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High-Yielding Corn and Soybean Management

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KSUCROPS Production Lab
Topic: Presentation highlights

CORN & SOYBEAN

1. Closing Yield Gaps
   A. Corn
   B. Soybean

2. Nutrient balance & Ratios

3. Take Home Message
**Closing Yield Gaps: Integrated-System Approach**

### SOYBEAN (S)/CORN (C)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>FP</th>
<th>CF</th>
<th>PI</th>
<th>EI</th>
<th>AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeding rate (S/C)</td>
<td>111k/30k</td>
<td>111k/30k</td>
<td>134k/36k</td>
<td>134k/36k</td>
<td>134k/36k</td>
</tr>
<tr>
<td>Row spacing (inch)</td>
<td>30</td>
<td>30</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Fertilization</td>
<td>No P-K (50N)*</td>
<td>P-K (50N)*</td>
<td>No P-K (50N)*</td>
<td>P-K (50+150N)*</td>
<td>P-K (50+150N)*</td>
</tr>
<tr>
<td>Micronutrients</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>1x (Fe, Zn, B)</td>
<td>2x (Fe, Zn, B)</td>
</tr>
<tr>
<td>Fungicide/Insecticide</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>1x</td>
<td>2x</td>
</tr>
</tbody>
</table>

**FP** = farmer practices, **CF** = comprehensive fertilization, **PI** = production intensity, **EI** = ecological intensification (**CF+PI**), **AD** = advanced plus. *Fertilizer N only applied in corn only.

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## Integrated-System: Corn-Phase

<table>
<thead>
<tr>
<th></th>
<th>CP</th>
<th>CF</th>
<th>PI</th>
<th>EI</th>
<th>AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>226</td>
<td>228</td>
<td>228</td>
<td>231</td>
<td>231</td>
</tr>
</tbody>
</table>

### Results

- **2014**
  - CP: 226
  - CF: 228
  - PI: 228
  - EI: 231
  - AD: 231

- **SIMILAR YIELDS ACROSS ALL EVALUATED APPROACHES**

- **Rows + Plant Density + Fungicide + NPKS**

### Conclusions

- Affirmative findings on the efficacy of the integrated system in corn production.
What are the key corn yield driving factors?

**CHANGES in PLANT BIOMASS PRODUCTION**

<table>
<thead>
<tr>
<th>Plant Biomass (lbs A⁻¹)</th>
<th>FP</th>
<th>CF</th>
<th>PI</th>
<th>EI</th>
<th>AD</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tbody>
</table>
What are the key corn yield driving factors?

Seasonal N Uptake

Growing Degree Days (°C day⁻¹)

Plant Nitrogen Uptake (lbs ha⁻¹)

FLOWERING

40%

GRAIN

LEAVES

STEM

Balboa, Ciampitti et al.

© IA Ciampitti, K-State Univ
What are the key corn yield driving factors?

**Farming Practice**
- Grain
- Leaves
- Stem

**Ecological**

N Uptake (lbs acre⁻¹) vs. Days after planting

Balboa, Ciampitti et al.
**Integrated-System: Corn (Irrigated)**

**2014**

<table>
<thead>
<tr>
<th>Treat</th>
<th>2014 Grain Yield (bu ac⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>224</td>
</tr>
<tr>
<td>CF</td>
<td>227</td>
</tr>
<tr>
<td>PI</td>
<td>227</td>
</tr>
<tr>
<td>EI</td>
<td>230</td>
</tr>
<tr>
<td>AD</td>
<td>230</td>
</tr>
</tbody>
</table>

**MAXIMUM YIELD** (Comprehensive Fertilization, CF)

↑ Balanced NPKS, 30” spacing, 36K density
NUTRIENT UPTAKE in CORN

CIAMPITTI & VYN, 2014

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>50% of the total biomass was accumulated at flowering; while >65% of N was already present at the same stage.

Ciampitti and Vyn (2014, Field Research, Crop Management Journal 1-7)
Nutrient balance N:K Ratio

CORN

%50 NK Database
1:1 N:K ratio CORN
Historical NK =
Key corn-soybean yield driving factors

ROW SPACING factor:
+Light interception $\Rightarrow$ +Canopy Cover $\Rightarrow$ Yields

Balboa, Ciampitti et al.

