
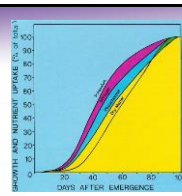

# Western Kansas Corn Production Update

Lucas Haag Ph.D., Asst. Professor/Northwest Area Agronomist
K-State Northwest Research-Extension Center, Colby

K-STATE Research and Extension

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# Some topics….

- Yield Components
- Spacing and Uniformity of Emergence
- Seeding Rate Response
- Hybrid Characterization
- Hybrid Maturity x Date of Planting Probabilities
- Water Management

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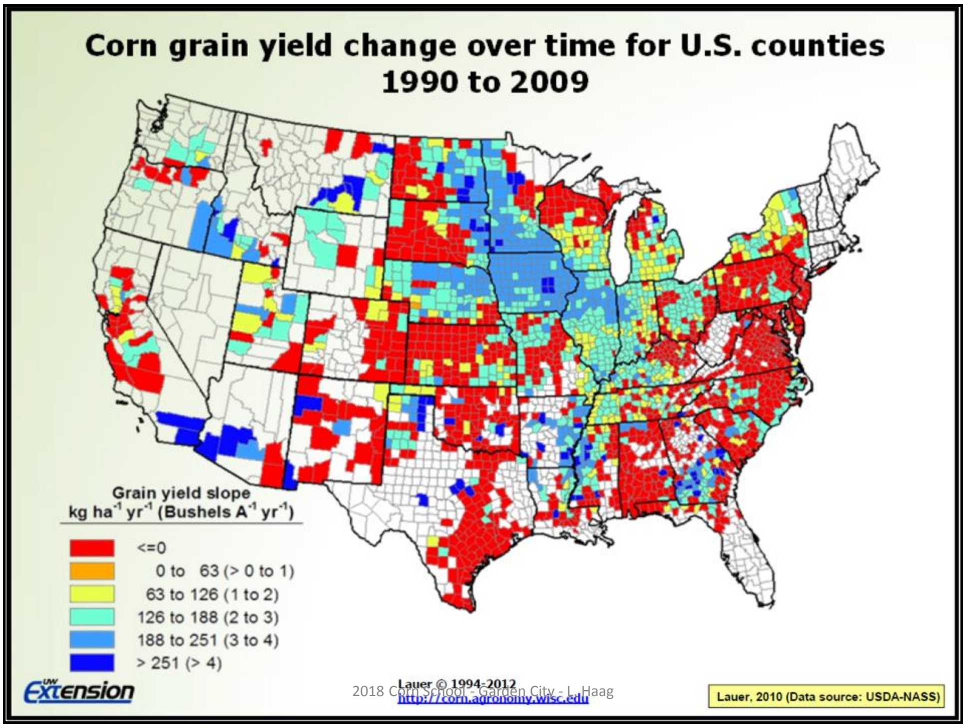


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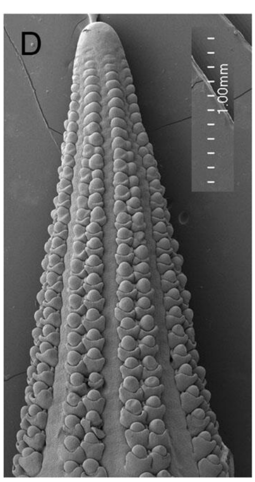
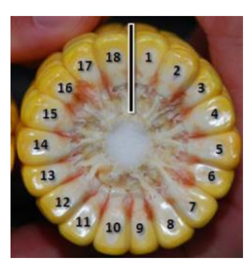
## V6 – Maximum number of Kernel Rows




- Severe stress: Moisture, Fertility, etc., can inhibit this process
- Not fixed until later in growth and development

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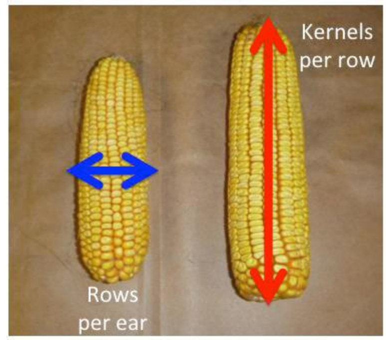
# Just Prior to R1

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

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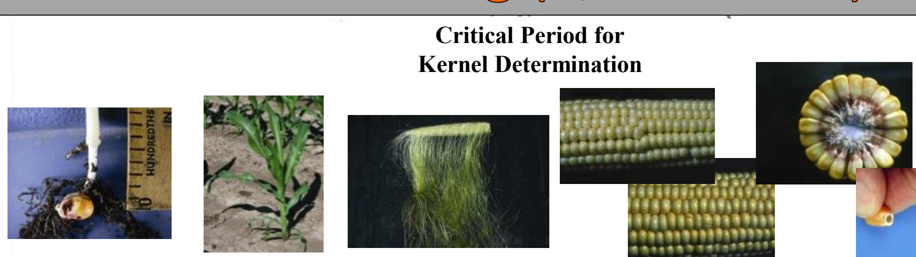
# Maize Phenological Stages


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




Ciampitti et al. (unpublished)



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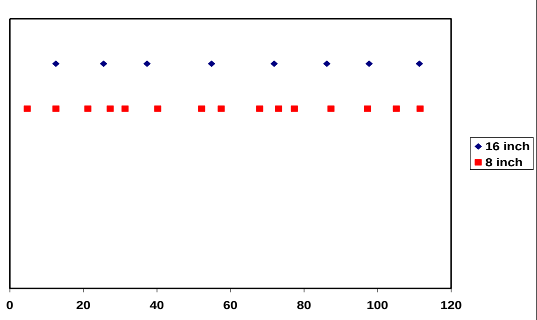
# Corn Spacing and Emergence: How big are the issues?



