Managing Rhizoctonia Damping-off, Root and Crown Rot of Sugarbeet

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Rhizoctonia Damping-Off, Crown Rot and Root Rot

- Causal agent – *R. solani* AG-2-2 IV and IIIB
- *R. solani* will cause infection at 65 F (and higher temperatures) in wet as well as in dry conditions.
- Infections are more severe in wet conditions.
General Management Principles

- Field selection – best fields; longer rotation with non-host crops such as wheat and barley
- Avoid planting host crops such as beans (soybean, edible beans) and corn that are favorable to the pathogen just before sugarbeet
- Control weeds - chenopods
- Improve drainage; do not throw infected dirt into crown
- Plant early in cool soils
- Use Rhizoctonia tolerant varieties
- Timely application of effective fungicides
Rhizoctonia Tolerant Varieties

- **Roundup Ready Varieties**
  - BTS 88RR31 (+Aph); BTS 89RR10
  - hR* Hilleshög 4022RR (+Aph); hR* Hilleshög 4094RR(+Aph)
  - Crystal 658RR (+Aph); Crystal 875RR (+Aph)
  - hR** SESVanderhave H36811RR; (+Aph)

- **Conventional Varieties**
  - Beta 1301R (+Aph) ; Beta 1833R; Beta 1135R
  - Hilleshög 3052Rz (+Aph); Hilleshög 3035Rz (+Aph)
  - SESVanderhave H46714

[www.crystalsugar.com](http://www.crystalsugar.com); [www.sbreb.org](http://www.sbreb.org)
Rhizoctonia Damping Off
Rhizoctonia Crown Rot
Rhizoctonia Root Rot
Rhizoctonia Root Rot
At What Soil Temperature is the Fungus Infective? Which Fungicides Control the Disease?

- *R. solani* will cause infection at 65°F and higher temperatures in the presence of adequate moisture.
Inoculated, Not Treated with Quadris, and at 50 to 80 F.
Inoculated, Treated with Quadris, at 50 to 80 F
80°F – Proline Effective

- Prothioconazole
- No Prothioconazole
- Control
When Should Fungicides Be Applied for Rhizoctonia Control?

- Fungicides such as Quadris, Headline and Proline should be applied before infection takes place.
Timing of Quadris Application – At or after Inoculation

Sugar beet plants inoculation with *R. solani* AG 2-2 IIIB followed by Quadris application at different times. Non-inoculated control (A), Inoculated control (B), 0 days (C), 3 days (D), 10 days (E), 14 days (F), 21 days (G).
Timing of Quadris Application – Early, Before Inoculation

Sugar beet plants treated with Quadris followed by inoculation with *R. solani AG 2-2 IIIB* at different times. 0 days (A), 7 days (B), 14 days (C), 21 days (D), and 28 days (E).
When Should Fungicides be Applied to Control Rhizoctonia Root Rot?

- Just before infection takes place.
- Since infection takes place when the soil temperature at the 4” depth is 65 F, fungicides should be applied when the soil temperature at the 4” depth is about 60 to 62 F (just before a rain event), irrespective of the plant size or leaf stage.
Which Fungicides are effective at Controlling Rhizoctonia Root Rot in Field Conditions (in a Normal Year)?
Growers Field (Rob Ehlert, Foxhome, MN) – Natural Inoculum -Non-treated Check
1 Application Quadris 9.2 fl oz/A
1 Application Proline 5.7 fl oz/A
### Infection in mid to late June - Fungicidal Control, 2009, MN

