Glyphosate Residues, Variety Performance and Protein Variability: Research Results from 2019
Features of glyphosate

- Mobile in plants, moves to active sinks
- Deactivated in the soil almost immediately
- Considered one of the safest pesticides from a toxicological perspective ($\text{LD}_{50} \approx 5,000 \text{ mg/kg}$)
- Use rates on a per acre basis are relatively high compared to many herbicides
- Glyphosate is metabolized slowly in soil, with a reported half life of 2 to 197 days, 47 days considered typical
- Little metabolism in the plant
Glyphosate residues in wheat

• Though considered safe from a toxicological point of view, claims that it causes cancer has increased scrutiny of residues in food

• Likely sources of glyphosate residues in small grains
  – From pre-harvest applications
  – Drift from nearby fields
  – Uptake from the soil – (minimal?)
Established maximum residue levels

- USA: 30 ppm
- Codex: 30 ppm
- EU: 10 ppm
- Japan, Canada and China: 5 ppm

Other chemicals for comparison:
- DON = 1 ppm in flour,
- Atrazine = 0.5 ppm in grain,
- 2,4-D = 2 ppm,
- Propiconazole = 0.09 ppm
Current recommendations for glyphosate as a pre-harvest

- Up to 0.75 lb ae per acre rate
- Do not apply to crop intended for seed
- Do not apply to barley for malting
- Can be tank mixed with 2,4-D, dicamba, and saflufenacil
- Apply at hard dough stage or ≤30% moisture
- 7 day pre-harvest interval
Impact of rate and timing on glyphosate residue in spring wheat grain, average of five site/years (adapted from Cessna et al., 1994)

<table>
<thead>
<tr>
<th>Grain moisture at time of application</th>
<th>0 ppm</th>
<th>0.45 ppm</th>
<th>0.9 ppm</th>
<th>1.25 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>41-60%</td>
<td></td>
<td></td>
<td></td>
<td>10.0</td>
</tr>
<tr>
<td>25-40%</td>
<td></td>
<td></td>
<td>6.0</td>
<td>2.0</td>
</tr>
<tr>
<td>&lt;25%</td>
<td></td>
<td>0.5</td>
<td>0.9</td>
<td>1.2</td>
</tr>
</tbody>
</table>

The graph shows the impact of different rates of glyphosate (0, 0.45, 0.9, and 1.25 ppm) on glyphosate residue in spring wheat grain at various grain moisture levels (41-60%, 25-40%, and <25%).
Experience from 2018

• Experiment where glyphosate was applied to the soil
  – All samples of grain were positive including the check, range was 0.021 to 0.054 ppm
  – Soil level in the spring after a fall burndown – 0.04 ppm
  – Soil level in fall in plots receiving spring application – none detected

• Samples from the center of six fields – no detectable amounts
Conclusions

• Detectable levels of glyphosate in the wheat are likely with a pre-harvest application
• Applying too early may result in residue levels that exceed currently accepted limits
• Glyphosate that enters the plant may accumulate in the grain if the plant is still growing
• Drift during the season may result in detectable residues in the grain
Trends in HRSW variety use in ND

2015 2016 2017 2018

SY Ingmar  SY Valda  SY Soren  Barlow  Bolles  Faller  Linkert  Elgin-ND  Glenn
Considerations when using data to select varieties

- **Yield and protein content are negatively correlated** – need to consider both yield and protein
- **Yield stability** – a variety that maintains relatively good performance across many environments is a desirable trait
- **Genotype by environment interaction** – occurs when the ranking in yield of varieties change when environment changes
Relationship between yield and protein content of spring wheat varieties, average of eastern locations, 2018.

\[ y = -0.0926x + 21.81 \]

\[ R^2 = 0.5464 \]
Relationship between the yield of a variety at a given location and the average yield at that location, North Dakota locations, 2018.

- **Faller**
  - Equation: $y = 1.2953x - 13.421$
  - $R^2 = 0.9785$

- **Glenn**
  - Equation: $y = 0.6314x + 21.348$
  - $R^2 = 0.8506$

- **SY Ingmar**
  - Equation: $y = 1.098x - 7.8454$
  - $R^2 = 0.9083$

Yield of an individual variety (bu/acre)

Average Yield of the location (bu/acre)
Example of a genotype by environment interaction, three varieties and three environments, North Dakota, 2018.

