Dry Beans

• Introduction of upright/bush type varieties the biggest game changer (direct harvest)
• Traditionally an irrigated crop, but some success into dryland wheat stubble
• Provides a broadleaf crop for rotation
• Established markets available

Rationale

• Most management recommendations are based on vine-type varieties and production system
• Little research data from the Tri-State Region exists
Objectives

• Evaluate Variety x Row Spacing x Seeding Rate dynamics for yield, harvestability, weed control, and disease susceptibility
• Investigate new fertility practices possible through narrow row seeding (in-furrow placement)
• Initiate a variety testing program

Dry Bean Research – 2019 Pintos
Sherman County - Irrigated

• 4 Varieties
  – Cowboy, Lariat, Torreon, Windbreaker
• 3 Seeding Rates
  – 60k, 100k, and 130k
• 2 Row Spacings
  – 10” and 30”
• 24 total treatments x 5 reps = 120 plots
**2019 Sherman County - Irrigated Pinto Yields**

Variety x Seeding Rate

<table>
<thead>
<tr>
<th>Seeding Rate</th>
<th>Cowboy</th>
<th>Lariat</th>
<th>Torreon</th>
<th>Windbreaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>60k</td>
<td>3364</td>
<td>3410</td>
<td>3140</td>
<td>3324</td>
</tr>
<tr>
<td>100k</td>
<td>3484</td>
<td>3161</td>
<td>3302</td>
<td>3203</td>
</tr>
<tr>
<td>130k</td>
<td>3539</td>
<td>3513</td>
<td>3302</td>
<td>3203</td>
</tr>
</tbody>
</table>

- **p = 0.0117**

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**Moving Forward into 2020**

- We have secured a USDA SCBDG to partially fund this project through the 2021 season
- Variety x Row Spacing x Seeding Rate trial will continue
- Plan to have a variety performance test
- Fertility trials will continue
- Regular monitoring with sUAV’s to monitor canopy closure
- Summer field day event
Dry Bean Fertility Management
Dry Bean Nutrient Removal

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>lb of Nutrient / cwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>5.00</td>
</tr>
<tr>
<td>P2O5</td>
<td>1.32</td>
</tr>
<tr>
<td>K2O</td>
<td>1.53</td>
</tr>
<tr>
<td>Ca</td>
<td>0.30</td>
</tr>
<tr>
<td>Mg</td>
<td>0.10</td>
</tr>
<tr>
<td>S</td>
<td>0.87</td>
</tr>
<tr>
<td>Fe</td>
<td>0.05</td>
</tr>
<tr>
<td>Zn</td>
<td>0.01</td>
</tr>
<tr>
<td>Mn</td>
<td>0.00</td>
</tr>
<tr>
<td>Cu</td>
<td>0.00</td>
</tr>
<tr>
<td>B</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Meeting the bean’s needs

Soil sample
- 0-6” Immobile nutrients
- 0-24” Mobile nutrients

Zone of plant uptake of Immobile nutrients (PO₄, K, Ca, Mg, Zn, Fe)
Zone of plant uptake of Mobile nutrients (NO₃, SO₄, Cl, BO₃)

Nutrient mobility effect on root uptake zones

Soil Nutrients

Primary Nutrients
- Nitrogen (N)
- Phosphorus (P)
- Potassium (K)

Secondary Nutrients
- Calcium (C)
- Magnesium (Mg)
- Sulfur (S)

Micronutrients
- Boron (B)
- Chlorine (Cl)
- Manganese (Mn)
- Iron (Fe)
- Copper (Cu)
- Molybdenum (Mo)
- Zinc (Zn)
- Nickel (Ni)
Nitrogen

- Dry beans are a legume capable of forming a symbiotic relationship with N-fixing bacteria
- Research in the Central High Plains has not shown that inoculation improves yield in fields where dry beans have been grown
- However, inoculation is recommended for fields that have never grown dry beans
Nitrogen

Nitrogen Recommendation, lb/ac

<table>
<thead>
<tr>
<th>lb/ac profile N</th>
<th>Nitrogen Recommendation, lb/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>75</td>
</tr>
<tr>
<td>21-40</td>
<td>60</td>
</tr>
<tr>
<td>41-60</td>
<td>45</td>
</tr>
<tr>
<td>61-80</td>
<td>30</td>
</tr>
<tr>
<td>81-100</td>
<td>15</td>
</tr>
<tr>
<td>&gt;100</td>
<td>0</td>
</tr>
</tbody>
</table>

