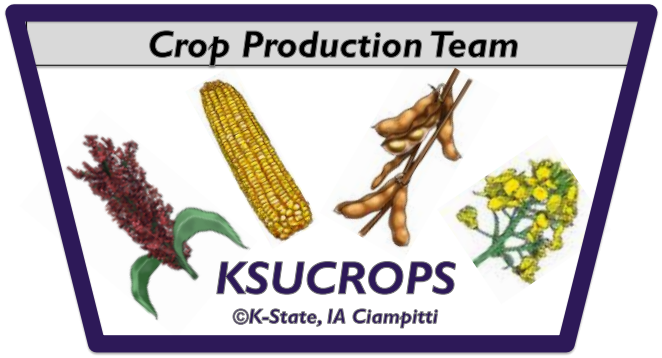
Balanced Nutrition & Crop Production Practices for Sorghum Nutrient Partitioning & Closing Yield Gaps

Ignacio A. Ciampitti, Cropping Systems Specialist
Bailey McHenry, MS Graduate Student
Department of Agronomy, K-State Univ.
ciampitti@ksu.edu , 785-410-9354
Crop Production Lab @KSUCROPS (TWITTER)

K-STATE Research and Extension



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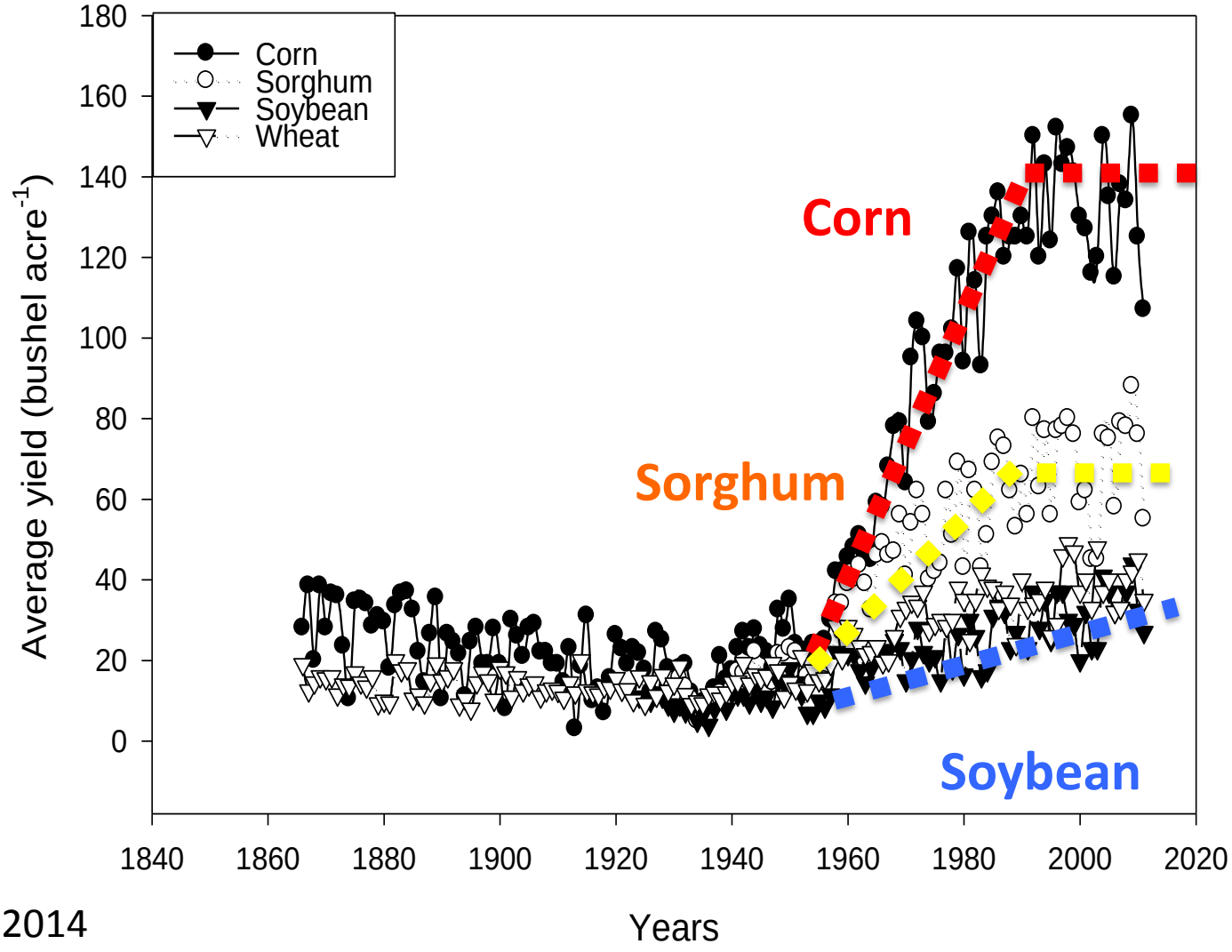
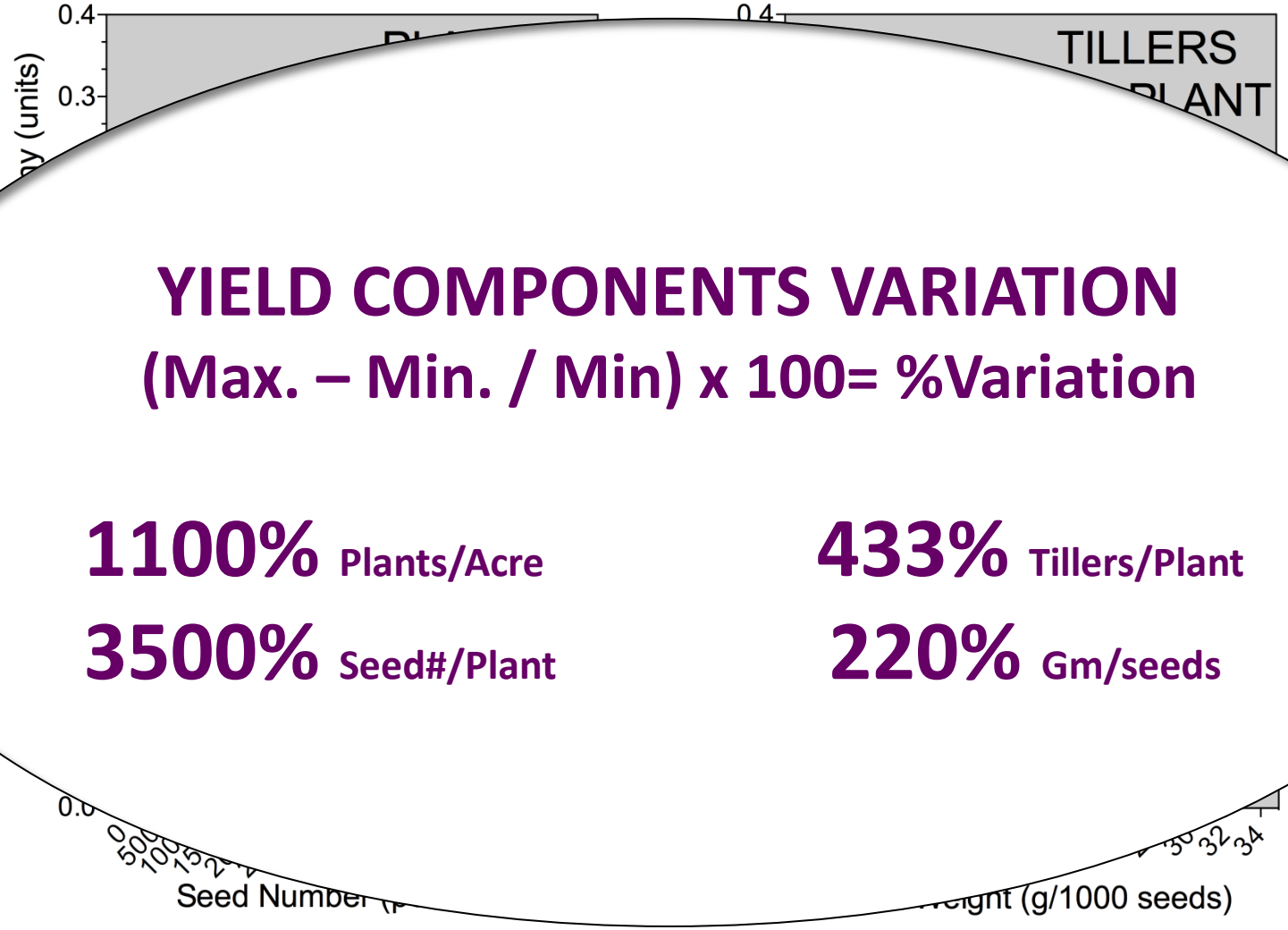
Historical Yield Evolutions: Kansas