<table>
<thead>
<tr>
<th>Treatments/A</th>
<th>Application date</th>
<th>Mortality/100’ row</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-treated Check</td>
<td>-</td>
<td>37</td>
</tr>
<tr>
<td>Quadris 9.2 fl oz</td>
<td>16 June</td>
<td>2</td>
</tr>
<tr>
<td>Quadris 9.2 fl oz</td>
<td>16, 29 June</td>
<td>2</td>
</tr>
<tr>
<td>Proline 5.7 fl oz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+NIS 0.125% v/v</td>
<td>16 June</td>
<td>7</td>
</tr>
<tr>
<td>Proline 5.7 fl oz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+NIS 0.125% v/v</td>
<td>16, 29 June</td>
<td>5</td>
</tr>
</tbody>
</table>

*LSD (0.05)*: 12
Summary

- In a typical year – cool (45 to 52 F) at planting and soil temperature reaching 65 F in mid-June – one application of Quadris or Proline when the average soil temperature is about 60 to 62 F will provide effective Rhizoctonia root rot control.
In Minnesota and North Dakota, average soil temperature at the 4 inch soil depth reached 65 F in mid-May in 2010 and early June (2-5) in 2011; most fields were wet and thus environmental conditions were favorable for damping-off and root rot infections of sugarbeet that were present as seedlings to 4-leaf stage.
Will an In-furrow Application of Fungicide Control Rhizoctonia Root Rot?
Effect of In-furrow Applications
Glyndon, MN – 2011 - Check

6 row plots; Inner 4 rows are treated (or not treated) with fungicides
Quadris 9.2 fl oz/A
Headline 9.1 fl oz/A
Headline 6 fl oz/A
Non-treated Check
Quadris 9.2 fl oz/A
Headline 9.1 fl oz/A
Headline 6 fl oz/A
# Glyndon 2011 Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate fl oz/A</th>
<th>Rec. Sugar Lb/Ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inoculated Check</td>
<td>-</td>
<td>3132</td>
</tr>
<tr>
<td>2. Quadris (In-furrow)</td>
<td>9.2</td>
<td>6126</td>
</tr>
<tr>
<td>3. Headline (In-furrow)</td>
<td>6</td>
<td>4687</td>
</tr>
<tr>
<td>4. Headline (In-furrow)</td>
<td>9.1</td>
<td>4532</td>
</tr>
<tr>
<td>5. Headline (In-furrow)/Quadris</td>
<td>6/9.2</td>
<td>4913</td>
</tr>
<tr>
<td>6. Headline (In-furrow)/Quadris/Proline</td>
<td>6/9.2/5.7</td>
<td>5030</td>
</tr>
</tbody>
</table>

LSD (0.05): 1326
Summary

Quadris at 9.2 fl oz was most effective at controlling *Rhizoctonia solani* when applied in-furrow in an inoculated soil where conditions became favorable for infection soon after planting.
Can Post-Applications of Quadris – After Soil Temperature of 65 F has been Attained – Help to Control *R. solani*?
Daily Average Bare Soil Temperature (4in Depth)
North Dakota Agricultural Weather Network (NDAWN)
## Effect of Post Applications (Band and Broadcast) of Quadris on *R. solani*; (1 vs 2 Applications)

### Treatment

<table>
<thead>
<tr>
<th>(Quadris 9.2 fl oz)</th>
<th>6/6</th>
<th>6/30</th>
<th>8/10</th>
<th>9/28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inoculated Check</td>
<td>197</td>
<td>134</td>
<td>68</td>
<td>42</td>
</tr>
<tr>
<td>Band, June 9</td>
<td>189</td>
<td>153</td>
<td>117</td>
<td>91</td>
</tr>
<tr>
<td>Broadcast, June 9</td>
<td>192</td>
<td>162</td>
<td>121</td>
<td>83</td>
</tr>
<tr>
<td>Band, June 9 and 20</td>
<td>209</td>
<td>195</td>
<td>178</td>
<td>159</td>
</tr>
<tr>
<td>Broadcast, June 9 and 20</td>
<td>189</td>
<td>172</td>
<td>158</td>
<td>132</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>NS</td>
<td>21</td>
<td>38</td>
<td>45</td>
</tr>
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</table>