# 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)

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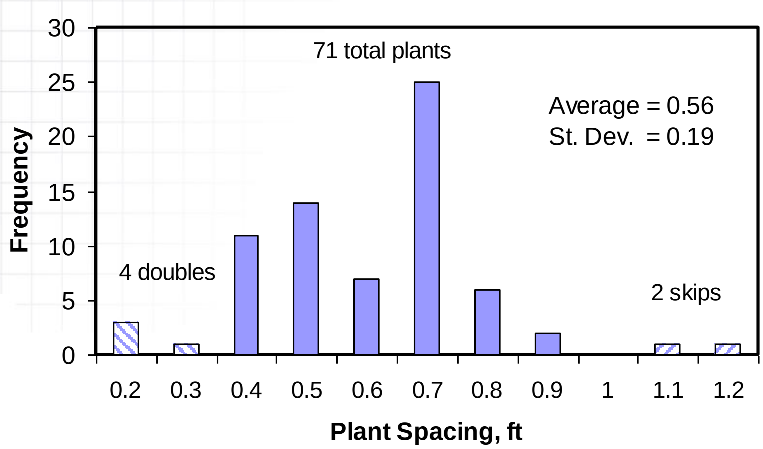
# Skips and Doubles

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# 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.

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# 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).

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# 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 barreness 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.

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# 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"

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# 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.

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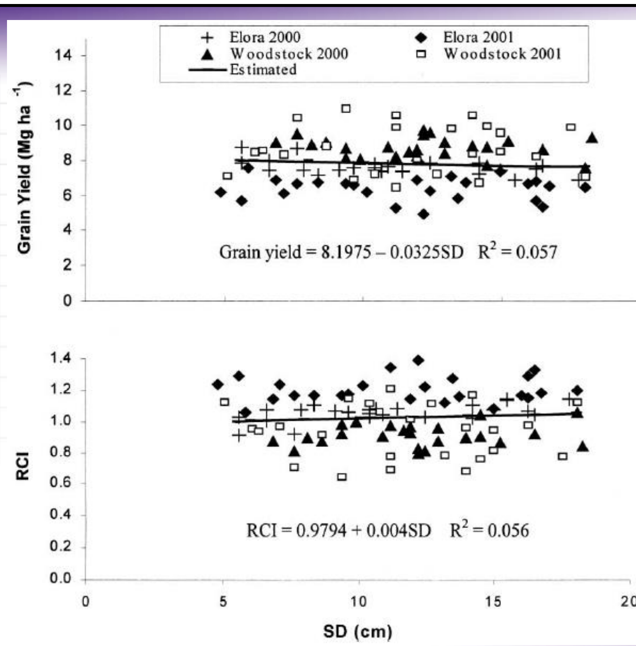


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# Garden City - Control vs. Treatments (one-way analysis)

Corn Stand Reduction Study
Garden City, KS 2008 - 2011

| Stage | Reduction | Yield | Vs. Contrtol | Dunnett Adjusted P |
|---|---|---|---|---|
| Control | | 183.0 | | |
| V5 | 25 | 169.0 | -14.0 | 0.6931 |
| V5 | 50 | 156.2 | -26.9 | **0.0262** |
| V5 | 75 | 88.0 | -95.0 | **<0.0001** |
| V8 | 25 | 169.7 | -13.3 | 0.7564 |
| V8 | 50 | 137.3 | -45.7 | **<0.0001** |
| V8 | 75 | 81.0 | -102.0 | **<0.0001** |
| V11 | 25 | 174.1 | -8.9 | 0.9780 |
| V11 | 50 | 130.1 | -52.9 | **<0.0001** |
| V11 | 75 | 72.0 | -111.0 | **<0.0001** |
| V14 | 25 | 146.9 | -36.2 | **0.0007** |
| V14 | 50 | 126.2 | -56.8 | **<0.0001** |
| V14 | 75 | 69.1 | -113.9 | **<0.0001** |

No difference between control and 25% removal treatments at V5, V8, and V11

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# What about uniformity of emergence?



# Delayed Emergence Results – Nafziger 2006

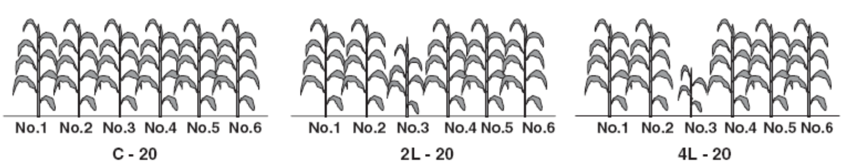
| Seed | Days to 90% Emergence | Duration of Emergence (days) | Yield (bu/acre) | Final Stand (plants/acre) |
|---|---|---|---|---|
| Uncoated | 7 | 2 | 208.7 | 33,189 |
| ½ coated | 17 | 17 | 185.7 | 33,686 |
| Coated | 20 | 11 | 176.4 | 32,100 |
| LSD(0.05) | | | 20.1 | NS |

# 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.



# Emergence Results – Tollenaar 2006




| Treatment | Plant position 1 | 2 | 3 | 4 | 5 | 6 | Plot |
|---|---|---|---|---|---|---|---|
| | Grain yield or difference (bu/acre) | | | | | | |
| Control | 119.6 | 126.4 | 113.4 | 110.2 | 113.5 | 118.1 | 116.9 |
| 2-leaf delay | 1.3 | 1.6 | -44.2‡ | 6.4 | 4.8 | 1.0 | -4.8‡ |
| 4-leaf delay | 2.6 | 5.4 | -89.3‡ | 10.2 | 9.1 | 2.9 | -9.9‡ |

‡ Significantly different from control

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# Plant Hierarchies in Maize

*Pagano and Maddonni, 2007*

- Plant variability in above ground biomass increased through the season, CV of 1.2% at 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

