Northwest Kansas Research Update

Lucas Haag Ph.D., Asst. Professor/Northwest Area Agronomist
K-State Northwest Research-Extension Center, Colby

NW Area Agronomy Research Program

• Conduct applied research relevant to the 29 county territory and the region
• 100% Funded by Industry
  – Contract projects with private firms
    (Valent Biosciences, Deere & Co., Syngenta, etc.)
  – Field Pea Performance Test Entries
  – Cover Your Acres Proceeds
• Industry funds also subsidize my extension activities
Outline

• Wheat
  – Solid-Stem Wheat Varieties
  – In-Furrow Urea
  – Variety x Seeding Rate
  – Durum Wheat Management
• Peas
  – Variety Testing
  – Seeding Rates
  – Winter Peas
• Corn
  – Dryland Hybrid x Seeding Rate
• Challenges, Opportunities, Priorities

Adaptability of Northern Plains Solid-Stemmed Wheat to Northwest Kansas

Lucas Haag, Assistant Professor and Northwest Area Agronomist
K-State Northwest Research-Extension Center, Colby Kansas
lhaag@ksu.edu, (785) 462-6281, Twitter: @LucasAHaag

Jeanne Falk Jones, Multi-County Agronomist,
K-State Northwest Research-Extension Center, Colby, Kansas

Alan Schlegel, Professor and Agronomist-in-Charge,
K-State Southwest Research-Extension Center, Tribune, Kansas
Wheat Stem Sawfly

- Adults emerge late May or early June
- ¾” long, smokey-brown wings
- Flight period 3-6 weeks
- Females lay 30-50 eggs (one per plant)
- Larvae move down to base of plant, cut stem and pack frass behind them
- Wheat plants then lodge, almost immediately prior to harvest

Wheat Stem Sawfly

- Has infested spring wheat in the Northern Plains for decades
- Moved into winter wheat in the 1980’s
- Infestations first noticed in Northeast Colorado in 2010
Cropping Systems Impact

• Intensified rotations in the Central Great Plains rely on good stubble

• Good news on stubble height and parasitoids
  – One more good reason to adopt stripper head technology

• Control options (other than solid stem) are counter-productive to high plains dryland production = residue destruction
Materials and Methods

- 10 Site-years (Tribune-4, Colby-4, Herndon-2)
- RCBD with 4 replications, plots 5’ x 40’
- Seeded at 60 (Tribune) or 90 lb ac\(^{-1}\) (Colby, Herndon)
- Machine harvested for yield
- Biomass and Yield Components
- Heading Date (Tribune)

Varieties Evaluated

<table>
<thead>
<tr>
<th>Variety</th>
<th>Source</th>
<th>Type</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denali</td>
<td>CSU</td>
<td>Local</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Gangin</td>
<td>CSU</td>
<td>Local</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Taelal</td>
<td>TAAAU</td>
<td>Local</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Menhah</td>
<td>KSU</td>
<td>Local</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>K-State4</td>
<td>KSU</td>
<td>Local Experimental</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redman</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>York</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Taeul</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Jetul</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Heul</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>York5</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Suir</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Waseir</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Wistle</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Wistle2</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Taeu</td>
<td>MSU</td>
<td>Solid-Stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Liurn</td>
<td>MSU</td>
<td>Montana Yellow-Stem</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Tribune Heading Date

<table>
<thead>
<tr>
<th>Variety</th>
<th>2014 Heading Date</th>
<th>2015 Heading Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAM112</td>
<td>May 15.5 a</td>
<td>May 4.5 a</td>
</tr>
<tr>
<td>TAM111</td>
<td>May 18.8 b</td>
<td>Winterhawk 6.3 b</td>
</tr>
<tr>
<td>Norris</td>
<td>May 19.3 b</td>
<td>Norris 7.0 b</td>
</tr>
<tr>
<td>Bynum</td>
<td>May 20.8 c</td>
<td>TAM111 7.5 b</td>
</tr>
<tr>
<td>Denali</td>
<td>May 21.3 c</td>
<td>Bynum 11.3 c</td>
</tr>
<tr>
<td>Bearpaw</td>
<td>May 22.3 d</td>
<td>Denali 12.0 c</td>
</tr>
<tr>
<td>Judee</td>
<td>May 22.5 d</td>
<td>Rampart 14.0 d</td>
</tr>
<tr>
<td>Genou</td>
<td>May 22.8 d</td>
<td>Judee 14.5 d</td>
</tr>
<tr>
<td>Rampart</td>
<td>May 23.0 d</td>
<td>Bearpaw 14.5 d</td>
</tr>
<tr>
<td>Warhorse</td>
<td>May 24.0 e</td>
<td>Genou 16.3 e</td>
</tr>
</tbody>
</table>

