Variable Rate Corn Seeding Based on Spatially Variable Growing Season Water Supply

Lucas A. Haag, Graduate Research Assistant
Precision Agriculture – Dryland Cropping Systems

Scott A. Staggenborg, Professor
Cropping Systems

K-STATE Kansas State University RESEARCH & EXTENSION

Corn Population Recommendations

- Recommendations are based on yield potential
- Yield potential in Kansas is largely driven by growing season water supply

Northwest (dryland)	13,000 to 18,000
Northeast	18,000 to 24,000
East central and Southeast	16,000 to 20,000
Central	14,000 to 18,000
Irrigated	24,000 to 30,000
Limited irrigation	16,000 to 25,000

Corn Production Handbook. D.L Fjell, R.L. Vanderlip, K.L. Roozeboom, Kansas State University. 1994.

Plants/acre	.5 lb ear	.6 lb ear
8,000	57	69
12,000	86	103
16,000	114	137
20,000	143	171
24,000	171	206
28,000	200	240

Adapted from NebGuide G79-487. University of Nebraska - Extension

K-STATE Kansas State University RESEARCH & EXTENSION

Variability in Growing Season Water Supply

- Physical Environment
  - Rainfall
  - Plant available water (FC-PWP)
  - Infiltration rates
  - Topography
- Management
  - Irrigation
  - Evaporative losses (residue management)

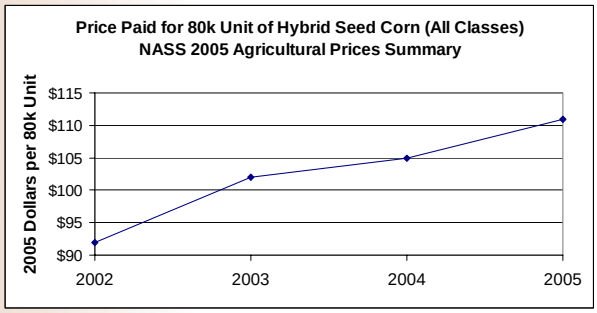
K-STATE Research & Extension
Kansas State University

Attempts at Variable Rate Corn Seeding

- Bullock et al., 1998. Found economic returns to variable rate seeding varied between \$0.15 to \$12.83 ha^{-1} based on the level of information available to the producer and ignoring cost of technology adoption.
- Barnhisel et al., 1999. Returns varied between -\$15.77 to \$50.90 with an overall increase of \$16.42 ha^{-1}.

K-STATE Research & Extension
Kansas State University

We operate in a changing world



- Hydraulic variable rate drives are quickly becoming standard equipment on new planters.
- The adoption of consoles capable of controlling the drives is becoming standard for other purposes such as liquid fertilizer control and variety logging.

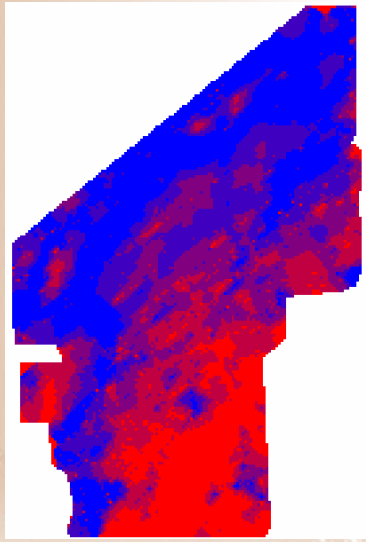
K-STATE Research & Extension
Kansas State University

Objective

Improve economic returns utilizing variable rate corn seeding based on spatially variable plant available water.

K-STATE Research & Extension
Kansas State University

Variability in Plant Available Water



$0.164 - 0.033\ (cm^3)(cm^3)^{-1}$

- Spatial variability in soil type leads to variability in plant available water.
- 54 Sample points within field
- 1/3 and 15 bar water contents tested
- Soil electro-conductivity was used in co-kriging to generate plant available water map

K-STATE Research & Extension Kansas State University

Methods – Small Plot Research

- Locations for small plots were selected based on extremes in spatial plant available water.
- Plots consisted of 5 population treatments replicated 4 times in a randomized complete block design.
- Treatments of 52, 60, 67, 71, 80k plants ha^{-1} were used.

K-STATE Research & Extension Kansas State University

Methods – Small Plot Research

- Plots were planted by the producer at 99k plants ha^{-1} and hand thinned.
- The center two rows of each four row plot were hand harvested.
- Proc GLM by Location was used to test the population main effect.