## Historical Yield Changes: Plant Density Effect

**Historical studies in plant density effect on corn yields showed increases in plants/acre**

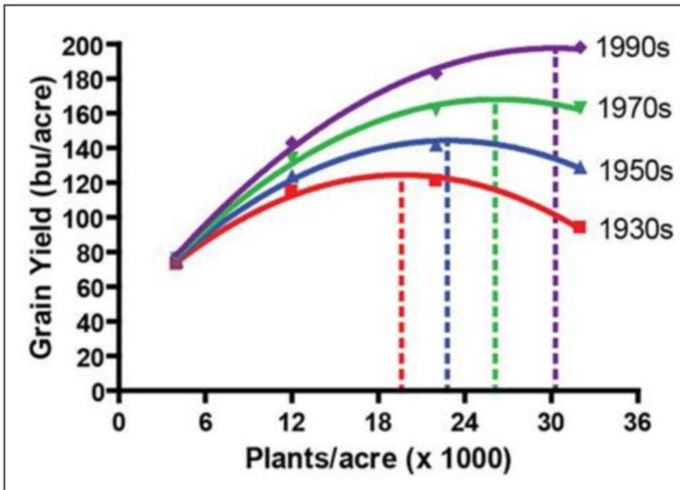


**Figure 1.** Grain yield response to plant population of hybrids from four eras of plant breeding (Duvick, 1993).

Pioneer website

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## DATA Overview

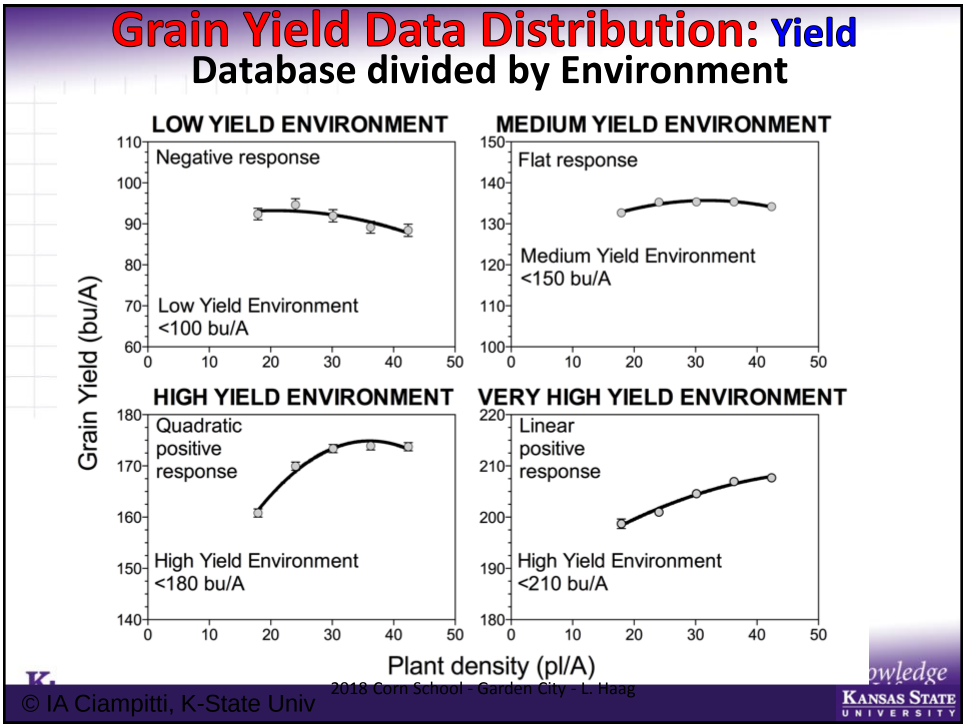
A "big data" analysis was conducted, Dupont Pioneer database, from 2000 to 2014 period (+120K points).

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
Grain Yield (bu/A)
Plant density (pl/A)
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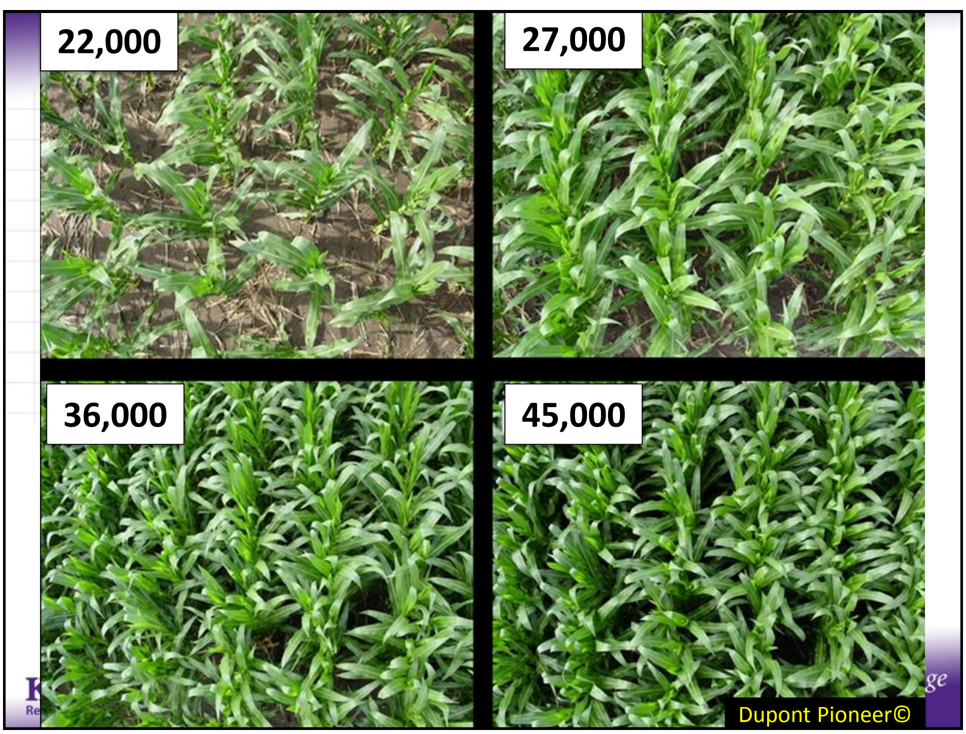
22,000
27,000
36,000
45,000
Dupont Pioneer©