† Letters within a column and an effect represent differences at LSD (0.05) unless noted otherwise

### 2014-2017 Yields

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Mean Yield of Local Varities</th>
<th>Mean Yield of Solid-Stemmed Varities</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>Tribune</td>
<td>59.7</td>
<td>39.7</td>
<td>66%</td>
</tr>
<tr>
<td></td>
<td>Colby</td>
<td>74.3</td>
<td>66.0</td>
<td>89%</td>
</tr>
<tr>
<td>2015</td>
<td>Tribune</td>
<td>60.0</td>
<td>53.4</td>
<td>89%</td>
</tr>
<tr>
<td></td>
<td>Colby</td>
<td>37.3</td>
<td>36.7</td>
<td>99%</td>
</tr>
<tr>
<td></td>
<td>Herndon</td>
<td>27.4</td>
<td>24.7</td>
<td>90%</td>
</tr>
<tr>
<td>2016</td>
<td>Tribune</td>
<td>84.3</td>
<td>70.3</td>
<td>83%</td>
</tr>
<tr>
<td></td>
<td>Colby</td>
<td>85.5</td>
<td>72.6</td>
<td>85%</td>
</tr>
<tr>
<td></td>
<td>Herndon</td>
<td>73.5</td>
<td>65.6</td>
<td>89%</td>
</tr>
<tr>
<td>2017</td>
<td>Tribune</td>
<td>55.8</td>
<td>31.4</td>
<td>56%</td>
</tr>
<tr>
<td></td>
<td>Colby</td>
<td>89.6</td>
<td>59.6</td>
<td>67%</td>
</tr>
</tbody>
</table>

Max 99%
Min 56%
Average 81%
Conclusions

• Solid stemmed wheats from the Northern Plains can be consistently grown in Northwest Kansas
• A reduction in yield should be expected
• If sawfly advances rapidly, these varieties could be used as a stop-gap until locally adapted varieties become available

In-Furrow Placement of Enhanced Urea Products with Wheat

Lucas Haag, Ph.D., Assistant Professor and Northwest Area Agronomist
Northwest-Research-Extension Center, Colby

Alan Schlegel, Ph.D., Professor and Agronomist-in-Charge
Southwest Research-Extension Center, Tribune

Dorivar Ruiz-Diaz, Ph.D., Associate Professor and Soil Fertility Specialist
Department of Agronomy, Manhattan
In-Furrow Urea Materials and Methods

- Western Sites: No-till into chem-fallow, Certified CSU-Byrd, target 1.05 million seeds/ac
- Hunter 2017: No-till into wheat stubble, Certified KSU-Larry
- Treatments (in addition to grower practice):
  - 10, 20, 30, 60 lbs/ac N as ESN, NBPT, or Urea
  - MAP to get 10 lbs/ac N (91 lbs/ac of MAP)
  - Control
- Locations:
  - Tribune, Colby, Herndon, and Hunter (2017)
- Measurements
  - Fall stand count
  - Spring Vigor
  - Head Counts
  - Grain Yield and Protein

Visual – Mitchell Co. 2/9/17

60 lb/ac Urea  60 lb/ac ESN
Fall Winter Wheat Stand, Across 8 Site-Years

N Source and Rate Applied With Seed at Planting, lbs/ac

Wheat Grain Yield Across Years

N Source and Rate Applied With Seed at Planting, lbs/ac
Conclusions

• Some indication that ESN and NBPT coated urea provides some safety over untreated urea if used in-furrow
• Not enough site-years yet to truly evaluate the risk of various levels
• Low levels (10 lb/ac) of ESN urea appear to offer minimal risk

