Leaf Rust in Spring Wheat

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USDA-ARS Cereal Disease Laboratory, St. Paul MN
Leaf Rust - *Puccinia triticina*

- Most common disease in spring wheat
- Occurs annually - guaranteed!!
- Losses can be severe
The Pathogen - *Puccinia triticina*

- Leaf rust spores 15-30µ in diameter
- Spores germinate in dew on leaf surface - 60 F optimal
- Infections develop in leaves - break leaf surface after 7 days - produce new spores at 8 days
- Spores carried in southerly winds for thousands of kilometers.
Wheat Leaf Rust Life Cycle

Life Cycle of *Puccinia* spp. on Wheat

- aecia on alternate host dikaryotization (n+n)
- aeciospores (n+n) airborne
- urediniospores (n+n) airborne
- uredinia on wheat from infection by aeciospores or urediospores
- telia on wheat straw
- pycnia on alternate host from infection by basidiospores
- basidiospore (n) airborne
- meiosis
- karyogamy (2n)
- teliospore on wheat straw (n+n)
Spread of Wheat Leaf Rust
Spread of Wheat Leaf Rust

- First seen in Texas - March
- Can survive on winter wheat from Texas to South Dakota - Rosemount in 2005
- First seen in Minnesota, end of May on winter wheat - mid June on spring wheat
Yield Losses

- Can be severe
- Higher yield loss if initial infections occur before heading
- Higher yield loss if temp. > 75 F after wheat headed
- Susceptible cultivars have greater loss
Yield Losses - 2004 Morris

(bushels/acre)

Oxen 17% 90
Knudson 4% 100
Reeder 12% 100
Briggs 9% 100
Oklee 12% 100
Marshall 36% 90

Without fungicide vs Fungicide
Leaf Rust in Minnesota

- First seen mid June on spring wheat - Red River Valley
- First week of July present on flag leaves
- Maximum disease level mid July at Morris
- Maximum disease level end of July - first week of August at Crookston
Leaf Rust Resistance in Spring Wheats

- Oxen - Susceptible - 17% loss
- Knudson - Resistant - 4% loss
- Alsen - Moderate Resistance - 9% loss
- Reeder - Susceptible - 12% loss
- Parshall - Susceptible - 24% loss
- Briggs - Resistant - 9% loss
- Oklee - MR - MS - 12% loss
- Ulen - Moderate Resistant
- Steele - Resistant
- Glenn - Resistant
Knudson - Very Resistant
Alsen - Moderately Resistant - Moderately Susceptible
Oxen- Moderately Susceptible
Thatcher - Very Susceptible
Leaf Rust Resistance in Spring Wheat

• Cultivars differ for leaf rust resistance genes
• New races of leaf rust increase - attack previously resistant cultivars
• Cultivars become susceptible over time - changes in races
• Most efficient method to reduce loss
Stripe Rust in Spring Wheat

- *Puccinia striiformis*
- More common in recent years
- Higher levels in winter wheats - spores migrate north
- Most hard red spring wheats are resistant to stripe rust
Stripe Rust in Spring Wheat

- Cool temperature rust
- Spores germinate and infect in cool wet weather
- Temps > 80 F stripe rust infections die off
- Not common in MN due to hot weather in July and resistant cultivars
Fungicide Sprays

• Apply to preserve high yield potential
• Applied with herbicide when wheat is tillering - Tilt, Stratego
• Applied at heading - prevent FHB infection - Folicur
• Highly effective in preventing leaf rust, cost of chemicals becoming more affordable
Roundup - Ready Wheat

• Monsanto - projects with various wheat breeding programs - J. A. Anderson Univ. of Minnesota

• Program ended due to lack of consumer acceptance - GMO concerns about “genes” in wheat

• All Roundup ready wheat materials destroyed or returned to Monsanto
Leaf Rust in Roundup Ready Wheat

- 2000 - RR wheat plots treated with Roundup had no leaf rust infections for two weeks following application of Roundup (glyphosate) at boot stage.
- Other treatments with an earlier Roundup application 21 days before boot stage had high leaf rust infection.
# Effects of Glyphosate on Leaf Rust - Adult Plants Greenhouse

<table>
<thead>
<tr>
<th>Wheat Line</th>
<th>Water + Surfactant</th>
<th>Glyphosate</th>
</tr>
</thead>
<tbody>
<tr>
<td>HJ98 RR</td>
<td>High Rust</td>
<td>No Rust</td>
</tr>
<tr>
<td>McVey RR</td>
<td>High Rust</td>
<td>No Rust</td>
</tr>
<tr>
<td>Oklee RR</td>
<td>Moderate Rust</td>
<td>No Rust</td>
</tr>
</tbody>
</table>
Effects of Glyphosate on Leaf Rust - Adult Plants Greenhouse

- Plants treated with water + surfactant or glyphosate at boot stage
- Plants inoculated with leaf rust 21 days later

