Western Kansas Corn Production Update

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K-State Northwest Research-Extension Center, Colby

Some topics....

• Yield Components
• Spacing and Uniformity of Emergence
• Seeding Rate Response
• Hybrid Characterization
• Hybrid Maturity x Date of Planting Probabilities
• Water Management
V6 – Maximum number of Kernel Rows

• Severe stress: Moisture, Fertility, etc., can inhibit this process
• Not fixed until later in growth and development
Just Prior to R1

• Maximum potential number of Kernels/Ear Row
• Sensitive to reductions in solar radiation, water stress, heat stress

Maize Phenological Stages

Drought can be critical around the period for grain number formation around flowering (+/- 2 weeks)

Ciampitti et al. (unpublished)
Corn Spacing and Emergence: How big are the issues?

Standard Deviation

- The standard deviation is the variability around the mean and the most commonly used term.
- However, it is likely not the best term for generalizing uniformity.
- This is especially true in Kansas where seeding rates vary tremendously.

Standard Deviation = 2.5”
Skips and Doubles

• Farmers know what skips and doubles are and they are easily spotted.
• Academics will define these as misses (spacing more than 1.5 times the intended spacing) and multiples (spacing less than 0.5 times the intended spacing)
• Quality of Feed is the leftover values (percent of plants that are not skips or doubles)

Skips and Doubles

71 total plants
4 doubles
2 skips
Average = 0.56
St. Dev. = 0.19
Purdue Study

- Bob Nielsen published results from an on-farm survey of corn plant uniformity in 1995
- This survey included 22 sites.
- They reported a 0.6 to 1 inch increase in SD per mph increase in planter speed. They also reported a 2.3 bu/acre yield loss when speed increased from 4 to 7 mph.
- They did not account for difference in plant population between the two speed treatments and only saw yield decreases in 5 of the 22 environments.

Nafziger and Lauer

- Nafziger (1996) reported that 10% skips reduced yields 5% to 8% and 10% doubles increased yields by 4 to 8%.
  - Was the first to suggest that the achieving the appropriate plant population with adequate spacing was the most important goal for maximizing corn yields.
- Lauer (2004) reported that plot grain yields rarely were affected by two-plant variations and yields were only affected four- and eight-plant variations (more hill like).
Pioneer

• Pioneer agronomists become interested in seed spacing uniformity in about 2000

• Early calibration demonstrations reported an average of 1.1 to 6.1 bu/acre increase for every one-inch of within-row plant spacing decrease.

• ALSO noted that you did not need a perfect stand to achieve maximum yields, on 2 to 3 inches of within row plant spacing standard deviation or less.

Pioneer - continued

• Reported no increase in barrenness with doubles. In fact these “extra” increased individual plant yields.

• Also reported plants growing next to gaps (skips) were the least productive on an individual plant basis.

The way these results are reported illustrate a fallacy in early plant spacing work, the focus on individual plants. We grow crops in a community. Plants can compensate across the community as a whole.
Tollenaar 2004

- Evaluated planter speed and metering systems.
  - Reported that at low speeds (4.5 mph), finger pick-up and vacuum systems produced similar SDs. (3 vs 3.3 in ± 0.4)
  - At higher speeds (7 mph), finger pick-up SD was 3.4 in and vacuum systems SDs were 4.1 ± 0.4 in.
  - Conventionally tilled systems had lower SDs than no-till systems (4.8 vs 5.3 in ± 0.4).
  - High SDs from an air seeder treatment (7.5 in) influenced regression results resulting in results of “the highest yields were attained from treatments with the lowest SDs”

Liu et al., 2004

- Mixed RR and conventional seed at various ratios to obtain irregular stands, planted at 31,800 seeds ac⁻¹
- Six treatments resulting in a SD range of 2.6 to 6.4 inches
- Plant spacing variability had no effect on grain yield, leaf number, plant height, LAI, or HI.
Garden City - Control vs. Treatments (one-way analysis)
Corn Stand Reduction Study
Garden City, KS 2008 - 2011

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<tr>
<th>Stage</th>
<th>Reduction</th>
<th>Yield</th>
<th>Vs. Control</th>
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<td>69.1</td>
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</table>

No difference between control and 25% removal treatments at V5, V8, and V11
What about uniformity of emergence?

Delayed Emergence Results – Nafziger 2006

<table>
<thead>
<tr>
<th>Seed</th>
<th>Days to 90% Emergence</th>
<th>Duration of Emergence (days)</th>
<th>Yield (bu/acre)</th>
<th>Final Stand (plants/acre)</th>
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<td>Uncoated</td>
<td>7</td>
<td>2</td>
<td>208.7</td>
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<td>½ coated</td>
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<td>Coated</td>
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<td>11</td>
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<td>LSD(0.05)</td>
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<td>20.1</td>
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Tollenaar 2006

• Previous research prompted a closer look at corn community response to imperfect stands.