Wheat Variety x Seeding Rate Study

Alan Schlegel, Ph.D., Professor and Agronomist-in-Charge
Southwest Research-Extension Center, Tribune

John Holman, Ph.D., Associate Professor and Cropping Systems Agronomist
Southwest Research-Extension Center, Garden City

Lucas Haag, Ph.D., Assistant Professor and Northwest Area Agronomist
Northwest-Research-Extension Center, Colby
Wheat Variety x Seeding Rate Study

Questions:
1. Are current seeding rate recommendations appropriate for current varieties
2. Is there a need for variety specific seeding rate recommendations OTHER THAN adjusting for seeds per lb.

• 2014 preliminary study at Garden City and Tribune
  – Garden City hailed out (<10 bu/ac yields)
  – Tribune showed no response to increasing seeding rate from 30 to 75 lb/ac)
• Garden City, Tribune, and Colby
• No-Till into sorghum stalks (W-S-F rotation)
Treatment Structure

• Seeding Rates
  – 2014
    • 30, 45, 60, 75 lb/ac
  – 2015-present
    • 30, 45, 60, 75 and 90 lb/ac

• Seed Size

• Varieties
  – TAM113 (2014 only)
  – TAM111 (prior to ‘17)
  – TAM114 (17-current)
  – Byrd
  – Winterhawk
  – T158

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>Variety</th>
<th>Seeding Rate</th>
<th>Variety x Seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tribune</td>
<td>2014</td>
<td>&lt;0.0001</td>
<td>0.0020</td>
<td>0.1761</td>
</tr>
<tr>
<td>Tribune</td>
<td>2015</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.0458</td>
</tr>
<tr>
<td>Tribune</td>
<td>2016</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.3607</td>
</tr>
<tr>
<td>Tribune</td>
<td>2017</td>
<td>0.0135</td>
<td>&lt;0.0001</td>
<td>0.9101</td>
</tr>
<tr>
<td>Garden City</td>
<td>2014</td>
<td>0.0084</td>
<td>0.0095</td>
<td>0.2444</td>
</tr>
<tr>
<td>Garden City</td>
<td>2015</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.0006</td>
</tr>
<tr>
<td>Garden City</td>
<td>2016</td>
<td>&lt;0.0001</td>
<td>0.2051</td>
<td>0.9986</td>
</tr>
<tr>
<td>Garden City</td>
<td>2017</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.3760</td>
</tr>
<tr>
<td>Colby</td>
<td>2015</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.7308</td>
</tr>
<tr>
<td>Colby</td>
<td>2016</td>
<td>0.0286</td>
<td>&lt;0.0001</td>
<td>0.1901</td>
</tr>
<tr>
<td>Colby</td>
<td>2017</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>0.2852</td>
</tr>
</tbody>
</table>

P > F

Results
Results – Seeding Rate Across All Site-Years
720 individual plots across 4 varieties and 11 site-years

Wheat Grain Yield Response to Seeding Rate
Average of TAM111/114, T158, Byrd, and Winterhawk

Optimal Seeding Rate not Affected by Location

Wheat Grain Yield Response to Seeding Rate
2015-2017 Garden City, Tribune, and Colby
average of TAM111/114, Byrd, Winterhawk, and T158
Caveats

1. Study was conducted on a lbs/acre basis
2. Through previous research and experience we know that optimal seeding rate varies by planting date
   - Our optimal seeding rates may be skewed by slightly later planting dates
3. While the locations and management were not nutrient limited, they are not super-high fertility either (i.e. no history of manure)

Conclusions Thus Far...