# 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

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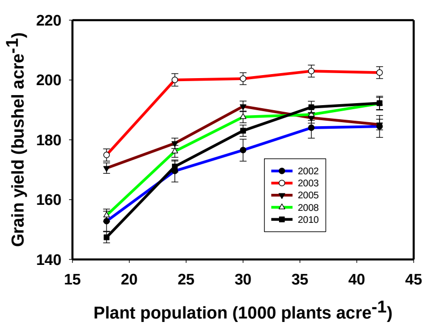
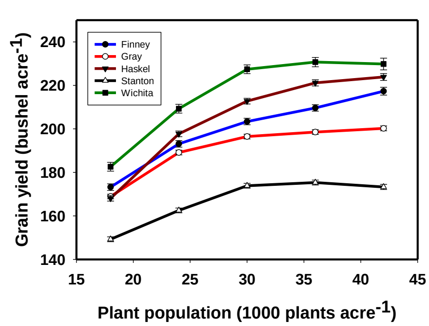
# Optimal Seeding Rate: "Between-years" and "Counties"

## "Between-years"




## "Counties"




**Optimal seeding rate was influenced by the year and the location (county) but primarily dependent on the yield environment**

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# On-Farm Hybrid Characterization

*Developing data for VRS implementation*

**Lucas A. Haag Ph.D.**

*Assistant Professor / Northwest Area Agronomist*
*K-State Northwest Research-Extension Center, Colby, Kansas*

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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

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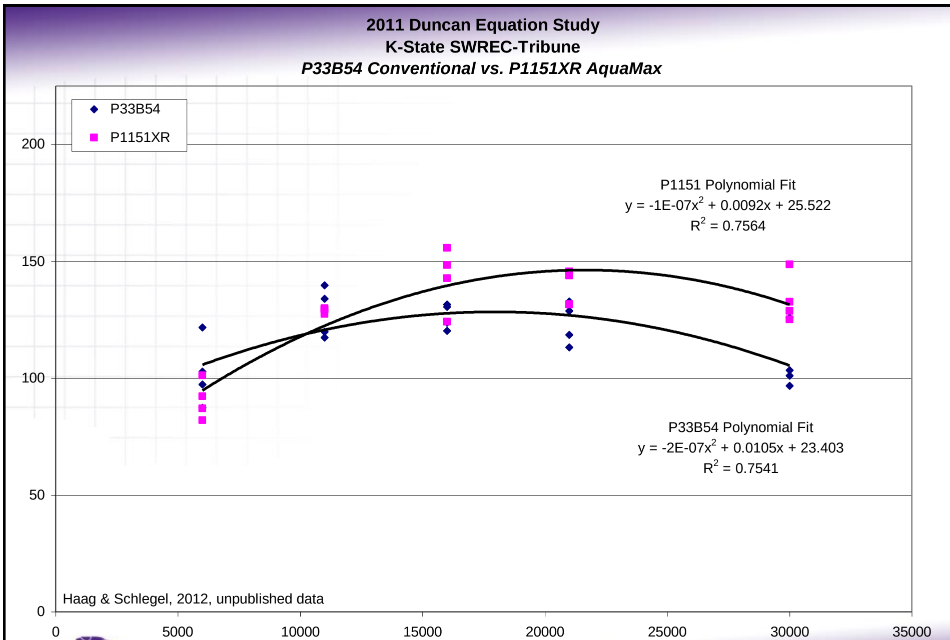


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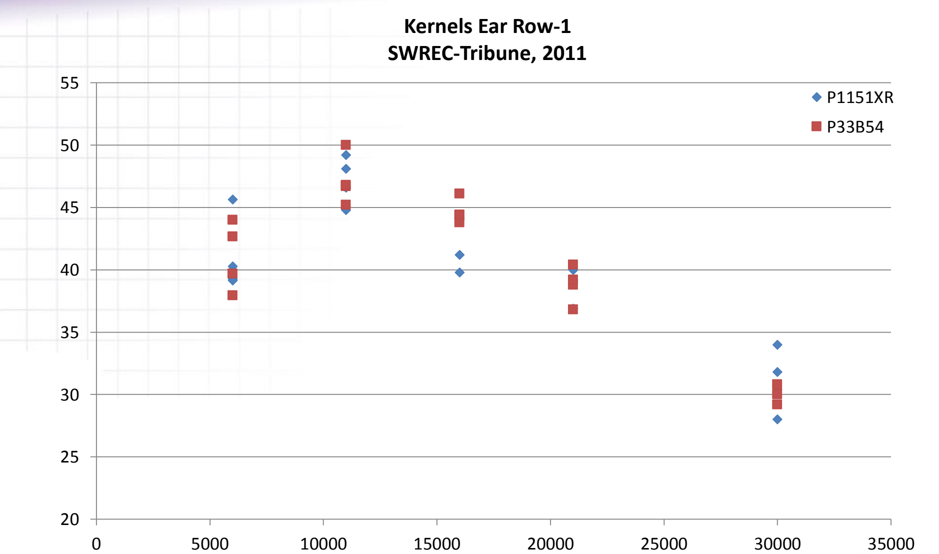


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# 2016 Field Trials

- 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
  - 5 Seeding Rates: 8.1, 14.2, 17.2, 20.7, 27k/ac
  - 4 Replications in a SPD
- Yield, Kernel Rows, Kernels per Row, Kernel Wt.

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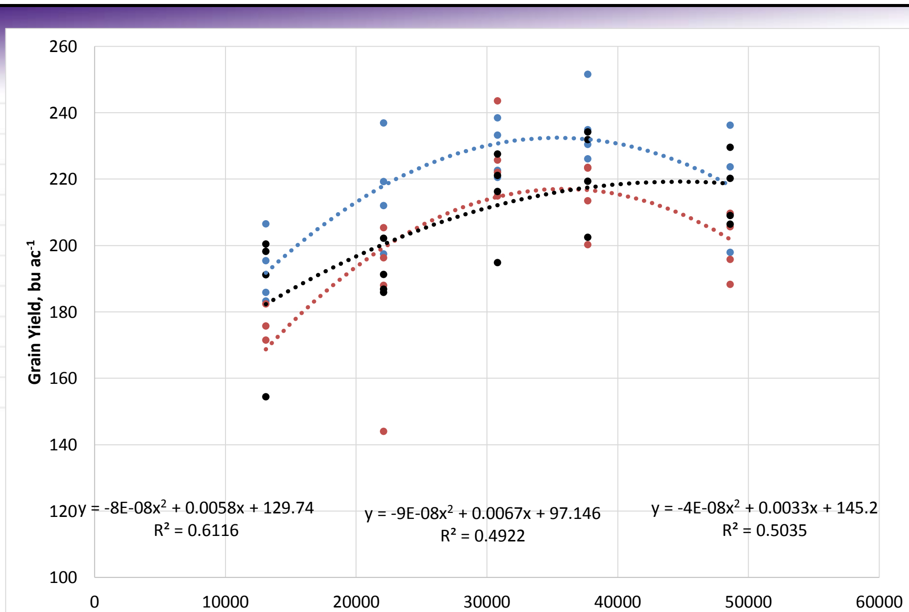