• They looked at plant emergence delays (2 and 4 leaf delays) and a skip-double and skip-triple.

• A two leaf delay in emergence reduced yields 5 bu/acre and a 4 leaf delay reduced yields 10 bu/acre.

• Skip-double and skip-triple DID NOT reduce yields compared with a uniform stand when the whole plot yield was considered because adjacent plants compensated for the skip.

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### Emergence Results – Tollenaar 2006

<table>
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<th>Treatment</th>
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<td>2-leaf delay</td>
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<td>2.6</td>
<td>5.4</td>
<td>-89.3‡</td>
<td>10.2</td>
<td>9.1</td>
<td>2.9</td>
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‡ Significantly different from control
Plant Hierarchies in Maize  
*Pagano and Maddonni, 2007*

- Plant variability in above ground biomass increased through the season, CV of 1.2% at V3 to 22% at V9-V10
- Early established hierarchies differ in biomass allocation to the ear around silking
- Dominant plants exhibited greater partitioning to the ear (HI=0.41) compared to dominated plants (HI=0.36)

Evaluating Seeder Performance

- *Seed/Plant spacing uniformity*
- Variability across the unit
- *Emergence rate*
How do we improve uniformity?

• Attachments
  – Metering
  – Seed Firmers
  – Press Wheels
• Adjustments
  – Speed
  – Down Force
• Maintenance
  – Metering System
  – Opener Disks
  – Seed Tubes

Using Seeding Depth to Overcome Spatial Variability (Haag’s opinion)

• Spatial variability
  soil temperature
  soil moisture
  bulk density
• What does the spatial variability of each of these characteristics look like as a function of depth
• Consistency of seed placement depth irrelevant if we’re not deep enough
A “big data” analysis was conducted, Dupont Pioneer database, from 2000 to 2014 period (+120K points).

Data from 22 states and 2 provinces in Canada.

Plant density trials (2-3 replicates) with five target plant densities: 18K, 24K, 30K, 36K, and 42K.

Yields were all adjusted to 15.5% grain moisture.

Main yield-density “response models” were explored.
Grain Yield Data Distribution: Yield Database divided by Environment

**LOW YIELD ENVIRONMENT**
- Negative response
- Low Yield Environment <100 bu/A

**MEDIUM YIELD ENVIRONMENT**
- Flat response
- Medium Yield Environment <150 bu/A

**HIGH YIELD ENVIRONMENT**
- Quadratic positive response
- High Yield Environment <180 bu/A

**VERY HIGH YIELD ENVIRONMENT**
- Linear positive response
- High Yield Environment <210 bu/A

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22,000
27,000
36,000
45,000

Dupont Pioneer©
Grain Yield Data Distribution: Yield Database divided by Environment

- LOW YIELDING ENVIRONMENT <100 bu/acre
  - Optimal plant density <20K plants/acre

- MEDIUM YIELDING ENVIRONMENT <150 bu/acre
  - Optimal plant density 22-26K plants/acre

- HIGH YIELDING ENVIRONMENT <180 bu/acre
  - Optimal plant density 28-32K plants/acre

- VERY HIGH YIELDING ENVIRONMENT 200 bu/acre
  - Optimal plant density 32-36K plants/acre

Optimal Seeding Rate:
“Between-years” and “Counties”

Optimal seeding rate was influenced by the year and the location (county) but primarily dependent on the yield environment.
On-Farm Hybrid Characterization

*Developing data for VRS implementation*

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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

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

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2018 Corn School - Garden City - L. Haag
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-10x^2 + 4E-05x + 16.225
R² = 0.1133

y = -1E-09x^2 + 7E-05x + 17.428
R² = 0.1836

y = -1E-09x^2 + 5E-05x + 17.114
R² = 0.4203

y = -1E-09x^2 - 0.0003x + 46.451
R² = 0.8941

y = -7E-09x^2 + 0.0001x + 39.223
R² = 0.7198

y = -1E-08x^2 + 0.0004x + 35.075
R² = 0.8244
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?
Population response of two hybrids

Hybrid 39 had the least response in yield across populations – population insensitive

Hybrid 10 had the most response in yield across population – sensitive to population