Assefa et al. 2014

Management Practices: Sorghum
Identifying Critical Plant Components



YIELD COMPONENTS VARIATION

(Max. – Min. / Min) x 100= %Variation

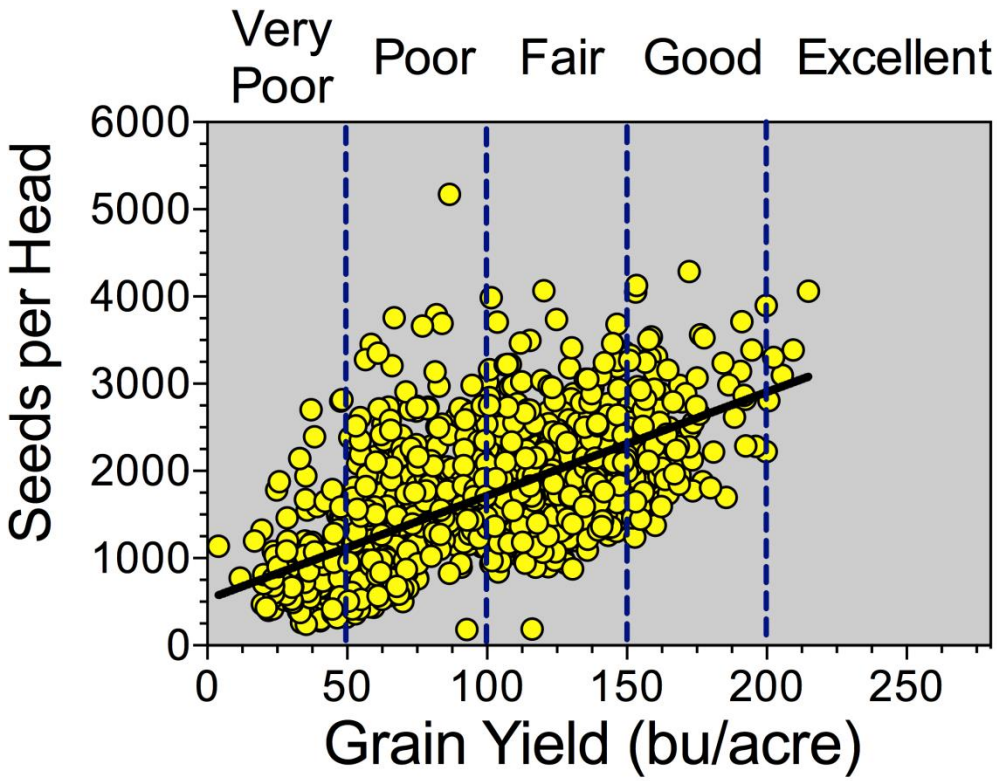
1100% Plants/Acre

433% Tillers/Plant

3500% Seed#/Plant

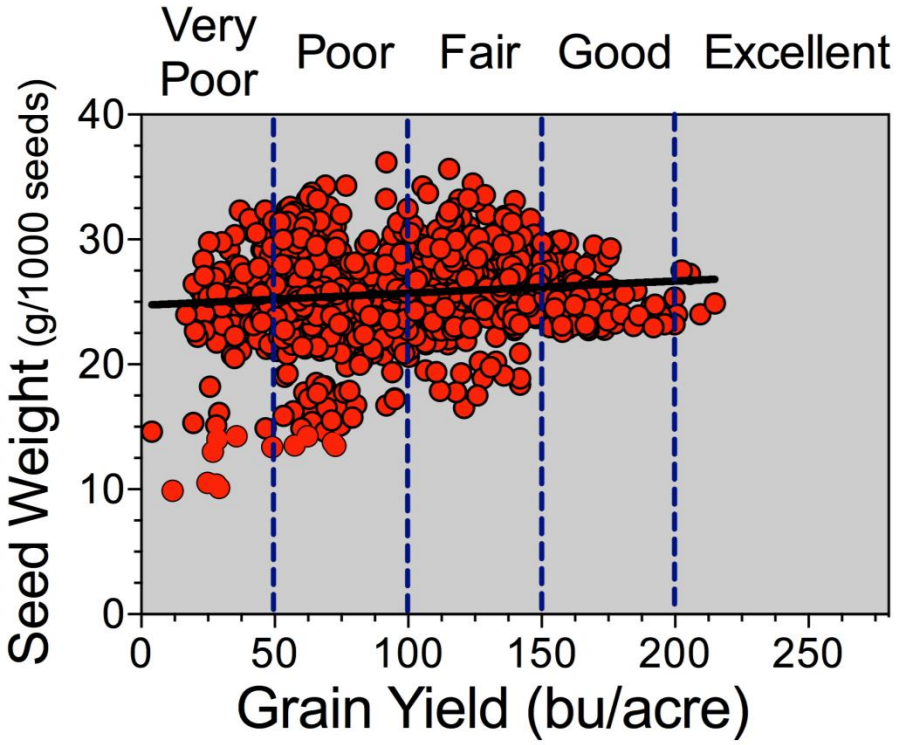
220% Gm/seeds

Management Practices: Understanding Sorghum Yield Components



Grain weight is slightly influencing ("flat trend") the final sorghum YIELD.

Grain number is the main YIELD component highly associated with the final sorghum YIELD.