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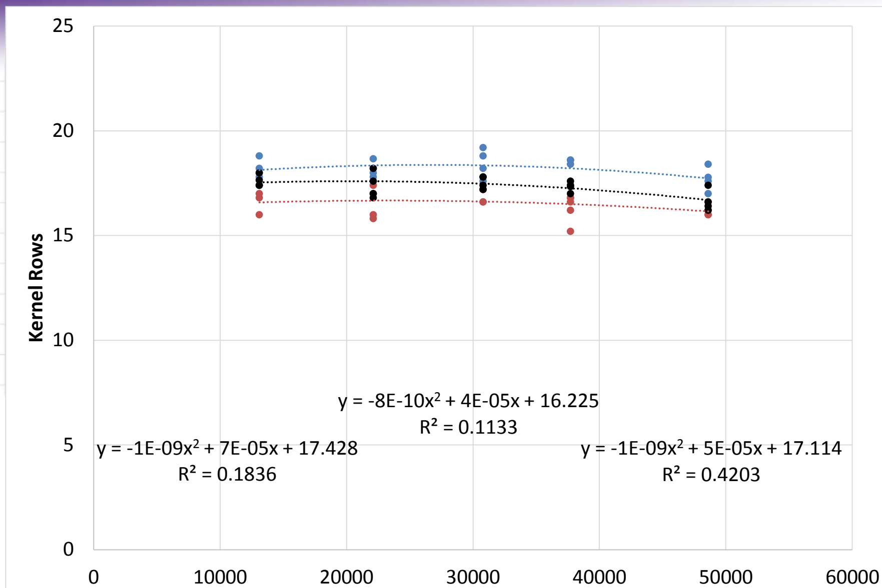


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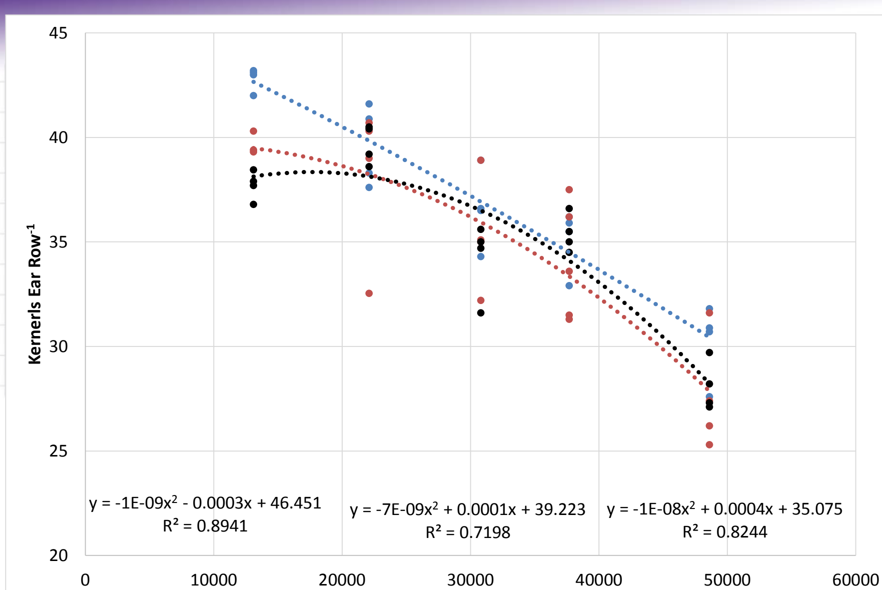


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# 2016-2017 Field Trials

- 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.

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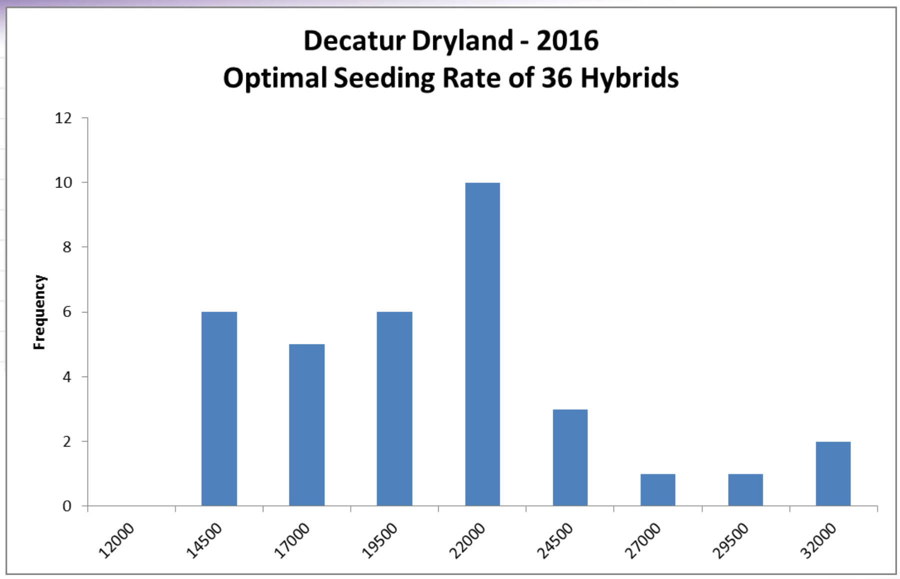


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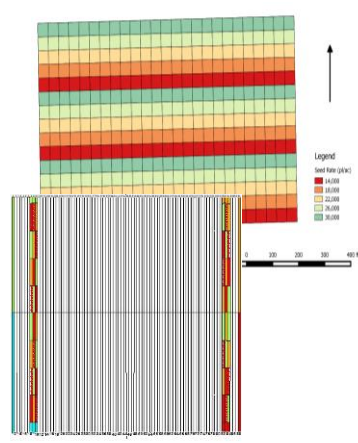
# On-Farm Seeding Rate Trials

- 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?