**Inoculated Nontreated Check**

**Quadris – Band June 9 & 20**

**Quadris- B/cast June 9 & 20**
## Effect of Post Applications (Band and Broadcast) of Quadris on *R. solani*; (1 vs 2 Applications)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stand 9/28</th>
<th>Yield</th>
<th>RSA</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(Quadris 9.2 fl oz)</em></td>
<td>Count/100’</td>
<td>(T/A)</td>
<td>(lb/A)</td>
</tr>
<tr>
<td>Inoculated Check</td>
<td>42</td>
<td>9.4</td>
<td>3881</td>
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<tr>
<td>Band, June 9</td>
<td>91</td>
<td>19.0</td>
<td>4852</td>
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<tr>
<td>Broadcast, June 9</td>
<td>83</td>
<td>16.4</td>
<td>4795</td>
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<tr>
<td>Band, June 9 and 20</td>
<td>159</td>
<td>26.2</td>
<td>7451</td>
</tr>
<tr>
<td>Broadcast, June 9 and 20</td>
<td>132</td>
<td>23.0</td>
<td>6165</td>
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<tr>
<td>LSD (P=0.05)</td>
<td>45</td>
<td>6.1</td>
<td>1511</td>
</tr>
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</table>

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*Inoculated Nontreated Check*

*Quadris – Band June 9 & 20*

*Quadris- B/cast June 9 & 20*
Summary – Quadris Post Application

➢ Two post-applications of Quadris, with the first applied about one week after average soil temperature of 65 F at the 4” depth was attained, generally provided better plant stand, yield and recoverable sucrose than one post-application and the non-treated check.

➢ Note plants were at Cotyledon-2 If and 4-6 If stages at fungicide applications.
Is it better to Apply Fungicides in a T-Band Compared to a Stream Application In-Furrow? You Apply Fungicides in Water @ 23 GPA; Will Growers Get Similar Disease Control When Using Lower Water Volumes?
In-Furrow Application Method

- **Fungicides**
  - Quadris @ 9.2 fl oz A
  - Headline @ 12 fl oz A

- **Nozzle Configurations**
  - TeeJet 0004 StreamJet nozzle
    - 23 gal A – solid stream
  - #35 orifice plate
    - 9 gal A – solid stream
  - TeeJet 4002 E flat fan nozzle
    - 16 gal A – 3” T-band
Nontreated Check
Quadris – 14.3 fl oz; 23 gpa; Stream In-furrow Application
Quadris – 14.3 fl oz; 9 gpa; Stream In-furrow Application
Quadris – 14.3 fl oz; 16 gpa; ‘T’-Band Application
Headline 12 fl oz; 23 gpa; Stream In-furrow Application
Headline 12 fl oz; 9 gpa; Stream In-furrow Application
Headline 12 fl oz; 16 gpa; ‘T’-Band Application
# Effect of Water Volume and Stream vs. ‘T’-Band Applications

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield Fl oz/GPA</th>
<th>Rec Sucrose T/A</th>
<th>Rec Sucrose lb/Ac</th>
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<tbody>
<tr>
<td>Check</td>
<td>15.9</td>
<td>4146*</td>
<td></td>
</tr>
<tr>
<td>Quadris 14.3/23</td>
<td>22.5</td>
<td>6475</td>
<td></td>
</tr>
<tr>
<td>Quadris 14.3/9</td>
<td>23.5</td>
<td>6770</td>
<td></td>
</tr>
<tr>
<td>Quadris 14.3/16 ‘T’</td>
<td>24.7</td>
<td>6820</td>
<td></td>
</tr>
<tr>
<td>Headline 12/23</td>
<td>20.3</td>
<td>5269*</td>
<td></td>
</tr>
<tr>
<td>Headline 12/9</td>
<td>22.9</td>
<td>6537</td>
<td></td>
</tr>
<tr>
<td>Headline 12/16 ‘T’</td>
<td>22.0</td>
<td>6632</td>
<td></td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>2.8</td>
<td>935</td>
<td></td>
</tr>
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</table>
Both Quadris (14.3 fl oz) and Headline (12 fl oz) at high rates were effective at controlling *Rhizoctonia solani* when applied in-furrow in an inoculated soil where conditions became favorable for infection soon after planting.

