</td>
<td>Bejo</td>
</tr>
</tbody>
</table>
Cavity spot incidence on carrot cultivars with different pigments 2005-2008
Cavity spot on coloured carrots 2009

Percent disease

- Atomic red
- White satin
- Mello Yello
- Envy
- White
- Red
- Cellobunch
- Yellow
- Purple
- Purple Haze
Early or late development of cavity spot -2007

Incidence (%)

First bar in cluster- August, second bar harvest assessment
Early or late development of cavity spot - 2008

First bar in cluster - August, second bar harvest assessment
Weather in relation to cavity spot incidence and severity

Correlations with monthly weather
- Total rainfall per month (mm)
- Number of days with rain (over 5 mm)
- Mean air temperatures, maximum, minimum and average for month.

Severity is related to:
- Number of days with rain in August \( (r = 0.92) \)
- Total rain in July and August combined \( (r = 0.86) \)
- Minimum temperatures in August and September \( (r = 0.87) \)
  *negatively correlated with average temperatures in August, September and October, \( (r = -0.90, -0.93, -0.86) \)
- Mean maximum temp. in August and September \( (r = -0.91) \)
## Rainfall at the plot sites 2007-2009

<table>
<thead>
<tr>
<th>Year and month</th>
<th>Actual (mm)</th>
<th>Long term average</th>
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</thead>
<tbody>
<tr>
<td>2007 July</td>
<td>27</td>
<td>61</td>
</tr>
<tr>
<td>2007 August</td>
<td>33</td>
<td>57</td>
</tr>
<tr>
<td>2008 July</td>
<td>137</td>
<td>69</td>
</tr>
<tr>
<td>2008 August</td>
<td>63</td>
<td>56</td>
</tr>
<tr>
<td>2009 July</td>
<td>135</td>
<td>76</td>
</tr>
<tr>
<td>2009 August</td>
<td>89</td>
<td>57</td>
</tr>
</tbody>
</table>
Cavity spot on coloured carrots

• Cavity spot highest in red carrots, especially ‘Atomic Red,’
• Cavity spot lowest in most purple carrots, especially ‘Purple Haze’.
• Orange carrots such as ‘Cellobunch’, and ‘Envy’ were moderately susceptible to cavity spot.
• Under low disease pressure (2007) ‘Alpha’ showed some resistance, but under high disease pressure (2008) it was more susceptible than ‘Cellobunch’.
Cavity spot development

- The resistant purple cultivars develop some cavity spot early, but it doesn’t increase with time
- Others develop high levels of cavity spot early

- Paper by Fredric Suffert and Francoise Montfort

- Primary infection from inoculum in soil
- Autoinfection and alloinfection: secondary infection that follows primary infection
- Increases in disease severity = lesion size. Is this another form of resistance?
Cavity spot and coloured carrots?

Cultivar selection – red carrots are very susceptible, some purple carrots are highly resistant, most orange carrots are moderately susceptible, but there are differences!

Can’t control rainfall, but for muck soils, don’t irrigate after the end of June unless absolutely necessary. On other soils, manage irrigation carefully.

Early harvest may avoid some disease, but this depends on cultivar and the weather
All research trials are summarized in the Annual Report

Download at the Muck Station web site:

[www.uoguelph.ca/muckcrop](http://www.uoguelph.ca/muckcrop)

The report will also be on the web site of the Ontario Ministry of Agriculture, Food and Rural Affairs.
Research team

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Michael Tesfaendrias
Catarina Saude
Shawn Janse
Laura Riches
Acknowledgements

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Thank you
Questions?
A new, or emerging, disease of carrots in Ontario?

Fusarium root rot

Fusarium infection that develops in the field is unusual- it is most often seen as Fusarium dry rot in storage.
Two Fusarium species were isolated from infected carrots. One is F. solani, the second not yet identified.

Healthy carrots were inoculated.

The unidentified Fusarium caused the most disease, but both can infect carrots.