Based on 2500 lb/ac yield goal
Adjust +/- 3 lb of N per 100 lb of yield goal
  e.g. add 15 lb/ac N for a 3000 lb yield goal
  e.g. subtract 30 lb/ac N for a 1500 lb yield goal

Inoculation vs. Applied N

D.W. Franzen, NDSU. Average of 30 site-years
### Phosphorus

**Phosphorus soil test method and critical levels**

<table>
<thead>
<tr>
<th>Olsen-P</th>
<th>Bray P-1</th>
<th>Mehlich 3</th>
<th>Banded</th>
<th>Broadcast</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>0-5</td>
<td>0-6</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>4-6</td>
<td>6-10</td>
<td>7-12</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>7-9</td>
<td>11-15</td>
<td>13-18</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>&gt;10</td>
<td>&gt;16</td>
<td>&gt;19</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Lbs P₂O₅/ac**

- **Olsen P, mg kg⁻¹**
  - 0
  - 5
  - 10
  - 15
  - 20
  - 25
  - 30
  - 35

- **Bray P, mg kg⁻¹**
  - 0
  - 10
  - 20
  - 30
  - 40
  - 50
  - 60

- **Resin P, mg kg⁻¹**
  - 0
  - 10
  - 20
  - 30
  - 40
  - 50
  - 60

- **H₃A, mg kg⁻¹**
  - 0
  - 10
  - 20
  - 30
  - 40
  - 50
  - 60

**Regression Equations**

- **M3 vs Olsen**
  - \( y = 1.93 + 0.43x \)
  - \( R^2 = 0.93 \)

- **M3 vs Bray**
  - \( y = 4.08 + 0.57x \)
  - \( R^2 = 0.96 \)

- **M3 vs Resin**
  - \( y = 1.67 + 0.73x \)
  - \( R^2 = 0.97 \)

- **M3 vs H₃A**
  - \( y = -1.66 + 0.99x \)
  - \( R^2 = 0.95 \)

**Additional Information**

- **pH:** > 7.6
- **Calcium carbonate:** > 8%
Zinc

<table>
<thead>
<tr>
<th>DTPA Soil Test</th>
<th>pH less than 7.5</th>
<th>pH more than 7.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppm</td>
<td>Lbs Banded</td>
<td>Lbs Broadcast</td>
</tr>
<tr>
<td>0-0.50</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>0.51-1.0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>1.01-1.5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>&gt;1.5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Fe

- Typically small seeded types such as black and navy are more sensitive than medium sized types like pinto, great northern, small red, or pink.
- Work with soybeans in Northwest Kansas has shown Ortho-Ortho EDDHA chelated Fe to be very effective when applied in-furrow or as a seed treatment.
What About Starter

- Beans are very sensitive to salts
- The total lbs of N and KO applied as an in-furrow starter should not exceed 20 lbs/ac
- Quite possible to see responses to starter P, especially in soils with low STP
- Zinc and/or Iron, likely most effective when applied as a starter

Dry Bean Water Use
Seasonal Water Use of Crops

Total ET = Precipitation + Irrigation + Soil Water Depletion

- Alfalfa: 31-33 in
- Corn: 23-26 in
- Dry Bean: 15-16 in
- Soybean: 18-22 in
- Sunflower: 18-26 in
- Winter Wheat: 16-18 in

Water Use Timing

![Graph showing water use timing for different crops]
Effect of VPD on Water Use Efficiency

Fig. 2. Relationship between dry bean production function slope and average June, July, and August vapor pressure deficit at Akron, CO.

Water Use for Dry Beans

Yonts. UNL. 2004
Timing of Stress

Early Season

Limited stress: initial irrigation delayed by 1 week
High stress: initial irrigation delayed by 2 weeks

Late Season

Limited stress: After Aug 10, beans received every other irrigation that was scheduled
High stress: After Aug 10, water was no longer applied after

Rooting Structure

Majority of roots are in top 18”
### Predicting the Last Irrigation

<table>
<thead>
<tr>
<th>Stage of Growth</th>
<th>Description</th>
<th>Approximate Days to Maturity</th>
<th>Water Use to Maturity (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R5 Early seed fill</td>
<td>One pod with fully developed seeds</td>
<td>35</td>
<td>7.0</td>
</tr>
<tr>
<td>R6 Mid-seed fill</td>
<td>50% of pods with fully developed seeds</td>
<td>25</td>
<td>4.2</td>
</tr>
<tr>
<td>R7 Beginning maturity</td>
<td>One pod has changed to mature color</td>
<td>15</td>
<td>2.0</td>
</tr>
<tr>
<td>R8 Harvest maturity</td>
<td>80% of pods have changed to mature color</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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