Headline in water at 23 GPA resulted in significantly lower recoverable sucrose compared to when applied with water at 9 GPA and 16 GPA; ‘T’-band may be safer than stream application.
Can Fungicides Mixed With Starter Fertilizer (10-34-0 @ 3 GPA) Provide Effective Rhizoctonia Control and Not be Phytotoxic to Plants?
Non-treated Check
Quadris 14.3 fl oz +10-34-0
Headline 12 fl oz +10-34-0
Headline 6 fl oz +10-34-0
Experimental 1 + 10-34-0
Experimental 2 +10-34-0
Experimental 1 on Seed+10-34-0
Dynasty Seed Trt +10-34-0
10-34-0
3 gal/A
In-Furrow
Quadris 14.3 fl oz/a
+ 10-34-0 3 gal/a
In-Furrow
Vertisan 38 fl oz/a
+ 10-34-0 3 gal/a
In-Furrow
Headline  12 fl oz/a
+ 
10-34-0  3 gal/a
In-Furrow
Headline 6 fl oz/a
+ 10-34-0 3 gal/a
In-Furrow
Penthiopyrad / At plant
+ 10-34-0 3 gal/a
In-Furrow
Dynasty / At plant + 10-34-0 3 gal/a In-Furrow
Quadris 9.2 fl oz +
10-34-0 3 gal/A

Check
Quadris 9.2 fl oz + 10-34-0 3 gal/A

10-34-0 3 gal/A
Quadris 9.2 fl oz + 10-34-0 3 gal/A

Quadris 14.3 fl oz + 10-34-0 3 gal/A
Quadris 9.2 fl oz + 10-34-0 3 gal/A

Headline 12 fl oz + 10-34-0 3 gal/A
Quadris 9.2 fl oz + 10-34-0 3 gal/A

Headline 6 fl oz + 10-34-0 3 gal/A
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield</th>
<th>Sucrose</th>
<th>Rec Sucrose/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>fl oz/ 23GPA</td>
<td>T/A (%)</td>
<td>(lb/Ac)</td>
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</tr>
<tr>
<td>Non-treated Check</td>
<td>18.0</td>
<td>14.5</td>
<td>4515 e</td>
</tr>
<tr>
<td>10-34-0 Check</td>
<td>16.4</td>
<td>14.8</td>
<td>4228 e</td>
</tr>
<tr>
<td>Quadris 9.2</td>
<td>27.2</td>
<td>15.8</td>
<td>7629 a</td>
</tr>
<tr>
<td>Quadris 14.3</td>
<td>25.2</td>
<td>16.3</td>
<td>7367 ab</td>
</tr>
<tr>
<td>Headline 6</td>
<td>20.5</td>
<td>15.4</td>
<td>5502 cde</td>
</tr>
<tr>
<td>Headline 12</td>
<td>22.0</td>
<td>15.8</td>
<td>6158 bc</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>4.5</td>
<td>1.2</td>
<td>1373</td>
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</table>
Summary

- No phytotoxicity was observed when Quadris and Headline were mixed with 10-34-0. However, Headline reduced or delayed emergence.
- Headline at 12 fl oz generally resulted in better disease control and higher yield and recoverable sucrose than Headline at 6 fl oz.
- Quadris applied in-furrow at 9.2 fl oz/A resulted in greatest extractable sucrose.
Should Sugar Beet be Treated with Quadris for Controlling 
*R. solani* Before the 4-Leaf Stage in Conditions Favorable for Infection?
I planted sugar beet in a field with a history of Rhizoctonia root rot rot when the soil temperature at the 4 inch depth was 55 F. My beets are just emerging. The meteorologist predicted that there will be very warm weather next week and the soil temperature will probably reach 65 F. Should I apply Quadris now or should I wait for the plants to become older (4 to 6 leaf beet)?
Quadris at 9.2 fl oz/A provided protection from *R. solani* in-furrow, banded soil surface, and foliar applications to sugarbeet as seed, cotyledonary, 2-leaf and 4-leaf stages.
Summary

