Sorghum Irrigation Management Studies

University of California
Agriculture and Natural Resources

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University of California ANR support for years 2013-2015 trials
University of California West Side REC and Kearney REC

Types of Sorghum to study?

Our irrigation studies so far have mostly looked at #1, 2 and 4 (sorghums can be multipurpose types as well, focus of work on forage types and mention grain types)

1) Grain Sorghum (hybrids, etc.) - primarily for animal and human consumption
2) Forage Sorghum (hybrids, etc.) - silage, green chop
3) Hybrid Sudangrass - used primarily for hay production and some grazing
4) Sweet Sorghum - molasses, syrup, biofuel?
5) Biomass sorghum - developed for renewable bio-products

Diversity in types, amount of grain production, eventual height, photoperiod response, other characteristics

In assessments of water use, consider:

1) Particularly in forage types, height differences, photoperiod & maturity differences exist across types ... potential to impact duration of leaf development, maturity timing & water use

2) major differences in rooting patterns & depth known across types

3) bmr types and brachytic types have potential impacts not only on forage quality, but also on issues such as lodging (could impact water use if lodges)

Planting / Soil Characteristics / Irrigation Method

West Side & Kearney REC 2012, 2013, 2014, 2015 sorghum studies

Soil Types	WSREC (clay loam soil); Kearney REC (sandy loam soil)
Row Spacing	30 inch rows
Plot width / length	8 beds in width per irrigation treatment replication Approximately 65 feet plot length, 4 field reps

Depth range in soil profile (ft)	**Available Soil Water held Per foot of soil profile (inches)**	
	West Side REC	Kearney REC
0 – 3	2.0 – 2.3	1.3 – 1.45
3 - 8	1.9 – 2.2	1.2 – 1.4

Irrigation Method	2012 6 inch gated pipe, one gate per planted row 2013-2015 surface drip irrigation (amount per irrig = about 2 inches Kearney, about 3.5 inches WSREC clay loam site)
	Plots irrigated individually so water application amounts could be determined
	Typical amount / applic. = 2.0 - 2.6 (KAREC); 3.5 - 4.0 inches (WSREC)

Irrigation Dates and Amounts –

WSREC and KAREC - year 2 sorghum studies

Irrig. Treat - ment #	2012 West Side REC Irrigation Dates and Amounts (inches water) - *Planted 6/23* - ***Large pre-plant irrigation (8-9 inches)***									
Date	6/26	7/01	7/23	7/29		8/20	8/30	9/10	9/19	Total
T1	3.2		3.0	1.6		3.4	3.0	2.9		**17.1**
T2	3.2		3.0	1.6		3.4	2.1			**13.3**
T3	3.2					3.4	3.0	3.7		**13.3**
T0	3.2	3.6								**6.8**

Soil conditions not suited to a non-irrigated treatment for T-0 treatment

Sorghum Calculated Evapotranspiration

year 2 – West Side REC site *(inches applied or soil water use)*

- sandy loam soil

Year	Type of Sorghum	Irrigation Trt #	In-Season Applied Water (inches)	Soil Water Use (in)	Total Est. Etc (in)
2012	Grain Sorghum	1	17.1	-2.3	**19.4**
		2	13.3	-2.4	16.7
		3	13.3	-2.8	16.1
		0	6.8	-6.9	**13.7**
2012	Forage Sorghum	1	17.1	-3.1	**20.2**
		2	13.3	-4.0	17.3
		3	13.3	-3.3	16.6
		0	6.8	-7.6	**14.4**

Sorghum Calculated Evapotranspiration

year 2 – Kearney REC site *(inches applied or soil water use)* - *sandy loam soil*

Year	Type of Sorghum	Irrigation Trt #	In-Season Applied Water (inches)	Soil Water Use (in)	Total Est. Etc (in)
2012	Grain Sorghum	1	16.6	-1.0	**17.6**
		2	12.7	-3.0	15.7
		3	12.5	-3.9	16.4
		0	4.7	-6.9	**11.6**
2012	Forage Sorghum	1	16.6	-2.3	**18.9**
		2	12.7	-4.1	16.8
		3	12.5	-4.4	16.9
		0	4.7	-8.5	**13.2**