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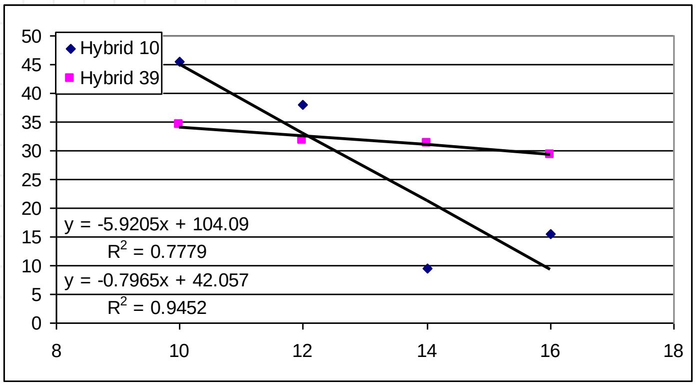
# Population response of two hybrids




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

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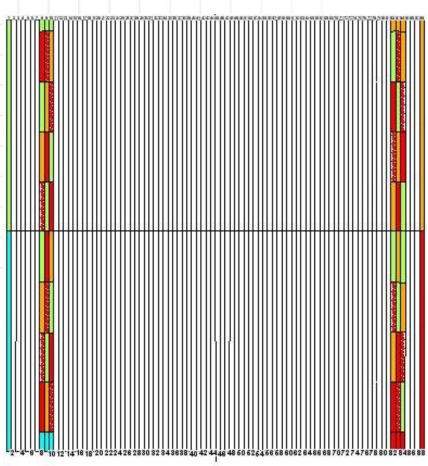
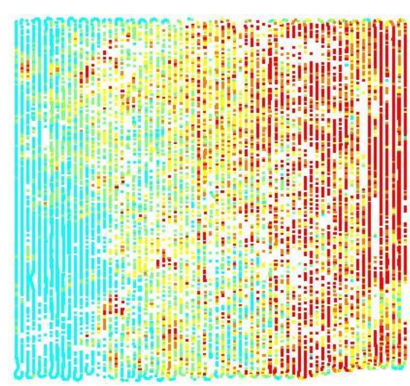
# Using Field Variability to Guide Plot Placement….. Learn More





0-3’ Soil EC

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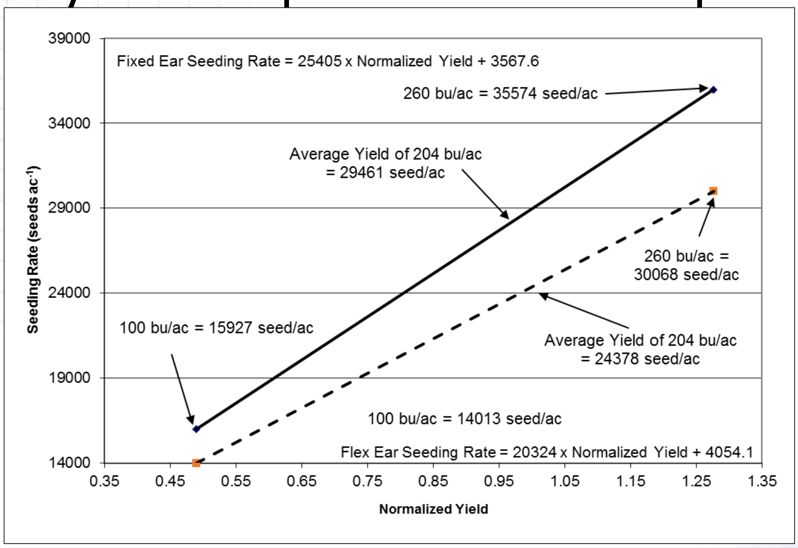
# Hybrid Response to VRS Scripts

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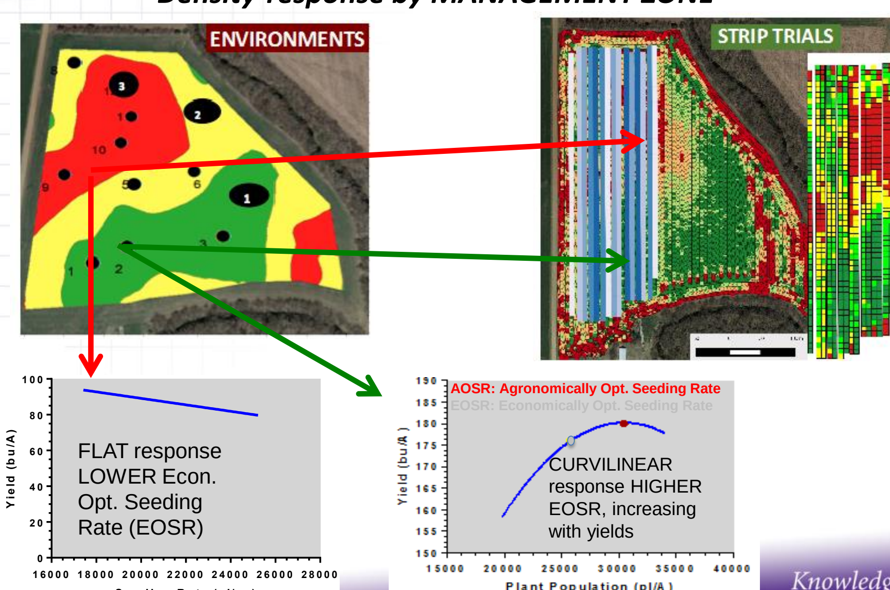
# Optimal Seeding Rate: "Within-a-field"