Water | Glyphosate
--- | ---
McVey RR

![Image of leaf rust symptoms on plants treated with water and glyphosate]
## Leaf Rust Ratings - Field Plots

<table>
<thead>
<tr>
<th>Wheat</th>
<th>Gly. App (DAP)</th>
<th>Days Trt-rating</th>
<th>76 DAP</th>
<th>Days Trt-rating</th>
<th>82 DAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oklee RR</td>
<td>None</td>
<td>------</td>
<td>30 S</td>
<td>------</td>
<td>40 S</td>
</tr>
<tr>
<td>Oklee RR</td>
<td>42</td>
<td>34</td>
<td>20 S</td>
<td>40</td>
<td>60 S</td>
</tr>
<tr>
<td>Oklee RR</td>
<td>49</td>
<td>27</td>
<td>5 MR</td>
<td>33</td>
<td>10 MR</td>
</tr>
<tr>
<td>Oklee RR</td>
<td>56</td>
<td>20</td>
<td>0</td>
<td>26</td>
<td>5 MR</td>
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<tr>
<td>Oklee RR</td>
<td>63</td>
<td>13</td>
<td>0</td>
<td>19</td>
<td>0</td>
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<tr>
<td>Oklee RR</td>
<td>84</td>
<td>--6</td>
<td>40 S</td>
<td>--2</td>
<td>60 S</td>
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</tbody>
</table>
## Rate and Timing of Glyphosate - Greenhouse Test

<table>
<thead>
<tr>
<th>Wheat</th>
<th>Rate</th>
<th>Timing</th>
<th>Rust</th>
</tr>
</thead>
<tbody>
<tr>
<td>HJ 98 RR</td>
<td>0.5X</td>
<td>3 leaf</td>
<td>0</td>
</tr>
<tr>
<td>HJ 98 RR</td>
<td>1.0X</td>
<td>3 leaf</td>
<td>0</td>
</tr>
<tr>
<td>HJ 98 RR</td>
<td>2.0X</td>
<td>3 leaf</td>
<td>0</td>
</tr>
<tr>
<td>HJ 98 RR</td>
<td>0.5X</td>
<td>5 leaf</td>
<td>High</td>
</tr>
<tr>
<td>HJ 98 RR</td>
<td>1.0X</td>
<td>5 leaf</td>
<td>High</td>
</tr>
<tr>
<td>HJ 98 RR</td>
<td>2.0X</td>
<td>5 leaf</td>
<td>High</td>
</tr>
</tbody>
</table>

Plants inoculated with rust at 3 leaf stage - glyphosate trt at 3 leaf and 5 leaf stage
Glyphosate Effects

- Outside leaves - untreated controls
- Inside leaves - treated with glyphosate
## Glyphosate Timing and Application Rate - Field Plots

<table>
<thead>
<tr>
<th>Wheat</th>
<th>Rate</th>
<th>DAP</th>
<th>74 DAP</th>
<th>77 DAP</th>
<th>81 DAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingot RR</td>
<td>None</td>
<td>None</td>
<td>5 S</td>
<td>20 S</td>
<td>40 S</td>
</tr>
<tr>
<td>Ingot RR</td>
<td>1.0X</td>
<td>31</td>
<td>5 S</td>
<td>20 S</td>
<td>30 S</td>
</tr>
<tr>
<td>Ingot RR</td>
<td>0.5X</td>
<td>38</td>
<td>trace</td>
<td>10 S</td>
<td>30 S</td>
</tr>
<tr>
<td>Ingot RR</td>
<td>1.0X</td>
<td>38</td>
<td>0</td>
<td>5 S</td>
<td>10 S</td>
</tr>
<tr>
<td>Ingot RR</td>
<td>2.0X</td>
<td>38</td>
<td>0</td>
<td>0</td>
<td>5 S</td>
</tr>
</tbody>
</table>
2002 Field Observations

- 2002 Field observations indicate longer retention of green leaf tissue in Roundup-treated plots

Outside rows = controls
Inside rows = Glyphosate treated
Glyphosate - Stem Rust

- Same effect of glyphosate giving resistance to stem rust in greenhouse tests
- No effect on FHB in greenhouse tests or field plots
Effects of Glyphosate

- Glyphosate transported throughout wheat plant
- Glyphosate conditioned systemic resistance to leaf rust
- Glyphosate inhibited spore germination in lab tests
- Glyphosate inhibits infection and establishment of rust in plants
Future of Roundup Ready Wheat

- Consumer acceptance critical
- Other crops, corn, soybean, GMOs common
- Other advantages may be needed for RR wheat to be accepted
- Glyphosate - RR Soybeans - reduce losses to soybean rust?
Leaf Rust in Spring Wheat

• Plant resistant cultivars reduce losses
• Fungicide treatments viable to maintain high yield potential