Since *R. solani* infects susceptible sugar beet when the soil temperature at the four inch depth averages 65 F and in the presence of adequate moisture, sugar beet, irrespective of growth stage, should be protected from *R. solani* infection with an application of Quadris before the average soil temperature reaches 65 F.
Is there any seed treatment that can be used to provide early season Rhizoctonia control?

Penthiopyrad – broad spectrum
Succinate dehydrogenase inhibitor (SDHI) – binds to ubiquinone binding pocket and inhibits mitochondrial activities
Managing *Rhizoctonia solani* with Seed Treatment + Quadris 9.2 fl oz/A; 2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stand Count/50’</th>
<th>Yield (T/A)</th>
<th>RSA (lb/A)</th>
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</thead>
<tbody>
<tr>
<td>Inoculated Check</td>
<td>48</td>
<td>16.0</td>
<td>5068</td>
</tr>
<tr>
<td>Quadris (Band; 2 Jun)</td>
<td>51</td>
<td>20.2</td>
<td>6396</td>
</tr>
<tr>
<td><strong>Quadris (If)/Quadris(B)</strong></td>
<td>84</td>
<td>25.7</td>
<td>8397</td>
</tr>
<tr>
<td>Penthiopyrad 14 g a.i (Seed treatment)</td>
<td>57</td>
<td>18.0</td>
<td>5788</td>
</tr>
<tr>
<td><strong>Pent. 14 g a.i/Quadris(B)</strong></td>
<td>73</td>
<td>26.7</td>
<td>8506</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>14</td>
<td>6.6</td>
<td>2174</td>
</tr>
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</table>
Resistant Variety: Quadris Foliar
Resistant Variety: Quadris In-furrow / Quadris Foliar
Resistant Variety: Penthioapyrad 14 g ai
Resistant Variety: Penthiopyrad 14 g ai / Quadris Foliar
Managing *Rhizoctonia solani* of Tolerant Variety with Seed Treatment + Quadris 9.2 fl oz/A; 2011

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stand</th>
<th>Yield</th>
<th>RSA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count/100’</td>
<td>(T/A)</td>
<td>(lb/A)</td>
</tr>
<tr>
<td>Inoculated Check</td>
<td>133</td>
<td>21.2</td>
<td>5414</td>
</tr>
<tr>
<td>Quadris (In-furrow A)</td>
<td>169</td>
<td>26.2</td>
<td>7567</td>
</tr>
<tr>
<td>Penthiopyrad 14 g a.i</td>
<td>154</td>
<td>24.3</td>
<td>6443</td>
</tr>
<tr>
<td>(Seed treatment)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quadris (Band; B)</td>
<td>160</td>
<td>25.2</td>
<td>6839</td>
</tr>
<tr>
<td>Quadris (IF, A)/Quadris(B)</td>
<td>164</td>
<td>28.8</td>
<td>8153</td>
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<tr>
<td>Pent. 14 g a.i/Quadris(B)</td>
<td>181</td>
<td>26.2</td>
<td>7882</td>
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Managing *R. solani* on Tolerant Variety with Seed Treatment + Quadris 9.2 fl oz/A; Early Planted - May 18, 2011