• The data we have collected so far is not supportive of variety specific seeding rates
• There are potential negative consequences to planting less than optimal seeding rates
  – If there is a lack of fall tillering your yield potential has been capped
Planting Date Likely Still the Biggest Driver

Durum Wheat Management

• Higher value wheat, typically used for pasta
• KSU Wheat Breeding has been working on developing winter durum wheats for over a decade
• A critical range of protein
• Target production will be on limited irrigation acres
Durum Wheat Management

- Varieties (4)
  - 2 KSU winter durum experimentals
  - Belgum line
  - SY Sunrise
- Planting Dates (4)
  - 9/15, 9/29, 10/13, 10/27
- Seeding Rates (4)
  - 0.9, 1.35, 1.8, and 2.25 million seeds/acre

K-State Field Pea Variety Testing

Lucas Haag, Ph.D.
Assistant Professor / Northwest Area Agronomist
Northwest Research-Extension Center, Colby, Kansas
Procedures

• No-Till into row-crop residue
• Seeded with Great Plains Drill on 10”
• Targeted drop of 365,000 live seed / acre
• Granular inoculant at 1.5x recommended rate
• Plots are 5’ x 40’
• 5 Replications
• Machine harvested

Field Pea VPT Locations
Trial Results and Field Pea Production Info
• www.northwest.ksu.edu/agronomy

![Field Pea Varieties](image)

<table>
<thead>
<tr>
<th>Location</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>Across Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rawlins</td>
<td>6</td>
<td>17</td>
<td>18</td>
<td>18</td>
<td>29.7</td>
</tr>
<tr>
<td>Thomas</td>
<td>6</td>
<td>18</td>
<td>22</td>
<td>20</td>
<td>33.0</td>
</tr>
<tr>
<td>Decatur</td>
<td>0</td>
<td>9</td>
<td>18</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>Gove</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Scott</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sherman IRR</td>
<td>-</td>
<td>11</td>
<td>55.2</td>
<td>-</td>
<td>55.2</td>
</tr>
</tbody>
</table>

Results
2014 Field Pea Response to Seeding Rate

2015 Field Pea Response to Seeding Rate
Ongoing / Future Work

- Continuing Seeding Rate Studies
- In-Furrow Placement of MAP
- Fungicide Seed Treatments
- Identification of differences in heat stress tolerance
Supported by Industry – Thank You

- Legume Logic
- Pulse USA
- Great Northern Ag
- Kauffman Seed
- Photosyntech
- Meridian Seeds

Winter Peas for Grain

- 8 Varieties
- 3 Planting Dates
  - 10/18; 10/30; and 11/15
- 2 Locations
  - NWREC, planted into summerfallow
  - Rawlins County, planted into fresh corn stalks
- Will evaluate for winter survival and yield
On-Farm Hybrid Characterization

Developing data for VRS implementation

Lucas A. Haag Ph.D.
Assistant Professor / Northwest Area Agronomist
K-State Northwest Research-Extension Center, Colby, Kansas

Hybrids and VRS

• Hybrid characterization is the key to effective VRS strategies
• Our ability to create VRT seeding prescriptions has exceeded our ability to characterize hybrids
  – Rapid hybrid turnover has further complicated this
• Yield components flex differently, at different rates, for different hybrids
• Fewer companies publicizing the “ear flex” scorings of products
  – Definition of ear flex, how much, what components
**2011 Duncan Equation Study**
K-State SWREC-Tribune

*P33B54 Conventional vs. P1151XR AquaMax*

**P1151 Polynomial Fit**

\[ y = -1E-07x^2 + 0.0092x + 25.522 \]

\[ R^2 = 0.7564 \]

**P33B54 Polynomial Fit**

\[ y = -2E-07x^2 + 0.0105x + 23.403 \]

\[ R^2 = 0.7541 \]

Haag & Schlegel, 2012, unpublished data

---

**Kernels Ear Row-1**
SWREC-Tribune, 2011

**K-State SWREC-Tribune**

2018 Cover Your Acres Conference
2016 Field Trials

- Fully irrigated trial at NWREC-Colby
  - 3 Hybrids
  - 5 Seeding Rates: 13.1, 22.1, 30.8, 37.8, and 48.6k/ac
  - 4 Replications in RCBD

- Dryland trial on-farm in Decatur County
  - 38 Hybrids
  - 4 Replications in a SPD

- Yield, Kernel Rows, Kernels per Row, Kernel Wt.

\[
y = -8E-08x^2 + 0.0058x + 129.74 \\
R^2 = 0.6116
\]

\[
y = -9E-08x^2 + 0.0067x + 97.146 \\
R^2 = 0.4922
\]

\[
y = -4E-08x^2 + 0.0033x + 145.2 \\
R^2 = 0.5035
\]
2016-2017 Field Trials

• Dryland trial on-farm in Decatur County
  – 38 Hybrids
  – 5 Seeding Rates:
    • 8,100
    • 14,200
    • 17,200
    • 20,700
    • 27,000/ac
  – 4 Replications in a split-plot design