Objectives

- Understand the effect of fertilizer applications and their interactions with diverse management practices
- Identify management factors that contribute to high sorghum yields
- Investigate nutrient uptake and partitioning under different environments and crop production practices (nutrient information is not yet available)

Materials & Methods

- **11 Treatments, 5 reps/location:**

1) (KS) Full Treatment or "Kitchen Sink" (high plant pop., 15" rows, GreenSeeker N, Insecticide/fungicide, micronutrients, starter fertilizer, plant growth regulator)
2) (PD) Plant Density (40,000 vs. 80,000)
3) (RS) Row Spacing (30" rows)
4) (Pre-N) Nitrogen (50 lbs/acre all at pre-planting)
5) (FI) Foliar Fungicide/Insecticide (Without chemicals)
6) (Micro) Foliar Micronutrients (Fe, Zn) (Without micronutrients)
7) (PGR) Plant Growth Regulator (Without PGR)
8) (NP) Fertilizer NPKS Starter (only NP starter)
9) (Cl) Chloride (Without Chloride)
10) (FP) Farmer Practice (Lower plant pop., wide rows, NP starter)
11) (KS+N) Non-limiting N = Kitchen Sink +N (Treatment #1 + 50 lbs extra N)

Treatments & Experimental Design

	Treatments										
	1 (KS)	2 (PD)	3 (RS)	4 (PD)	5 (F/I)	6 (Micros)	7 (PGR)	8 (NP)	9 (Cl)	10 (FP)	11 (KS+N)
Seeding rate	Optimum	Normal	Optimum	Optimum	Optimum	Optimum	Optimum	Optimum	Optimum	Normal	Optimum
Row Spacing	15"	15"	30"	15"	15"	15"	15"	15"	15"	30"	15"
N Program	GS	GS	GS	Standard	GS	GS	GS	GS	GS	Standard	GS
Fungicide/Insecticide	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Micronutrients	Fe, Zn	Fe, Zn	Fe, Zn	Fe, Zn	Fe, Zn	None	Fe, Zn	Fe, Zn	Fe, Zn	None	Fe, Zn
PGR	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Starter Fertilizer	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NP	NPKSZn	NP	NPKSZn
Chloride	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
GreenSeeker + N	No	No	No	No	No	No	No	No	No	No	Yes

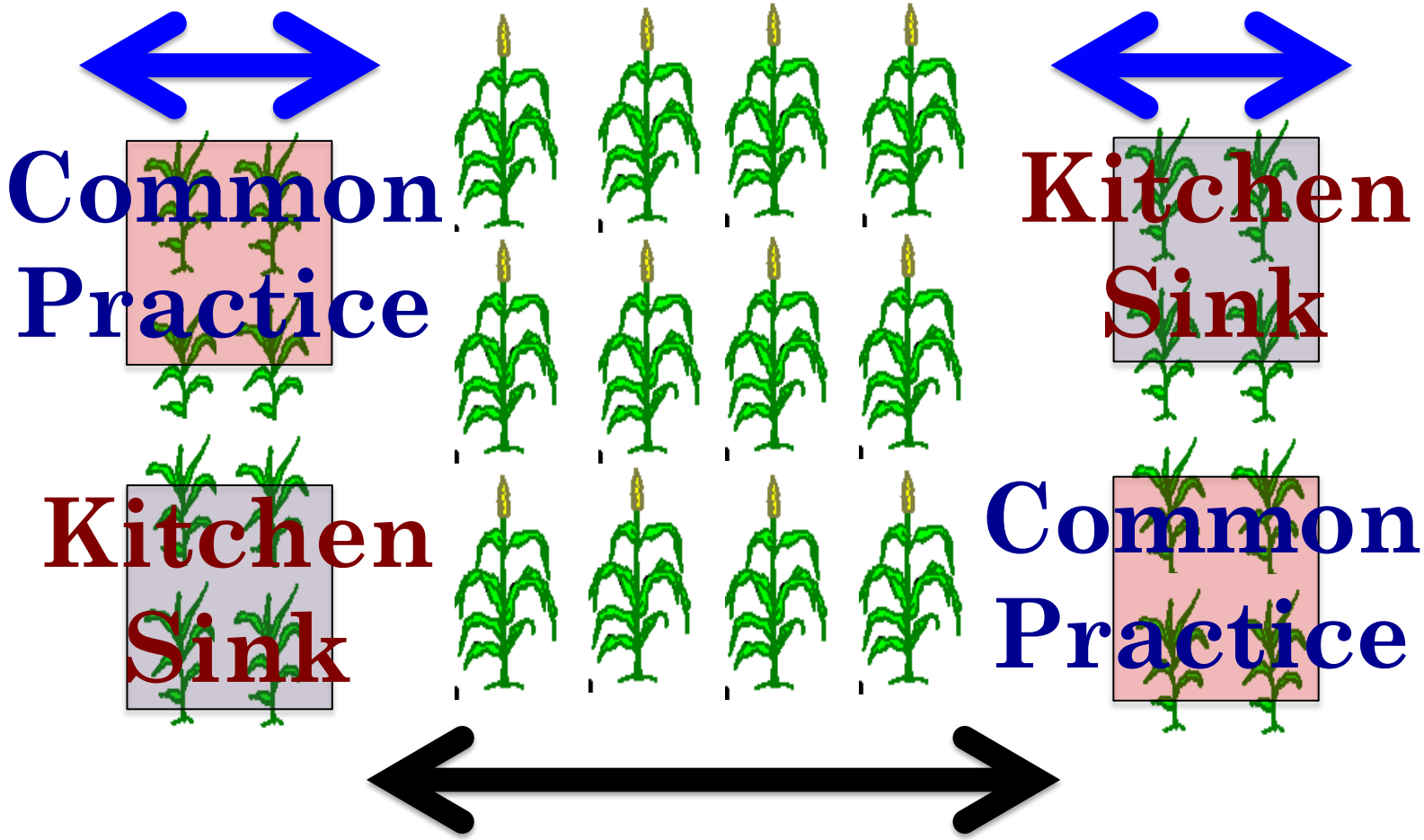
Soil Characterization

Soil parameters	Rossville	Scandia
Buffer pH (SMP)	7.4	6.6
Mehlich P (ppm)	22.7	27.2
Summation CEC (meq/100g)	5.6	28.5
OM (%)	1.2	2.8
K (ppm)	102.3	614.7

Crop Phenology

Plant Phenology	Rossville	Scandia
Planting Date	May 19	May 22
V-5 growth stage	June 27	July 2
Flowering	August 1	August 4
Mid-Reproductive	August 29	September 2
Harvest	September 26	November 14

Plot Layout



COMPARE **KITCHEN SINK, and other alternatives** vs. **COMMON PRACTICES in** SORGHUM

Treatments & Experimental Design

Treatment #	N	Average GreenSeeker N	Total N	P2O5	K2O	S	Cl	Fe	Zn	TOTAL N
	lbs per acre									
1	20	35	55	20	20	20	20	2	2	105
2	20	39	59	20	20	20	20	2	2	109
3	20	20	40	20	20	20	20	2	2	90
4	20	0	20	20	20	20	20	2	2	120
5	20	30	50	20	20	20	20	2	2	100
6	20	27	47	20	20	20	20	0	0	97
7	20	27	47	20	20	20	20	2	2	97
8	20	30	50	20	0	0	20	2	2	100
9	20	33	53	20	20	20	0	2	2	103
10	20	0	20	20	0	0	0	0	0	70
11	20	78	98	20	20	20	20	2	2	148

Application Rates:
Tilt (fungicide): 2-4 fl. oz. per acre
Sevin (insecticide): 1-2 quarts per acre
MCP-Agrofresh (plant growth regulator): 100 g per acre