Irrigation Dates and Amounts –

KAREC – year 3 Grain and Silage sorghum studies

Irrig. Treat-ment #	Year 3 Kearney KAREC Irrigation Dates and Amounts (inches water) - *Planted 6/17* - ***Pre-irrigations to apply total of 5.5 inches***										
Date	7/07	7/14	7/24	7/30	8/10	8/17	8/29	9/02	9/15	9/23	Total
T1	2.4	1.9	1.6	1.8	1.7	1.8	1.9	1.6	1.9	1.9	**18.5**
T2	2.4	1.9	1.6	1.8	1.7	1.8	1.9	1.6			**14.7**
T3	2.4		1.6	1.8	1.7	1.8	1.9	1.6	1.7	1.0	**15.2**
T4	2.4	1.9			1.7	1.8			1.7	1.8	**11.3**
T5	2.4	1.9			1.7	1.8					**7.9**

Soil conditions not suited to a non-irrigated treatment for T-0 treatment

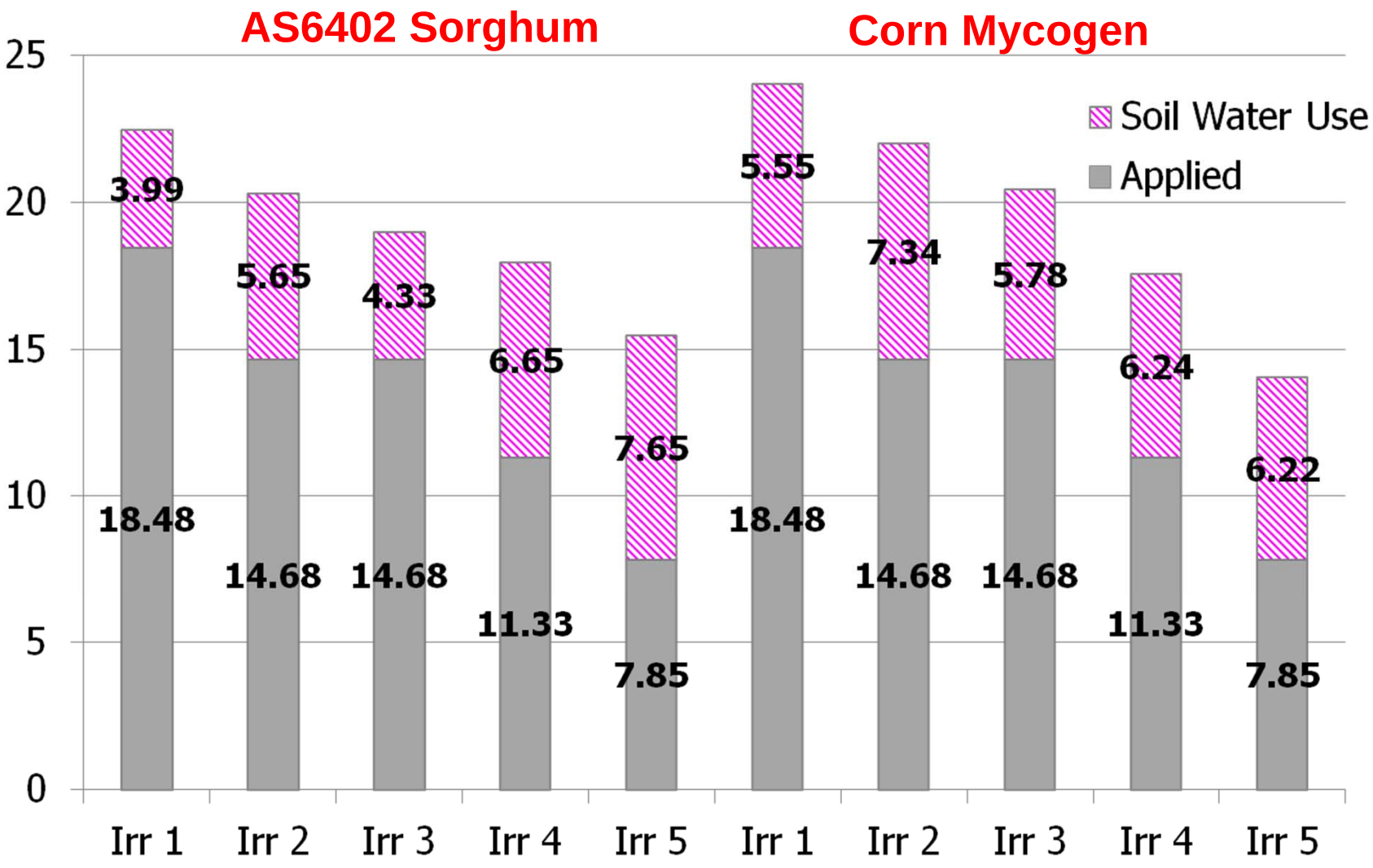
Irrigation Dates and Amounts –