K-STATE Research & Extension Kansas State University

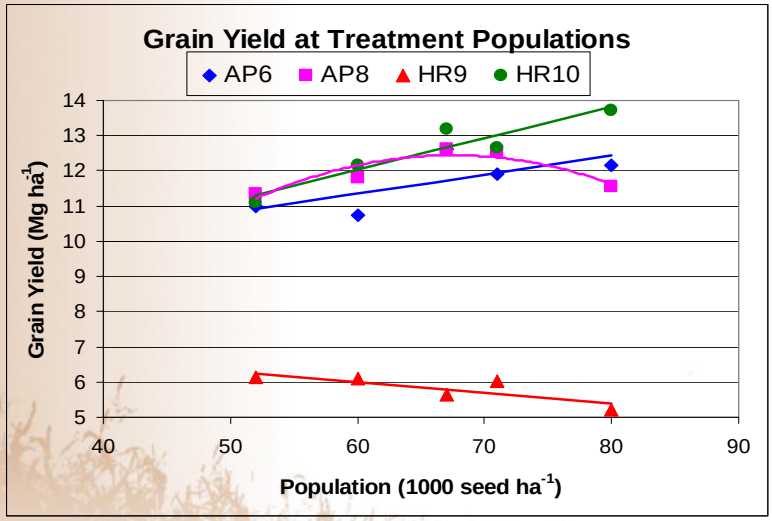
Small Plot Results

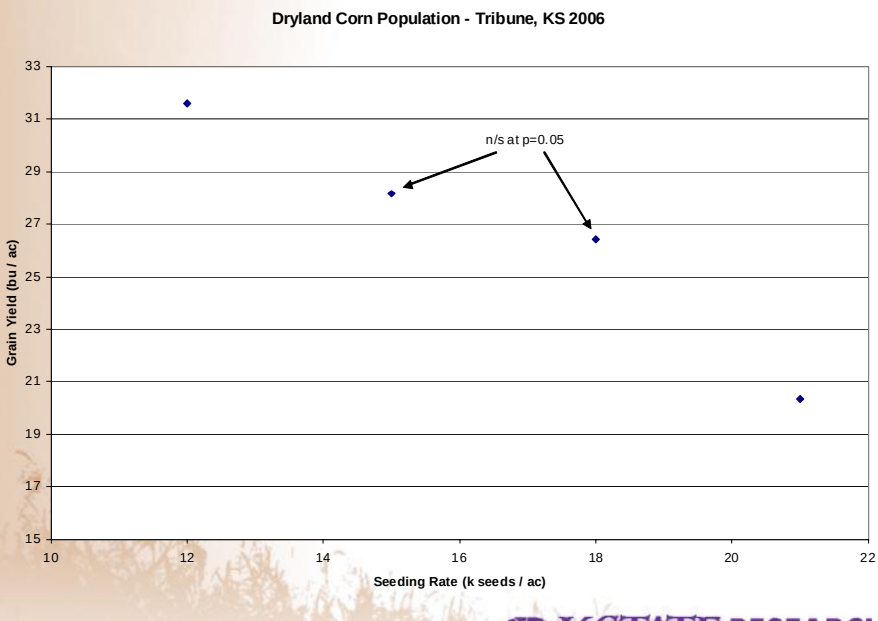
Grain Yield (kg ha^{-1}) at Treatment Populations

Field	Plot	Pr > F	Population (1000 seeds ha^{-1})				
		alpha = 0.05	52	60	67	71	80
OG	1	n/s	-	-	-	-	-
	2	n/s	-	-	-	-	-
	3	n/s	-	-	-	-	-
AP	4	n/s	-	-	-	-	-
	5	n/s	-	-	-	-	-
	6	0.0828	10974	10723	12605	11915	12166
	7	n/s	-	-	-	-	-
	8	0.0748	11351	11789	12605	12542	11539
	11	n/s	-	-	-	-	-
HR	9	0.0046	6146	6083	5644	6020	5205
	10	<.0001	11100	12166	13169	12667	13733

K-STATE Research & Extension Kansas State University

Small Plot Results





Small Plot Results

Insignificant population main effect at some locations

- The insignificant population responses are significant from an economic point of view.
- The same yield can be obtained from 52k ha^{-1} as 80k ha^{-1}.
- The cost difference between 52k and 80k seeding rate (assuming \$111 / 80k seed unit) is \$38.85 ha^{-1}.
- Areas not responsive to varying levels of population likely have another yield limiting factor.

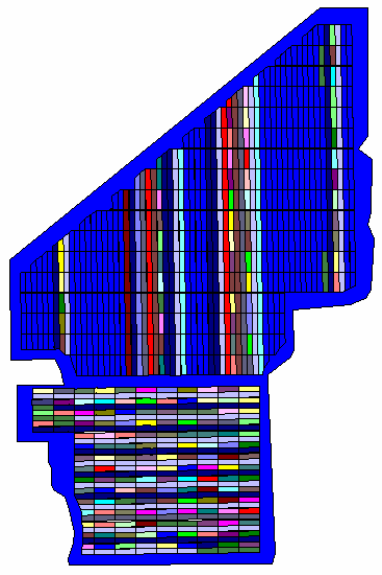
K-STATE Research & Extension
Kansas State University

Conclusions

- In this study yield was significantly affected by population in select environments.
- Yield responded to population at locations where growing season water supplies were at extremes.
- The ability to better identify these select environments would provide better opportunities for variable rate seeding.
- Insignificant responses in population are important from an economic point of view.

K-STATE Research & Extension
Kansas State University

Future Goals



Make use of field level research data.

Alternating strips of fixed populations and variable rate prescription.

Future Goals

- Quantify total growing season water supply factors, not just the portion associated with plant available water.
- Use the small plot data to better identify spatially where yield will respond to population differences.

Acknowledgements

Kramer Brother Farms, John Kramer, Junction City, Kansas

Steve Arnold, Johnson, Kansas

Haag Farms, Gayle Haag, Bartley, Nebraska

The entire staff at the Kansas State University Tribune Branch Experiment Station

Crop Production Research Group

- Fellow Grad Students: Sarah Evert, Mike Epler, Mauro Carignano, Chris Pachta
- Student Technicians: Derek Belton, Scott Kramer, Craig Pringle, Emily Bunk

Any Questions or Comments

Lucas Haag
lhaag@ksu.edu
(308) 340-1041 Mobile
(785) 532-7250 Office

References Cited

Bullock, D.G., D.S. Bullock, E.D. Nafziger, T.A. Doerge, S.R. Paszkiewicz, P.R. Carter, and T.A. Peterson. 1998. Does variable rate seeding of corn pay. Agron. J. 90:830-836

Barnhisel, R.I., S.A. Shearer, and M.J. Bitzer. 1999. A precision ag approach to study the economic benefits of varying seeding and nitrogen rates of con. In Agron. Abstracts. ASA-CSSA-SSSA Annual Meeting, Salt Lake City, UT. 31 Oct. – 4 Nov.