© IA Ciampitti, K-State Univ
Integrated-System Approach
Experimental sites

Setup 2014 WG08 Soy experiments at Scandia (Kansas)
Integrated-System: Soybean (Irrigated)

MAXIMUM YIELD (ECOLOGICAL INTENSIFICATION, EI)

↓ Rows + ↑ Plant Density + Fungicide + NPKS

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Integrated-System: Soybean (Dryland)

Gaps: Review
Materials & Methods
Results
Conclusions

MAXIMUM YIELD (ECOLOGICAL INTENSIFICATION, EI)

 Rows + Plant Density + Fungicide + NPKS

Mgmt
YIELD
GAIN
Standard Practices
What are the key soybean yield driving factors?

Changes in leaf area production (from planting to harvest)

Similar leaf area production for all treatments
Greater total biomass for irrigated vs. dryland sites. High-yields were connected to greater final biomass at maturity.

Grain partitioning increased as yields raised within a water supply environment, but higher partitioning was observed under the dryland site.
Plant Biomass and Partitioning Ratio

Farming Practice

Lower biomass accumulation with low yielding environment. Lower biomass partition to the grain, more % biomass accumulated.

Ecological Intensification

Larger biomass accumulation with high yielding environment. Higher biomass partition to the grain, more % biomass accumulated by flowering.
Plant N Demand vs. Grain Yield: Review

\[ Y = 0.22^* X \]

\[ R^2 = 0.82; n = 623 \]

High-yielding soybean, larger quantity of N is needed
Irrigated
Irrigated
Irrigated
Do high-yielding soybeans need to be fertilized with Nitrogen (N)?

High yielding soybean systems were achieved in detriment of the protein concentration levels (Rowntree et al., 2013).

INTERACTION with MODERN SOYBEAN GENOTYPES

Is N limiting yields?
Is N grain quality?
Soybean Nitrogen Accumulation

- Cumulative nitrogen for corn occurs earlier and more rapidly than for soybean
  - 50% Soy Nitrogen accumulation at R4
- Nodule function decreases after R5.5

Research from: (Hanway and Weber, 1971)
High Yielding environments (>65 bu acre\(^{-1}\))

- N uptake
- N\(_2\) fixation
- N soil = (-)
- 75% with (+) response.
- Applications after R3 +670kg ha\(^{-1}\) Why???

Low Yielding environments (<65 bu acre\(^{-1}\))

- Poor nodule system,
- Low N supply at planting,
- Plant water stress,
- Soil pH problems,
- Low temperatures,
- Absence of native Bradyrhizobium

31% of total Cases
Average response 8 bu acre\(^{-1}\)

Adapted from Salvagiotti et al., 2008

**Flowering**
- 30%*
- 29%*

Ciampitti, Balboa, et al., unpublished, K-State Univ.
Based on plant N partitioning, estimated %Ndfa at the plant-scale was ~70%.

Ciampitti, Balboa, et al., unpublished, K-State Univ.
Nutrient balance N:K Ratio

%50 NK Database
1.6-to-2.2 units
AVERAGE
2:1 N:K ratio

SOYBEAN

High-Yielding ARG

6:1
2:1
1:1

USA
World

High-yielding Soybean fitted into a more balanced nutrient ratio 2:1 N:K, regardless the geo-cluster.
What are the key corn & soybean yield driving factors?

- Greater partition efficiency of biomass and nutrients to the grain fraction.

- Narrow Rows + ↑ Plant Density + Fung. = ↑ Light Interception, ↑ Conversion, ↑ Duration

- Balanced fertilization + Intensive Use Inputs
SUMMARY

- High yields = earlier light interception in non-limiting water conditions.
- Balance nutrition and use of inputs are needed to capture high-yields in soybean.
- Knowledge Gaps:
  - Corn
    - N timing (↑ NUE) x Hybrid
  - Soybean
    - Seeding rate x Branching ability
    - N fixation x Modern genotypes
Funding Support

KANSAS CORN COMMISSION

BASF
We create chemistry

IPNI

Global Soybean Project
US, ARG, & BRZ

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THANKS! Questions?

Crop Production Team

KSUCROPS