***Density-response by MANAGEMENT ZONE***

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# Double-planted and planter technologies

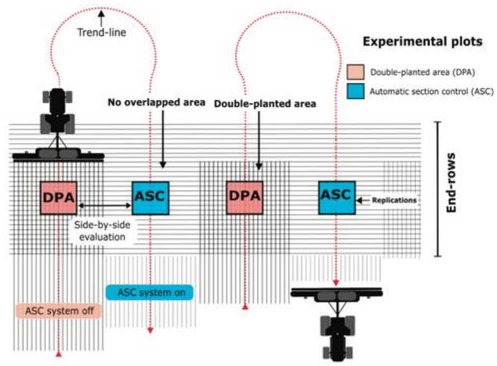



Fig. 1. Experimental plot layout and location in double-planted area (DPA) and without over-planting by utilization of automatic section control (ASC) controlled row-by-row for both corn and soybean crops during 2015/2016 and 2016/2017 growing seasons,

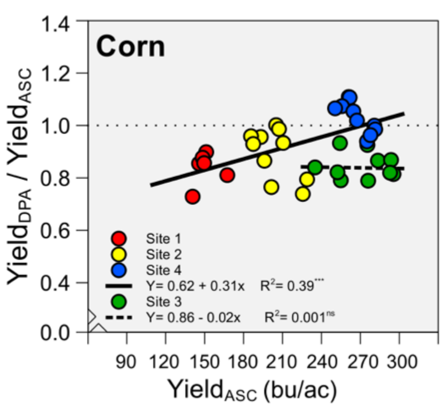
**DPA = double planted area**

**ASC = automatic section control**





# Double-planted and planter technologies





# Planting Date x Maturity Probabilities

| Historical Probability of Reaching Black Layer Before a 28° F Freeze - Garden City 1948-2016 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hybrid | | Planting Date | | | | | | | | | | |
| Relative Maturity | Black Layer GDU | 17-Apr | 24-Apr | 1-May | 8-May | 15-May | 22-May | 29-May | 5-Jun | 12-Jun | 19-Jun | 26-Jun |
| 118 | 2815 | 98.6% | 98.6% | 98.6% | 97.1% | 94.2% | 88.4% | 75.4% | 58.0% | 20.3% | 11.6% | 1.4% |
| 113 | 2768 | 98.6% | 98.6% | 98.6% | 98.6% | 95.7% | 89.9% | 76.8% | 69.6% | 29.0% | 14.5% | 2.9% |
| 110 | 2670 | 100.0% | 100.0% | 100.0% | 98.6% | 98.6% | 94.2% | 89.9% | 79.7% | 55.1% | 20.3% | 7.2% |
| 108 | 2604 | 100.0% | 100.0% | 100.0% | 100.0% | 98.6% | 98.6% | 94.2% | 87.0% | 69.6% | 33.3% | 14.5% |
| 105 | 2520 | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 98.6% | 98.6% | 92.8% | 81.2% | 55.1% | 20.3% |
| 103 | 2463 | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 98.6% | 97.1% | 88.4% | 69.6% | 29.0% |
| 96 | 2357 | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 97.1% | 84.1% | 55.1% |
| 91 | 2250 | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 92.8% | 78.3% |
| Average GDU | | 3477 | 3407 | 3336 | 3258 | 3167 | 3064 | 2953 | 2833 | 2696 | 2546 | 2386 |
| Maximum GDU | | 4055 | 3978 | 3895 | 3788 | 3636 | 3593 | 3466 | 3332 | 3171 | 3029 | 2870 |
| Minimum GDU | | 2738 | 2727 | 2684 | 2646 | 2575 | 2502 | 2453 | 2367 | 2264 | 2117 | 1972 |

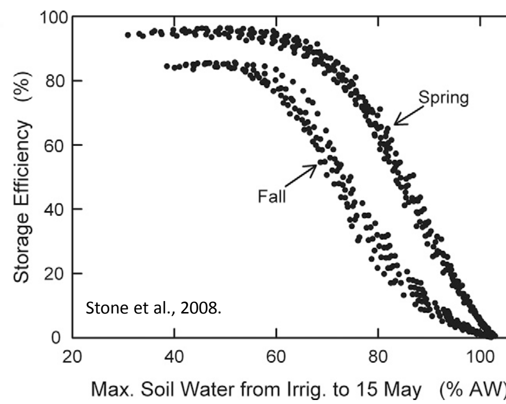
www.northwest.ksu.edu/agronomy



# 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

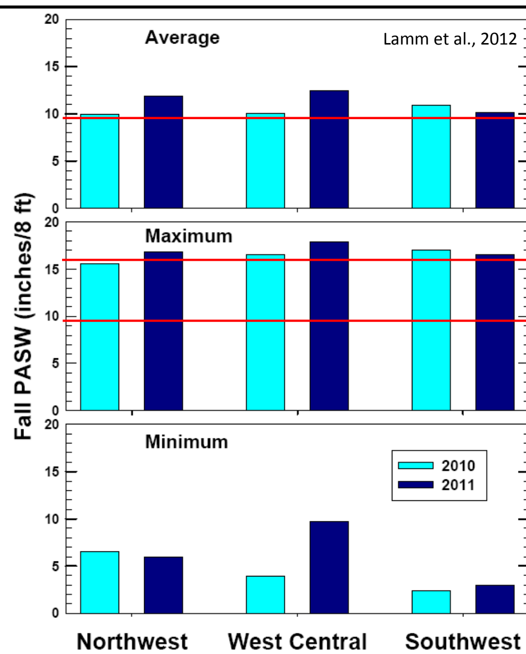





# Potential Water Loss

In an 8' profile, 60% available soil water would be approximately 9.6" in a Western Kansas silt-loam soil

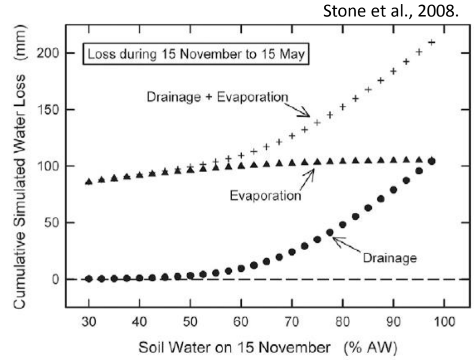
Storage efficiency of additional water approaches zero at 100% ASW, or 16" in this case



# 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

Stone et al., 2008.