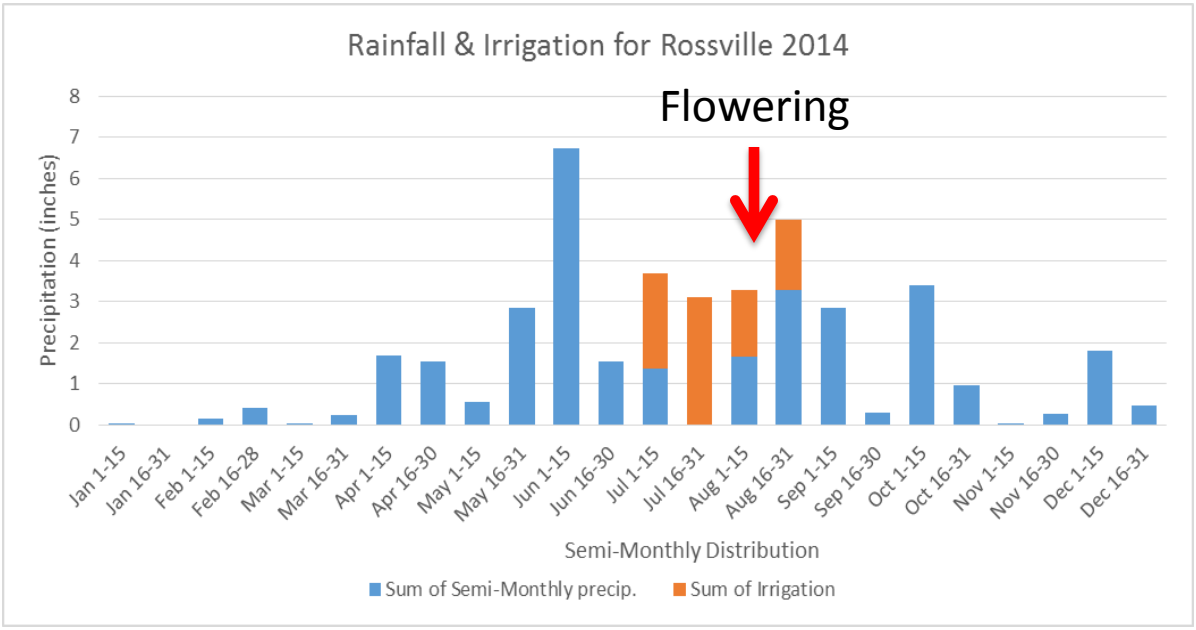
All chemicals were applied 15-20 days after flowering time

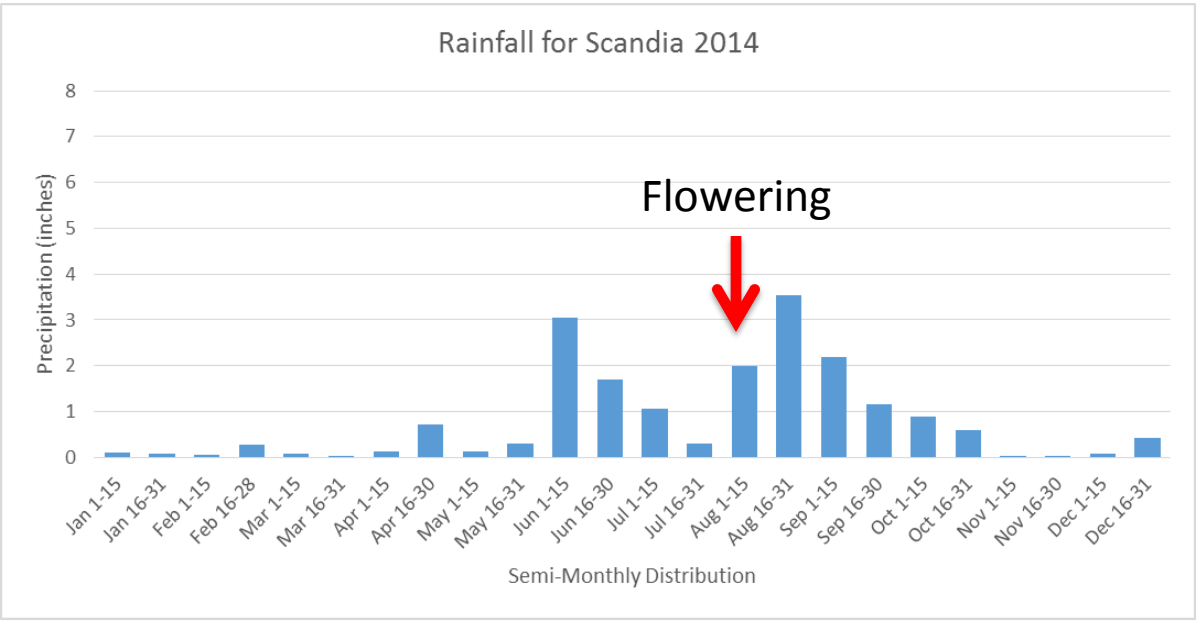
Treatment	PGR (g/plot)	Fungicide (mL/plot)	Insecticide (mL/plot)
1	1	1.4	11
2	1	1.4	11
3	1	1.4	11
4	1	1.4	11
5	1	0	0
6	1	1.4	11
7	0	1.4	11
8	1	1.4	11
9	1	1.4	11
10	0	0	0
11	1	1.4	11