• Yield, Kernel Rows, Kernels per Row, Kernel Wt.
On-Farm Seeding Rate Trials

- Big enough range in seeding rates, +/- 2k isn’t likely to show a response
- Treatment areas 300’ long minimum, multiple field locations
- Can I use a highly variable field to generate a lot of characterization data?
Using Field Variability to Guide Plot Placement..... Learn More

Hybrid Response to VRS Scripts

- Fixed Ear Seeding Rate = 25405 x Normalized Yield + 3567.6
  - 260 bu/acre = 35574 seed/acre
- Average Yield of 204 bu/acre = 29461 seed/acre
- Average Yield of 204 bu/acre = 24378 seed/acre
- 100 bu/acre = 15827 seed/acre
- 100 bu/acre = 14013 seed/acre
- Flex Ear Seeding Rate = 20324 x Normalized Yield + 4054.1
## Planting Date x Maturity Probabilities

### Historical Probability of Reaching Black Layer Before a 28°F Freeze - Oberlin, 1893-2016

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>118</td>
<td>2815</td>
<td>96.0%</td>
<td>91.4%</td>
<td>88.6%</td>
<td>84.8%</td>
<td>74.3%</td>
<td>65.7%</td>
<td>43.8%</td>
<td>22.9%</td>
<td>12.4%</td>
<td>1.9%</td>
<td>1.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>113</td>
<td>2768</td>
<td>96.8%</td>
<td>94.3%</td>
<td>89.5%</td>
<td>88.6%</td>
<td>78.1%</td>
<td>70.5%</td>
<td>55.2%</td>
<td>33.3%</td>
<td>16.2%</td>
<td>2.9%</td>
<td>1.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>2670</td>
<td>98.4%</td>
<td>97.1%</td>
<td>95.2%</td>
<td>91.4%</td>
<td>87.6%</td>
<td>76.2%</td>
<td>71.4%</td>
<td>51.4%</td>
<td>24.3%</td>
<td>10.5%</td>
<td>1.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>108</td>
<td>2604</td>
<td>98.4%</td>
<td>96.1%</td>
<td>97.1%</td>
<td>94.3%</td>
<td>84.6%</td>
<td>76.2%</td>
<td>60.0%</td>
<td>38.1%</td>
<td>17.1%</td>
<td>2.9%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>2520</td>
<td>99.2%</td>
<td>98.0%</td>
<td>98.1%</td>
<td>97.1%</td>
<td>93.3%</td>
<td>81.4%</td>
<td>73.3%</td>
<td>53.8%</td>
<td>23.7%</td>
<td>9.5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>2453</td>
<td>99.2%</td>
<td>99.0%</td>
<td>99.0%</td>
<td>98.1%</td>
<td>97.1%</td>
<td>93.3%</td>
<td>85.0%</td>
<td>70.0%</td>
<td>63.8%</td>
<td>34.3%</td>
<td>15.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95</td>
<td>2357</td>
<td>100.0%</td>
<td>99.0%</td>
<td>99.0%</td>
<td>98.1%</td>
<td>92.4%</td>
<td>87.6%</td>
<td>78.1%</td>
<td>55.2%</td>
<td>26.7%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91</td>
<td>2250</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>99.0%</td>
<td>99.0%</td>
<td>98.1%</td>
<td>93.3%</td>
<td>87.6%</td>
<td>76.2%</td>
<td>49.5%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Average GDU:** 3270 3207 3141 3066 2981 2882 2777 2661 2533 2391 2239

**Maximum GDU:** 4143 4074 3960 3846 3723 3620 3502 3398 3230 3038 2869

**Minimum GDU:** 2299 2331 2279 2223 2168 2050 1952 1879 1719 1665

www.northwest.ksu.edu/agronomy

---

Questions / Comments?

lhaag@ksu.edu 785.462.6281

Twitter @LucasAHaag or www.facebook.com/NWKSAgronomy