Using Field Variability to Guide Plot Placement..... Learn More

0-3’ Soil EC
Hybrid Response to VRS Scripts

- Fixed Ear Seeding Rate = 25405 x Normalized Yield + 3567.8
- 260 bu/ac = 35574 seed/ac
- Average Yield of 204 bu/ac = 29461 seed/ac
- 260 bu/ac = 30068 seed/ac
- 100 bu/ac = 15927 seed/ac
- Average Yield of 204 bu/ac = 24378 seed/ac
- Flex Ear Seeding Rate = 20324 x Normalized Yield + 4054.1

Optimal Seeding Rate: “Within-a-field”
Density-response by MANAGEMENT ZONE

- FLAT response
- LOWER Econ. Opt. Seeding Rate (EOSR)
- CURVILINEAR response HIGHER EOSR, increasing with yields
Double-planted and planter technologies

DPA = double planted area

ASC = automatic section control
Planting Date x Maturity Probabilities

Historical Probability of Reaching Black Layer Before a 28°F Freeze - Garden City 1948-2016

<table>
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<td>92.8%</td>
<td>78.3%</td>
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<td>23.0%</td>
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Average GDU: 3477 3407 3336 3258 3167 3064 2953 2833 2696 2546 2386
Maximum GDU: 4055 3978 3895 3788 3636 3503 3466 3332 3171 3029 2970
Minimum GDU: 2736 2727 2684 2646 2575 2502 2453 2367 2264 2117 1972

www.northwest.ksu.edu/agronomy

Irrigation Management
Water Loss to Drainage

If the profile is at or above 60% full the storage efficiency of fall or spring precipitation or preseason irrigation diminishes rapidly.

Potential Water Loss

In an 8’ profile, 60% available soil water would be approximately 9.6” in a Western Kansas silt-loam soil. Storage efficiency of additional water approaches zero at 100% ASW, or 16” in this case.
Potential Water Loss

- Proper management of irrigation at the end of the season
- Calendar not a good method (more on this later)
- Don’t want to short the crop, but also don’t want to reduce our storage efficiency for winter precipitation and pre-season irrigation

Irrigation Termination

<table>
<thead>
<tr>
<th>Stage of Growth</th>
<th>Approximate number of days to maturity</th>
<th>Water use to maturity (inches)</th>
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<td>Blister</td>
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<td>Dough</td>
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<td>Beginning dent</td>
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<td>5</td>
</tr>
<tr>
<td>Full dent</td>
<td>13</td>
<td>2.5</td>
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<tr>
<td>Black layer</td>
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<td>Grain Sorghum</td>
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Adapted from K-State MF2174, Rogers and Sothers.
### Timing of Irrigation Termination

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<tr>
<th>Year</th>
<th>Date of Anthesis</th>
<th>Date of Maturity</th>
<th>Irrigation Season Termination Date For 80% Max Yield</th>
<th>90% Max Yield</th>
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<td>13-Aug</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>18-Jul</td>
<td>19-Sep</td>
<td>14-Aug</td>
<td>28-Aug</td>
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</tr>
<tr>
<td>2008</td>
<td>24-Jul</td>
<td>10-Oct</td>
<td>31-Jul</td>
<td>27-Aug</td>
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<tr>
<td></td>
<td>Average</td>
<td></td>
<td>19-Jul</td>
<td>27-Aug</td>
<td>28-Aug</td>
</tr>
<tr>
<td></td>
<td>Standard Dev.</td>
<td></td>
<td>3 days</td>
<td>13 days</td>
<td>13 days</td>
</tr>
<tr>
<td></td>
<td>Earliest</td>
<td></td>
<td>12-Jul</td>
<td>17-Jul</td>
<td>12-Aug</td>
</tr>
<tr>
<td></td>
<td>Latest</td>
<td></td>
<td>24-Jul</td>
<td>21-Sep</td>
<td>21-Sep</td>
</tr>
</tbody>
</table>

*Estimated dates are based on the individual irrigation treatment dates from each of the different studies when the specified percentage of yield was exceeded.*

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**This table was created to show the fallacy of using a specific date to terminate the irrigation season.**

<table>
<thead>
<tr>
<th>Statistics for 16 years 1993-2008</th>
<th>Irrigation Season Termination Date For</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>80% Max Yield</td>
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<tr>
<td>Mean</td>
<td>2-Aug</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>13 days</td>
</tr>
<tr>
<td>Earliest</td>
<td>17-Jul</td>
</tr>
<tr>
<td>Latest</td>
<td>14-Sep</td>
</tr>
</tbody>
</table>

F. Lamm, K-State NWREC
Upcoming Opportunities

• CYA: January 16-17, Oberlin
  – www.northwest.ksu.edu/CoverYourAcres

• KARTA: January 18-19, Junction City
  – www.kartaonline.org

• Central Plains Irrig., Colby, Feb 20-21
  – www.ksre.ksu.edu/sdi/events

Questions?
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