Weather Conditions: 2014

Precipitation: 20 inch
Irrigation: extra 9 inch

Total Water: 29 inch

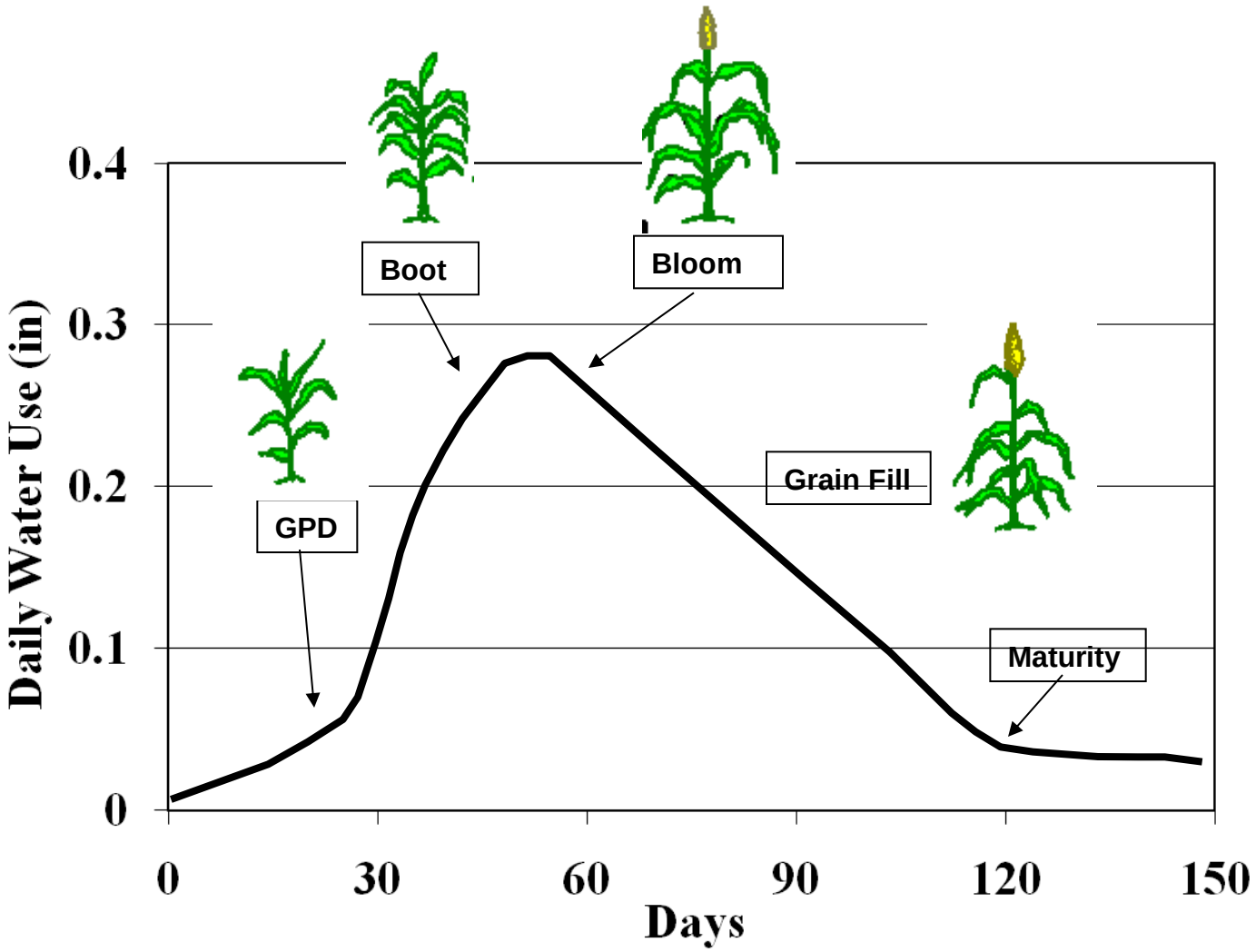




Precipitation: 16 inch
Irrigation: -

Total Water: 16 inch

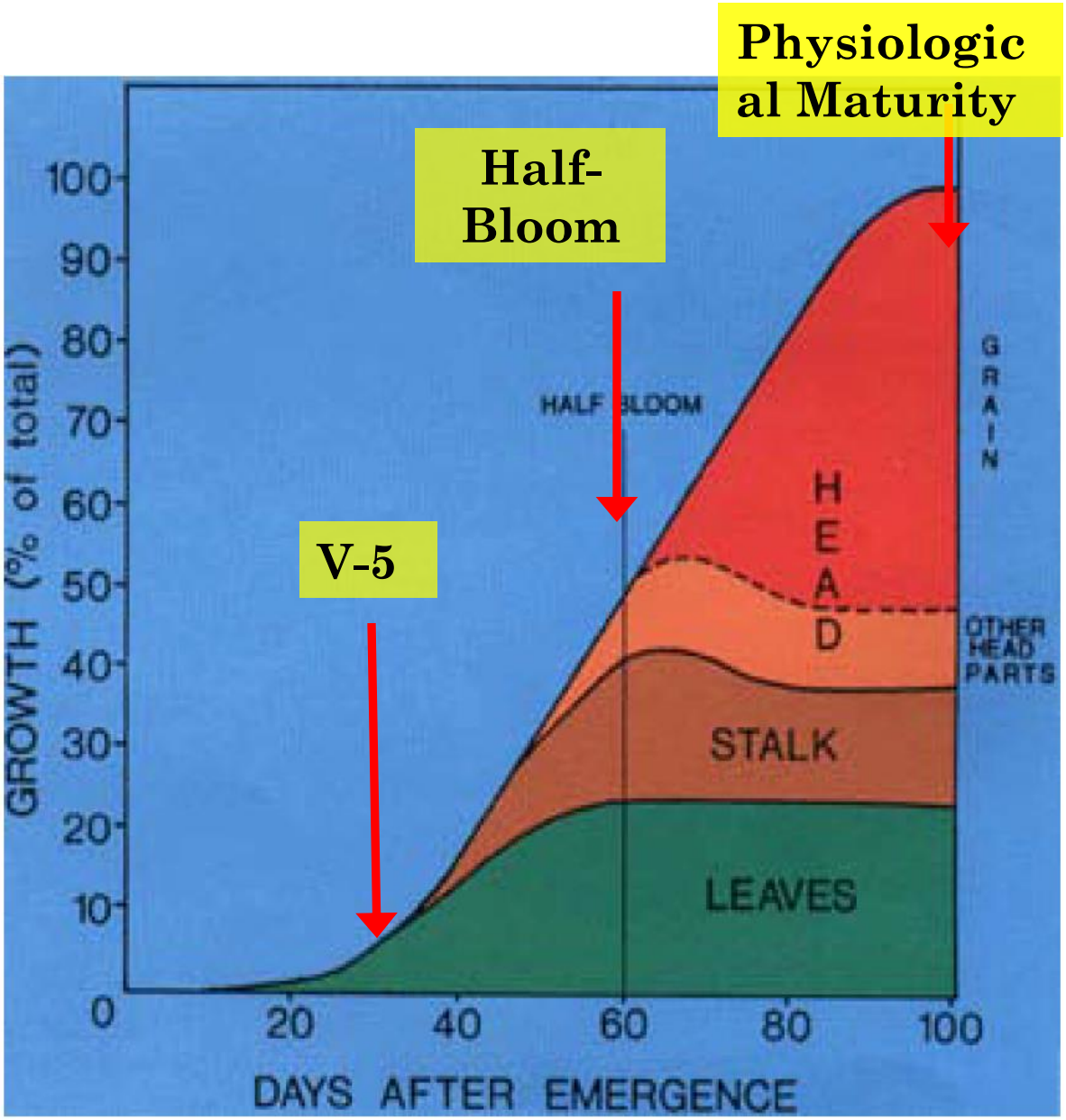
Grain Sorghum Water Use



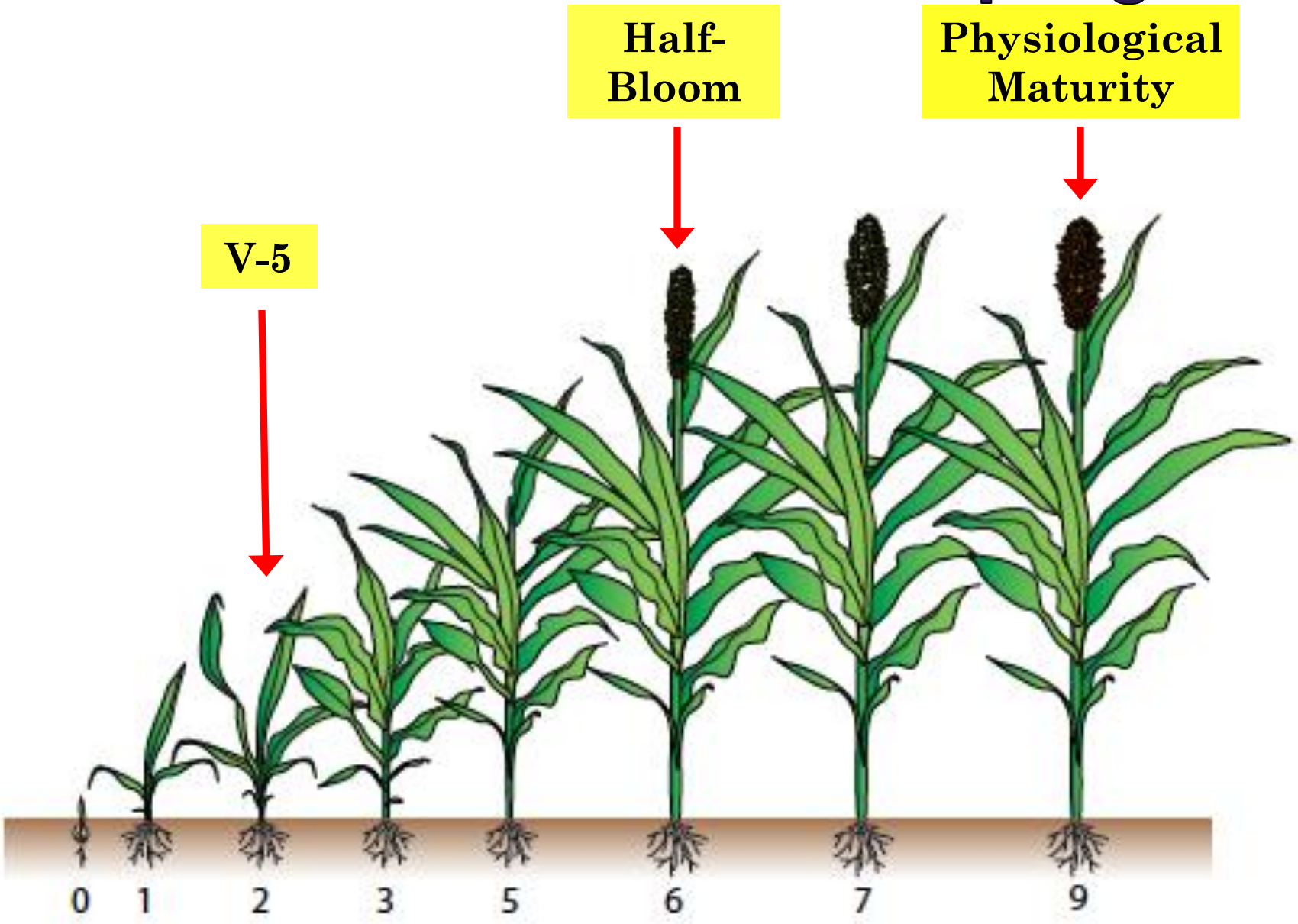
Data Collection

- Plant population: stand counts
- Accurate meteorology measurements (light intensity, temperature, precipitation, humidity, wind speed)
- Soil Nutrient Analysis at pre-planting
- Leaf Area Index at 5th leaf collar, half-bloom
- Chlorophyll (SPAD) readings at 5th leaf collar, and half-bloom
- Canopy temperature at half-bloom
- Aboveground biomass, nutrient concentrations, and nutrient uptake at 5th leaf collar, half-bloom and physiological maturity (Stems, leaves, and heads)
