Collecting and Deciphering Precision Ag Data to Improve Your Production Decisions

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Sensing Grain Protein

• ProSpectra™ Analyzer
  • Reflectance spectra (0.5 nm intervals over 600-1100 nm)
• DeLight instrument control and data logging software.
• Integrated GPS port.
Bench and Field Testing
Verify Protein Response

Long et al. 2007. Agronomy Journal
Weed Index Map

Based on amount of red light absorbed by chlorophyll of weedy foreign material in harvested grain
2\textsuperscript{nd} Generation Sensor

**Textron ProSpectra**
- 600-1100 nm
- 1024 channels
- Silica detector

**Polytec 1721**
- 850-1650 nm
- 400 channels
- InGaAs detector

$15,000 \quad $32,000
Improved Instrument Performance

Polytec
$R^2 = 0.98$
$SE = 0.34\%$

Prospectra
$R^2 = 0.90$
$SE = 0.87\%$
### Other Instruments

<table>
<thead>
<tr>
<th>Development Co.</th>
<th>Origin</th>
<th>Wavelength Range</th>
<th>Channels</th>
<th>Light Source</th>
<th>Detector</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>AvaSpec</td>
<td>The Netherlands</td>
<td>1000-2500 nm</td>
<td>256</td>
<td>Halogen Lamp</td>
<td>InGaAs</td>
<td>$19,450</td>
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<tr>
<td>Avantes</td>
<td>The Netherlands</td>
<td>1000-1750 nm</td>
<td>512</td>
<td>Halogen Lamp</td>
<td>InGaAs</td>
<td>$12,950</td>
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<tr>
<td>StellarNet</td>
<td>FL</td>
<td>900-1700 nm</td>
<td>512</td>
<td>Halogen Lamp</td>
<td>InGaAs</td>
<td>$13,125</td>
</tr>
</tbody>
</table>
Critical Protein Level

Engel, Long, and Carlson. 1999. Precision Agriculture
Where Was N Deficient for Yield?

- **30 bu/a**
  - 14% protein
  - knoll

- **60 bu/a**
  - 11% protein
  - bottom

Increasing Productivity
## Reported Levels

<table>
<thead>
<tr>
<th>Level (%)</th>
<th>Class</th>
<th>Location</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.5</td>
<td>HRW</td>
<td>Colorado</td>
<td>Goos et al. 1984</td>
</tr>
<tr>
<td>13.2</td>
<td>HRS</td>
<td>Montana</td>
<td>Engel et al. 1999</td>
</tr>
<tr>
<td>12.5</td>
<td>HRW</td>
<td>Montana</td>
<td>Engel et al. 2005</td>
</tr>
<tr>
<td>12.8</td>
<td>HRS</td>
<td>Sask.</td>
<td>Seles &amp; Zentner 2001</td>
</tr>
<tr>
<td>8.8</td>
<td>SWW</td>
<td>Oregon</td>
<td>Glenn et al. 1988</td>
</tr>
</tbody>
</table>
Relationship Between Grain Yield and Protein

Figure 2. Yield-protein relationship for wheat fertility tests from 1967 to 1993 in southwest Saskatchewan.

Selles and Zentner. 1998.
U. Sask. Extension Press

Local Correlation
- significantly negative
- not significant
- significantly positive

p = 0.01

Grain Protein Maps

• Another way for creating management zones.
• Rationale:
  • Crops are indicators of conditions in the root zone.
  • Grain protein is correlated with plant available soil N.
  • Grain protein and yield express an integrated response over the growing season.
Calculations

• N Removed = \(\frac{\text{Yield} \times \text{Protein}}{100 \times 5.7}\)

• N Deficit = \((\text{Target Level} - \text{Current Level}) \times \text{Fertilizer N Equivalent}\)

• N applied = N Removed + N Deficit

N Equivalent

Graph showing the relationship between applied N (lb/ac) and grain protein (%). The graph includes three lines representing different moisture levels:

- **Low Moisture (7.3 in)**
- **Normal Moisture (11.5 in)**
- **High Moisture (16.5 in)**

The graph indicates an inverse slope, suggesting that as applied N increases, grain protein generally decreases. The source of the data is Long and Engel. 1997. Site Specific Management Guideline #24 http://www.ipni.net/ssmg
Deriving N Management Zones

## Spring Wheat Protein, 1997

<table>
<thead>
<tr>
<th>Fertility</th>
<th>Area</th>
<th>N Rate</th>
<th>Applied N</th>
<th>Protein N rate</th>
<th>Applied N</th>
<th>Protein</th>
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<tbody>
<tr>
<td><strong>Uniform Rate</strong></td>
<td><strong>Variable Rate</strong></td>
<td></td>
<td></td>
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<tr>
<td>Low</td>
<td>6.5</td>
<td>30</td>
<td>195</td>
<td>13.3</td>
<td>90</td>
<td>585</td>
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<tr>
<td>M. Low</td>
<td>21</td>
<td>30</td>
<td>630</td>
<td>13.4</td>
<td>70</td>
<td>1470</td>
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<tr>
<td>Mod.</td>
<td>48</td>
<td>30</td>
<td>1440</td>
<td>15.2</td>
<td>50</td>
<td>2400</td>
</tr>
<tr>
<td>M. High</td>
<td>98</td>
<td>30</td>
<td>2940</td>
<td>15.7</td>
<td>30</td>
<td>2940</td>
</tr>
<tr>
<td>High</td>
<td>89</td>
<td>30</td>
<td>2670</td>
<td>16.7</td>
<td>5</td>
<td>445</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>263</td>
<td>7875</td>
<td></td>
<td></td>
<td>7840</td>
<td></td>
</tr>
</tbody>
</table>

Long, Engel, and Carlson. 2000. Precision Agriculture
Protein Indices are Imperfect

• Not be suited for rainfall regimes where yield potential exceeds 60 bu/ac

• Some cultivars do not experience yield loss when protein is below the critical level (Fowler, 2003)

• Weather-soil interactions:
  • Influences mineralizable N and plant N uptake
  • Excess N leads to yield reductions under severe drought
  • Protein is abnormally elevated under severe drought (Seles and Zentner, 2001)
Grain Segregator
Grain Segregator
Flow Through Position

- Material Flow
- Grain Bin Filling Auger Housing
- Diverter valve in the closed “flow-through” position
- Discharge Outlet to Rear Bin
Divert Position

Material Flow

Grain Bin Filling Auger Housing

Diverter valve in the open “divert” position

Discharge Outlet to Front Bin
Segregator in Operation
Dollar Return Vs. Mean Protein

Conclusions

• Use of optical sensors may be useful for:
  • Mapping protein, oil, or starch content within fields.
  • Post harvest indicator of N nutrition sufficiency.
  • Deriving N management zones for variable rate application.
  • Grain segregation by a grain quality parameter that is important in pricing.