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stand</th>
<th>Yield</th>
<th>RSA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>May 18(A), June 9 (B)</strong></td>
<td><strong>Count/100’</strong></td>
<td><strong>(T/A)</strong></td>
<td><strong>(lb/A)</strong></td>
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<tr>
<td>Inoculated Check</td>
<td>133</td>
<td>21.2</td>
<td>5414</td>
</tr>
<tr>
<td>Pent. 7 g a.i</td>
<td>156</td>
<td>24.6</td>
<td>6586</td>
</tr>
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<td>Pent. 7 g a.i/ Quadris</td>
<td>186</td>
<td>25.2</td>
<td>6883</td>
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<td>Penthiopyrad 14 g a.i</td>
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<td>24.3</td>
<td>6443</td>
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<tr>
<td>Pent. 14 g a.i/Quadris</td>
<td>181</td>
<td>26.2</td>
<td>7882</td>
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<tr>
<td>Pent. 28 g a.i</td>
<td>174</td>
<td>26.5</td>
<td>7421</td>
</tr>
<tr>
<td>Pent. 28 g a.i/ Quadris</td>
<td>189</td>
<td>25.7</td>
<td>6925</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>25</td>
<td>3</td>
<td>800</td>
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</tbody>
</table>
Summary – Seed Treatment

- Penthiopyrad, as a seed treatment, provided good early season control against *R. solani*.
- The combination of penthiopyrad as a seed treatment and a timely foliar application of Quadris provided effective control of *Rhizoctonia solani*.
Conclusions – In-furrow Applications

- Fungicide protection is needed when planting in warm, moist soils with a history of *R. solani*.
- There may be some stand loss when fungicides are applied alone or with starter fertilizers as an in-furrow application.
- Headline tend to reduce stand more than Quadris when applied in-furrow.
- ‘T’ – band may be safer than ‘stream’ in-furrow application.
Conclusions – In-furrow Applications

➢ Please read and follow your fungicide labels – you use fungicides with a starter fertilizer/or insecticide/herbicide (or any other product at your own risk).
Conclusions – Band vs Broadcast

- 7” band application typically provides better disease control than broadcast application.
- However, when it is wet and warm (approaching 65 F), it is better to apply a broadcast application (aircraft) rather than doing nothing.
Conclusions - Action

- In fields with a history of very little Rhizoctonia – one post application of Quadris when the average temperature at the 4” soil depth is 60 to 62 F will adequately control the disease.

- In fields with a history of moderate to severe disease, use Rhizoctonia tolerant varieties, an in-furrow, and post application of fungicides when the average temperature at the 4” soil depth is 60 to 62 F.
Conclusions – Timeliness

- In fields with a history of severe disease, if an effective fungicide could not be applied before the average temperature at the 4” soil depth reaches 65°F, two post applications (with the first as soon as possible after 65°F) of Quadris 10 to 14 days apart may help to control *R. solani* (based on one year’s field data).

- Thank you!!!
Six rows – Fusarium Tolerant Variety
Six rows - Fusarium Susceptible Variety
Effect of precipitated calcium carbonate (Waste lime) on Fusarium susceptible variety
Symptoms on seedling
Effect of precipitated calcium carbonate on 
Rhizoctonia Root Rot
Summary – Precipitated Calcium Carbonate

- Precipitated calcium carbonate resulted in improved plant populations at both the Rhizoctonia and Fusarium infested sites. However, disease pressure was very severe resulting in poor yields of the surviving plants. An integrated management system that includes tolerant varieties, timely application of fungicides, and precipitated calcium carbonate will lead to better control of soil-borne diseases of sugarbeet.

- Thank you!!!
Acknowledgements – Thank You

- Growers through the SBREB for funding my research and educational programs.
- Seed, chemical and allied industries, and agriculturists and consultants for assistance.
- Kevin Etzler, Vince Ulstad, and Kevin Nelson for research conducted on their farms.
- Personnel at ACSC tare laboratory, East Grand Forks.
- Colleagues at NDSU for assistance in harvesting.
- Aaron Carlson – conducting trials.