- Grain yield (moisture, test weight, and yield components: grain number/head and seed weight)

Biomass & Nutrient Sampling



Biomass & Nutrient Sampling



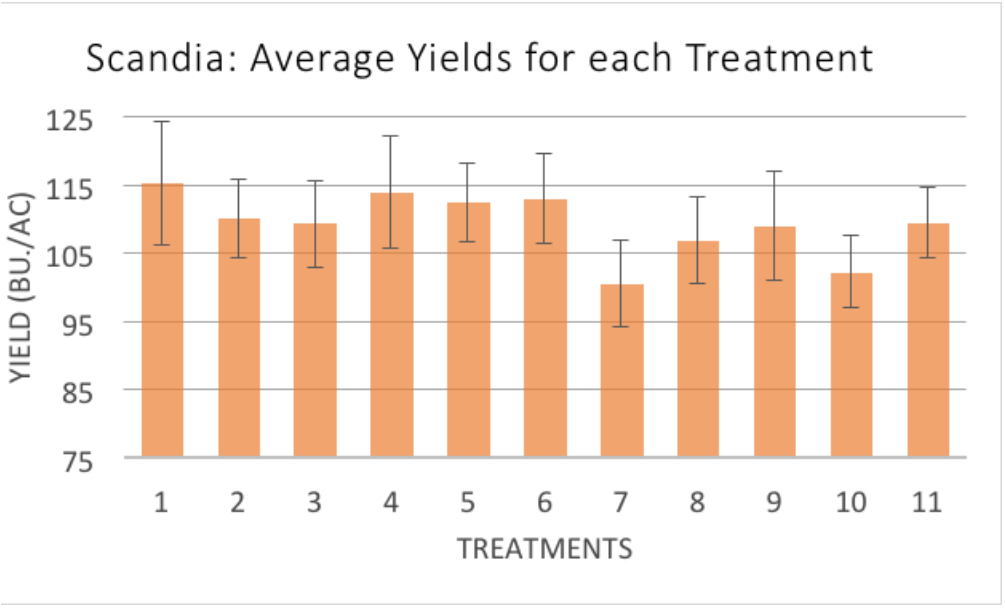
Results 2014 Season
Closing Grain Sorghum Yield Gaps

Field Site	Mean Yield	Min. Yield	Max. Yield	Coefficient of Variation
	- bushels per acre-			%
Scandia	109	82	139	13.7
Rossville	129	101	151	8.3

Grain sorghum yields were superior at Rossville (irrigated site), +20 bu/acre, as compared with the Scandia site.

Total variation (max. – min.) was similar in both sites (50-57 bu/acre), but the coefficient of variation (CV) was lower at Rossville (+5% lower).

Closing Grain Sorghum Yield Gaps



#1 = Kitchen Sink (KS)

#10 = Common Practice (CP)

YIELD GAP = 12 bu/acre

MAX. YIELD #1, 4, 5, 6

MIN. YIELD #7 (No-PGR), 10

#9 = Kitchen Sink (- Cl)