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# Irrigation Termination

| Stage of Growth | Approximate number of days to maturity | Water use to maturity (inches) |
|---|---|---|
| Corn | | |
| Blister | 45 | 10.5 |
| Dough | 34 | 7.5 |
| Beginning dent | 24 | 5 |
| Full dent | 13 | 2.5 |
| Black layer | 0 | 0 |
| | | |
| Grain Sorghum | | |
| Mid bloom | 34 | 9 |
| Soft dough | 23 | 5 |
| Hard dough | 12 | 2 |
| Black layer | 0 | 0 |
| | | |
| Soybeans | | |
| Full pod | 37 | 9 |
| Beginning seed | 29 | 6.5 |
| Full seed | 17 | 3.5 |
| Full maturity | 0 | 0 |

Adapted from K-State MF2174, Rogers and Sothers.

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# Timing of Irrigation Termination

| Year | Date of Anthesis | Date of Maturity | Irrigation Season Termination Date For | | |
|---|---|---|---|---|---|
| | | | 80% Max Yield | 90% Max Yield | MaxYield |
| 1993 | 20-Jul | 30-Sep | 5-Aug | 5-Aug | 15-Aug |
| 1994 | 20-Jul | 15-Sep | 5-Aug | 15-Aug | 15-Aug |
| 1995 | 20-Jul | 29-Sep | 5-Aug | 13-Aug | 18-Aug |
| 1996 | 20-Jul | 3-Oct | 17-Jul | 17-Jul | 29-Aug |
| 1997 | 23-Jul | 1-Oct | 23-Jul | 23-Jul | 27-Aug |
| 1998 | 20-Jul | 28-Sep | 20-Jul | 20-Jul | 24-Aug |
| 1999 | 23-Jul | 6-Oct | 24-Jul | 13-Aug | 20-Sep |
| 2000 | 12-Jul | 20-Sep | 14-Sep | 20-Sep | 20-Sep |
| 2001 | 16-Jul | 29-Sep | 30-Jul | 22-Sep | 22-Sep |
| 2002 | 22-Jul | 30-Sep | 4-Aug | 30-Aug | 7-Sep |
| 2003 | 22-Jul | 23-Sep | 3-Aug | 3-Aug | 18-Aug |
| 2004 | 19-Jul | 28-Sep | 8-Aug | 21-Aug | 27-Aug |
| 2005 | 20-Jul | 28-Sep | 2-Aug | 9-Aug | 29-Aug |
| 2006 | 17-Jul | 25-Sep | 30-Jul | 13-Aug | 13-Aug |
| 2007 | 18-Jul | 19-Sep | 14-Aug | 21-Aug | 28-Aug |
| 2008 | 24-Jul | 10-Oct | 31-Jul | 6-Aug | 27-Aug |
| **Average** | **19-Jul** | **27-Sep** | **2-Aug** | **13-Aug** | **28-Aug** |
| **Standard Dev.** | **3 days** | **6 days** | **13 days** | **19 days** | **13 days** |
| **Earliest** | **12-Jul** | **14-Sep** | **17-Jul** | **17-Jul** | **12-Aug** |
| **Latest** | **24-Jul** | **10-Oct** | **14-Sep** | **21-Sep** | **21-Sep** |

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

F. Lamm, NWREC

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

| Statistics for 16 years 1993-2008 | Irrigation Season Termination Date For | | |
|---|---|---|---|
| | 80% Max Yield | 90% Max Yield | MaxYield |
| Mean | 2-Aug | 13-Aug | 28-Aug |
| Standard Deviation | 13 days | 19 days | 13 days |
| *Earliest* | *17-Jul* | *17-Jul* | *12-Aug* |
| *Latest* | *14-Sep* | *21-Sep* | *21-Sep* |

F. Lamm, K-State NWREC

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# 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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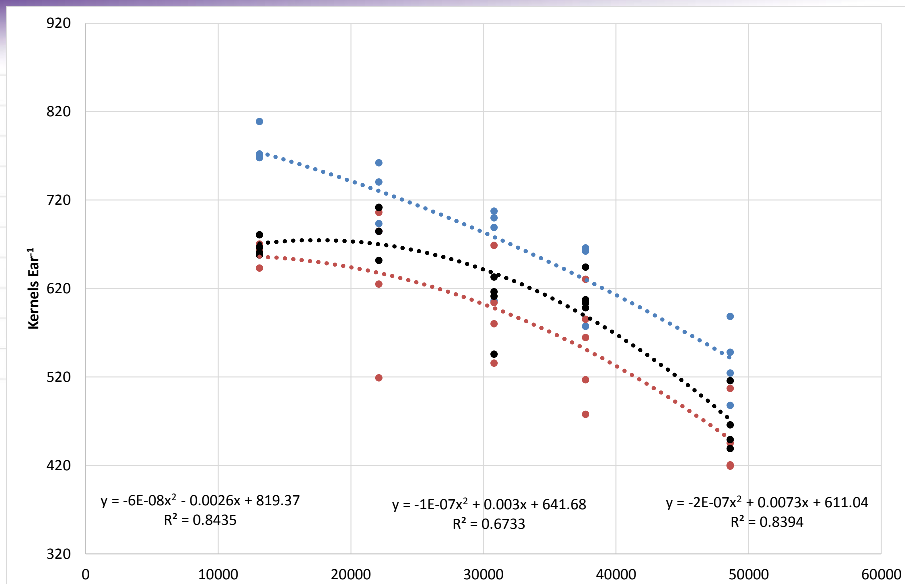


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