- **Faller**
- **Glenn**
- **SY Ingmar**

The graph shows the yield of individual varieties compared to the average yield of the location. The equations and R² values are as follows:

- **Faller**
  - Equation: $y = 1.5219x - 29.779$
  - $R^2 = 0.9994$

- **Glenn**
  - Equation: $y = 0.6883x + 18.863$
  - $R^2 = 0.8016$

- **SY Ingmar**
  - Equation: $y = 0.7381x + 20.109$
  - $R^2 = 0.9753$
Steps to using data for selecting spring wheat varieties.

1. Rank varieties by yield (averaged over location that are similar to farm, i.e. eastern locations (stability, >confidence)

2. Select the highest yielding with protein values you are comfortable with

3. Look at selected varieties over other locations and look at three year means

4. Examine other important traits (disease resistance, maturity, lodging resistance)
Varieties with yields > mean, western North Dakota, 2018
Varieties with protein > mean, all locations
North Dakota, 2018
<table>
<thead>
<tr>
<th></th>
<th>$.25 per % +14%</th>
<th>$.50 per % +14%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lanning</td>
<td>$345</td>
<td>Lanning</td>
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<td>Caliber</td>
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<td>Caliber</td>
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<td>TCG-Climax</td>
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<tr>
<td>TCG-Climax</td>
<td>$326</td>
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<td>Shelly</td>
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<td>Rollag</td>
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<td>LCS Trigger</td>
<td>$324</td>
<td>Elgin-ND</td>
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<tr>
<td>WB9479</td>
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<tr>
<td>Elgin-ND</td>
<td>$321</td>
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</tr>
<tr>
<td>Varieties</td>
<td>$.25 per % +14%</td>
<td>$.50 per % +14%</td>
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<tr>
<td>--------------</td>
<td>-----------------</td>
<td>-----------------</td>
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<tr>
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<td>Prosper</td>
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<td>Faller</td>
<td>$420</td>
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<tr>
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<tr>
<td>HRS 3419</td>
<td>$413</td>
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</tr>
<tr>
<td>SY Ingmar</td>
<td>$411</td>
<td>Prosper</td>
</tr>
</tbody>
</table>
Optimum Seeding Rates for New Spring Wheat Varieties

J Stanley, NDSU
Joel Ransom, NDSU Extension
Results from Recent MN/ND Study

• Optimum seeding rate (SR) is variety dependent
  – Derived from SR vs. Yield response curve

• Tillering capacity differs among varieties
  – Increasing seeding rate decreases stems per plant

• Yield models are complicated by environment
  – The SR that is optimum increases as YP decreases
    • Inferences limited as lowest yields were >50 bu ac\(^{-1}\)
Experiment Locations

- Minnesota
  - Crookston
  - Lamberton
- North Dakota
  - Prosper
  - Minot
  - Dickinson
  - Hettinger
All locations

(1.77 million seeds x 93% germination) x (1 – 15% stand loss) = 1.40 million
Response of spring wheat cultivars to seeding rate, average of all varieties, three locations, 2018.
Identifying Causes of Within-Field Protein Variability in Spring Wheat

Melissa Geiszler
Why Look at Protein Variability?

• Which are the most influential factors influencing protein?
  – H2O and N → OM and soil texture

• Can the causes of variability can be managed?
  – Account for target protein content in VRN application?
  – Can we turn low protein zones into higher protein zones?
How Does it Work?

- Next Instruments: CropScan 3000H
Yield
- Encirca ERU Soil Unit
  - High: 120.9
  - Low: 53.0

Protein
- Encirca ERU Soil Unit
  - High: 13.9
  - Low: 10.82

Moisture
- Encirca ERU Soil Unit
  - High: 14.4
  - Low: 10.8
Conclusions

• Preliminary results show promise in identifying “protein zones” that might benefit from specific management
• Can help quantify the effects of variation in the field and management practices on protein as well as yield
• What are some addition question we should be considering?