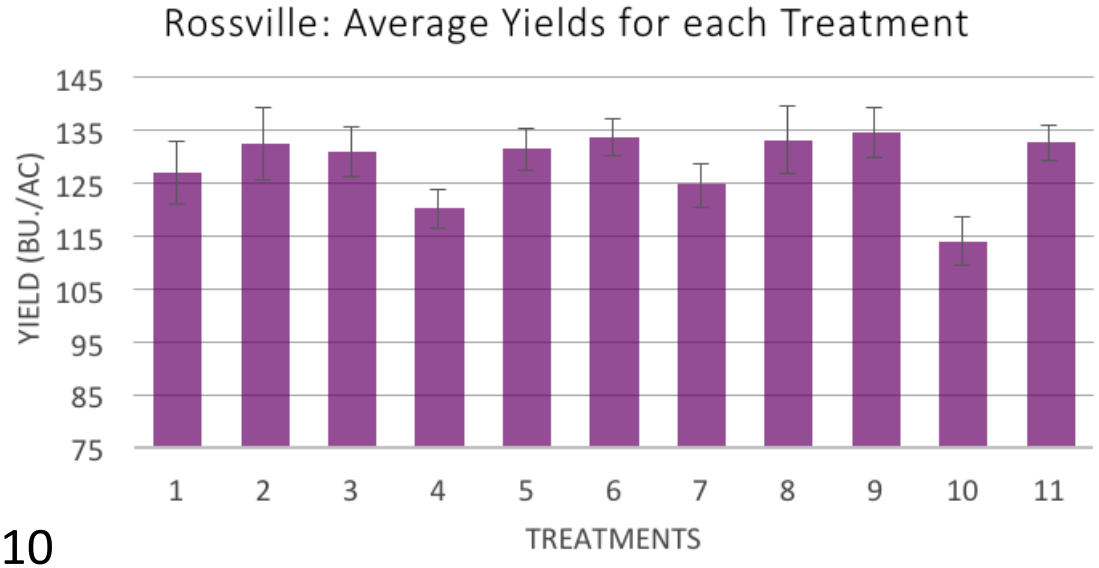
#10 = Common Practice

YIELD GAP

20 bushels per acre

MAX. YIELD #9, 8, 6, 5, 3, 2, 1

MIN. YIELD #7 (No-PGR), 4 (Pre-N), 10



Leaf Area Index (LAI): 2014 Season

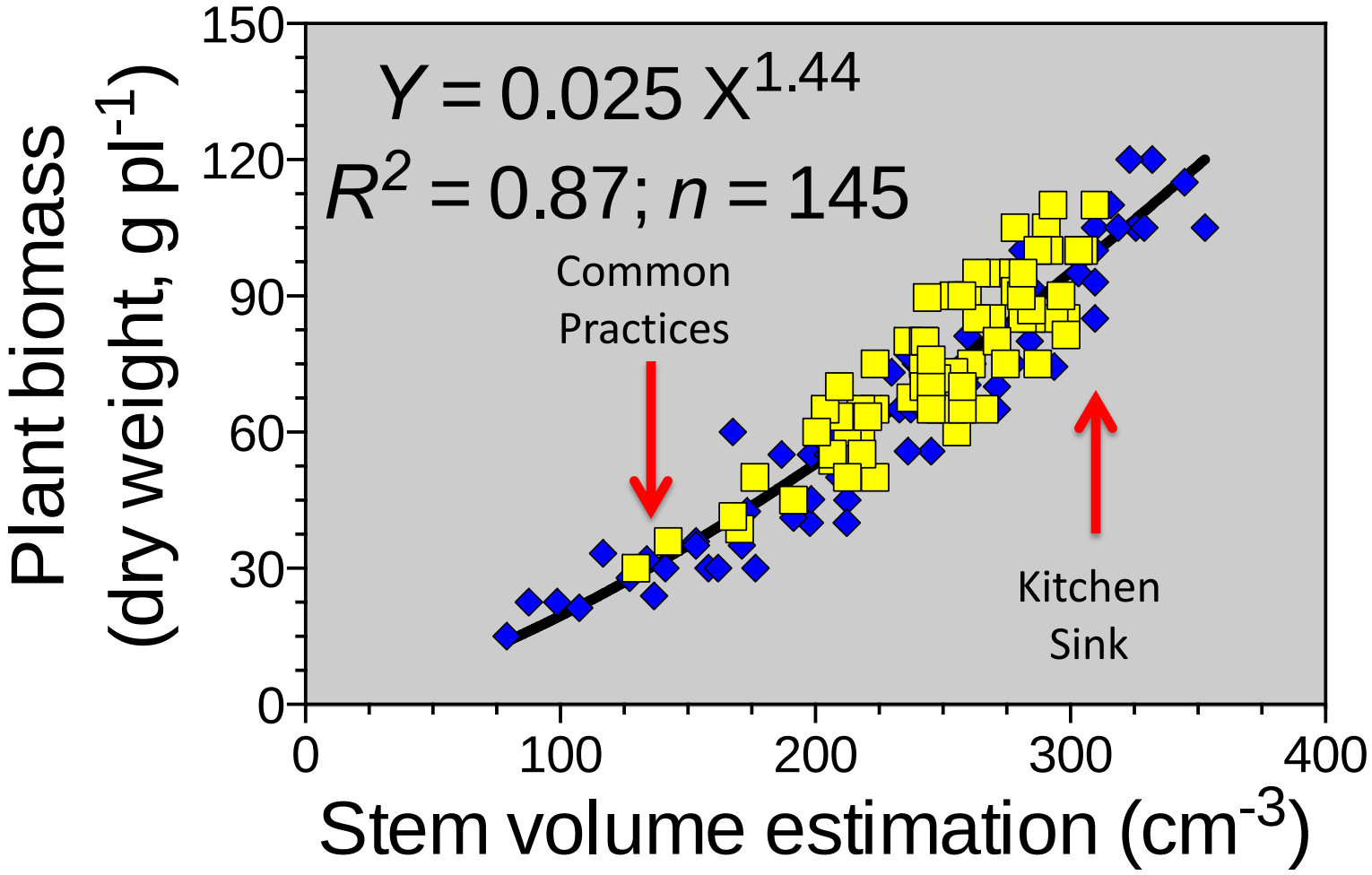
	1	2	3	4	5	6	7	8	9	10	11
Average of V-5	1.33	1.35	1.41	1.46	1.49	1.48	1.51	1.55	1.52	1.53	1.54
Average of Flowering	4.26	4.51	4.52	4.47	4.39	4.42	4.38	4.43	4.39	4.35	4.31

LAI at flowering was similar across treatments

Plant Biomass vs. Stem Volume Estimation

Input Variables

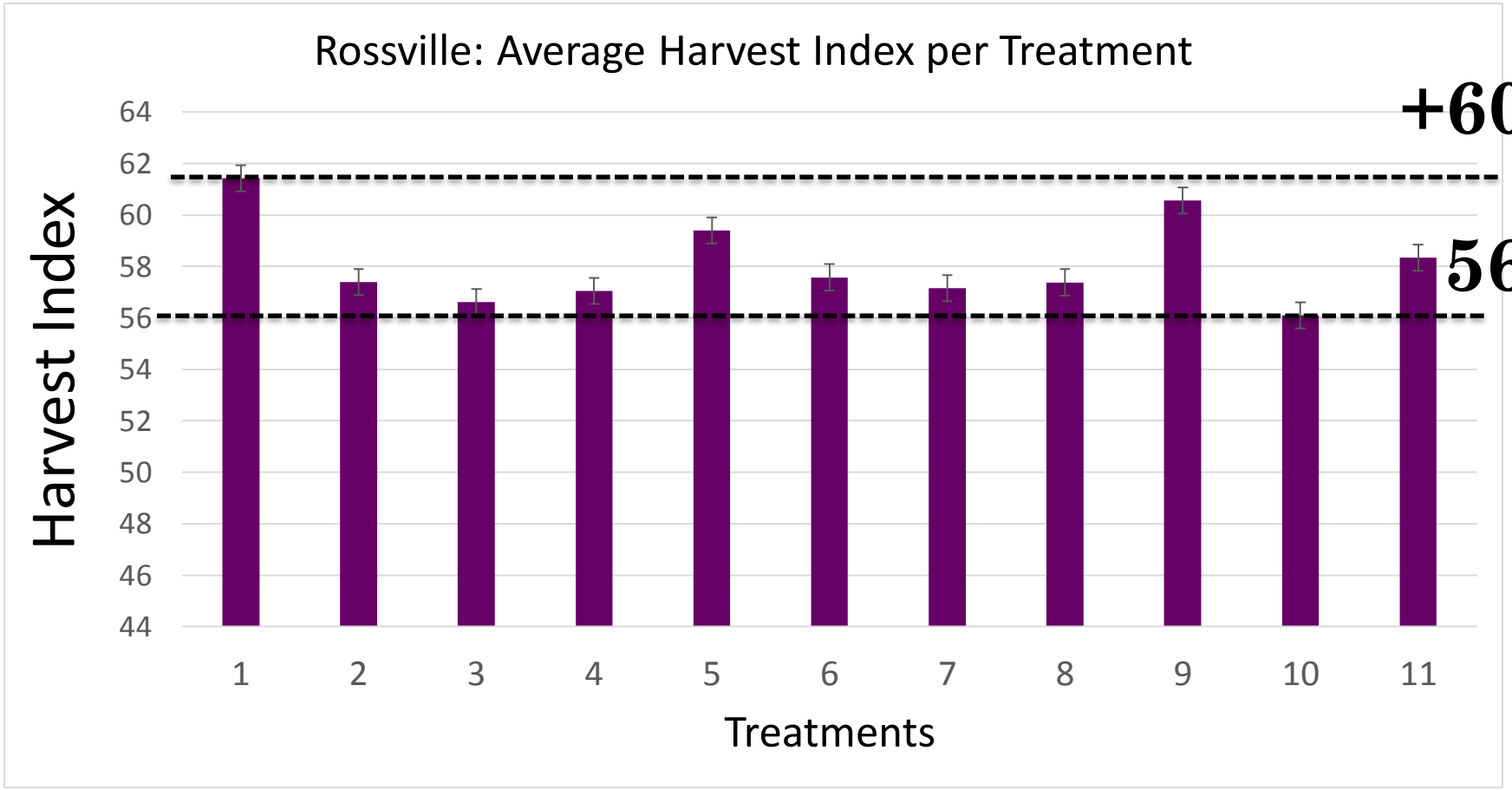
Stem volume (SV)= π x (**Stem diameter**/2) x **plant height**



YIELD COMPONENTS: Grain Harvest Index

Grain Harvest Index = Grain yield/
(stover + grain biomass)

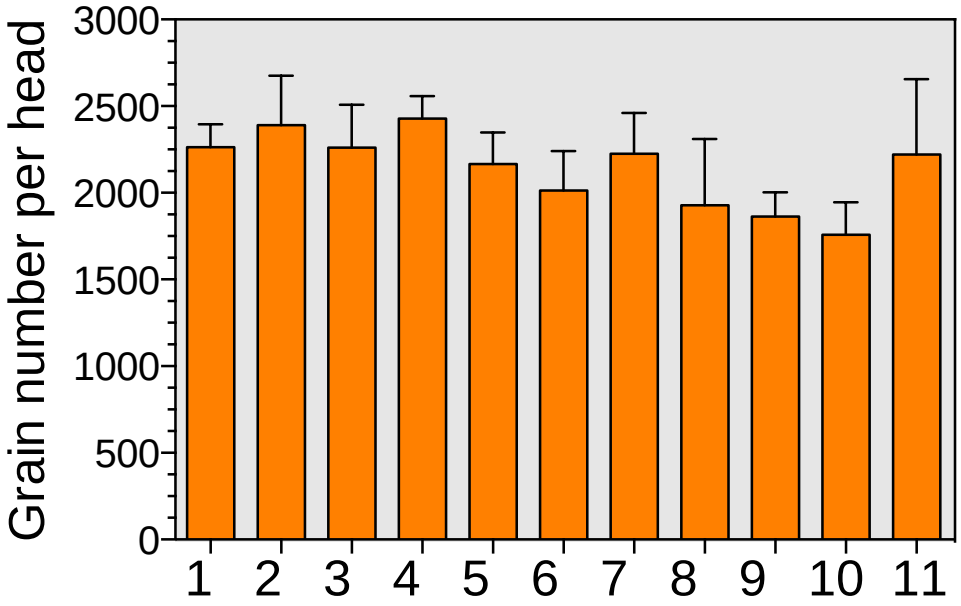
Rossville 2014



Seed number per head and seed weight (g/1000 seeds) did not differ.

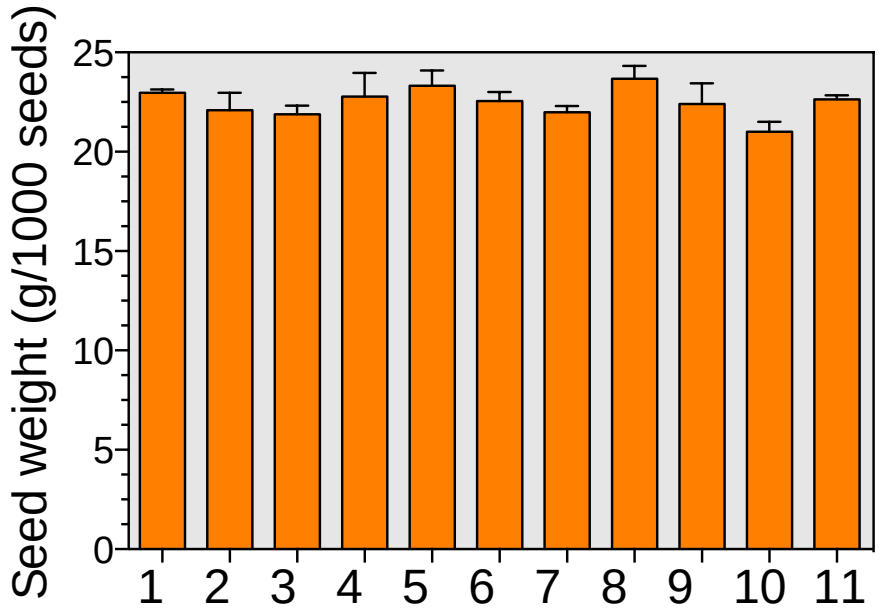
YIELD COMPONENTS:
Grains per Head & Seed Weight

Scandia 2014



Grains per head
KS (#1) > CP (#10)
2263 > 1945 grains per head

Seed weight (g/1000 seeds)
KS (#1) > CP (#10)
23 > 22 g/1000 seeds



Summary

- Under irrigation, max. yield was obtained in the KS treatment, primarily related to a change in the biomass conversion efficiency (grain HI).
- Under dryland, max. yield was obtained via changes in grain yield components: seed number per head and seed weight.
- For Scandia (northern location), row spacing, population, and starter fertilizer seemed to be the main production practices impacting yields.
- For Rossville, precise N fertilization (rather than pre-plant N) seemed to be a key factor for increasing sorghum grain yields (under irrigation).

QUESTIONS?

Ignacio A. Ciampitti, Cropping Systems Specialist
Department of Agronomy, K-State Univ.
ciampitti@ksu.edu, 785-410-9354
@KSUCROPS (TWITTER)

Crop Production Team
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