WSREC – year 3 Grain and silage sorghum studies

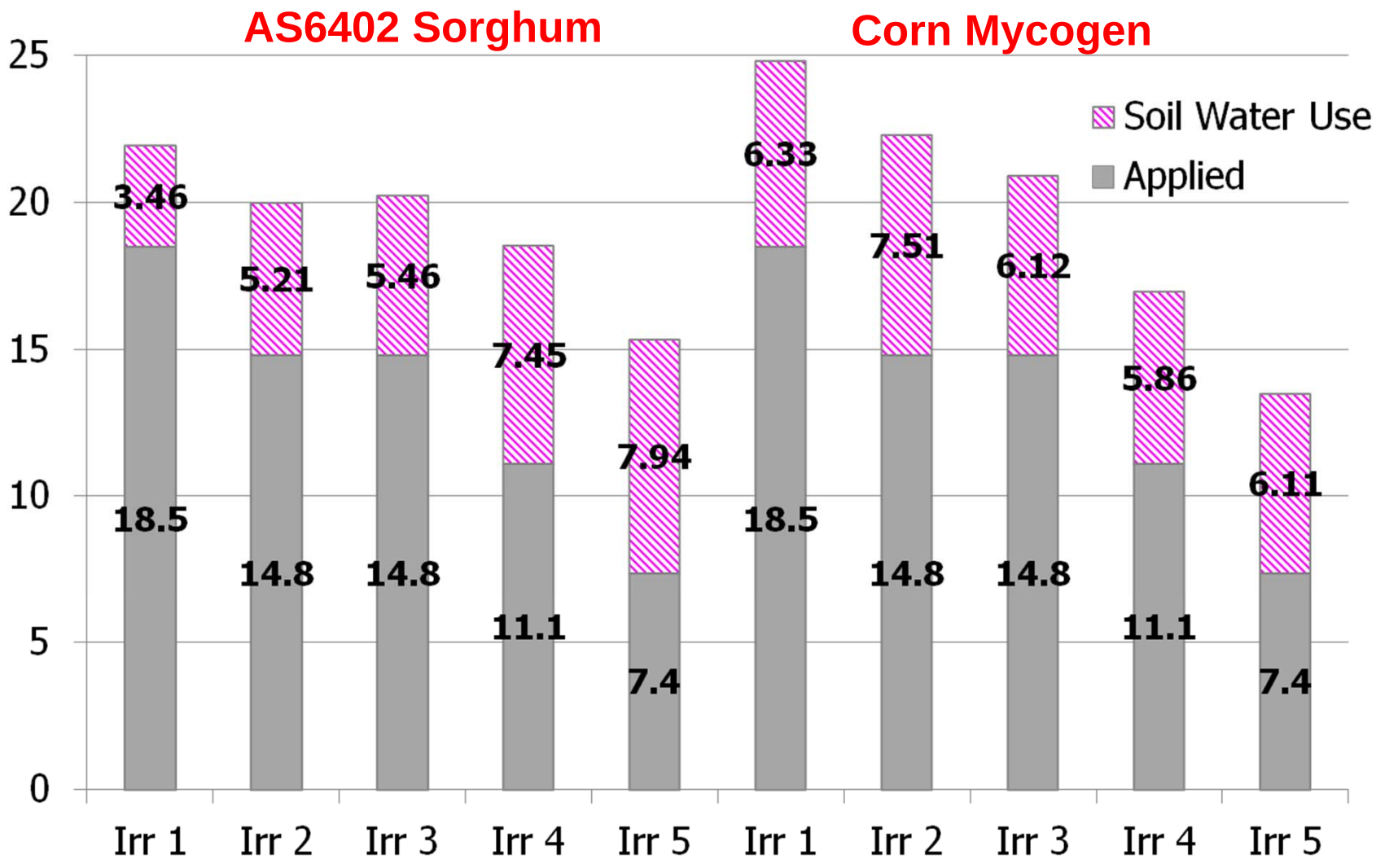
Irrig. Treat-ment #	**Year 3 West Side REC Irrigation Dates and Amounts (inches water)** - *Planted 6/16* - ***Two pre-irrigations to apply total of 7.3 inches***									
Date		7/8-10		7/28-31		8/16-19		9/5-9		9/26-29	Total
T1		3.7		3.7		3.7		3.7		3.7	**18.5**
T2		3.7		3.7		3.7		3.7		0	**14.8**
T3		0		3.7		3.7		3.7		3.7	**14.8**
T4		3.7		0		3.7		0		3.7	**11.1**
T5		3.7		0		3.7		0		0	**7.4**

Soil conditions not suited to a non-irrigated treatment for T-0 treatment

Forage Sorghum/Corn Applied Irrigation plus Soil Water Use year 1 study B – KAREC site *(inches applied & soil water use)*

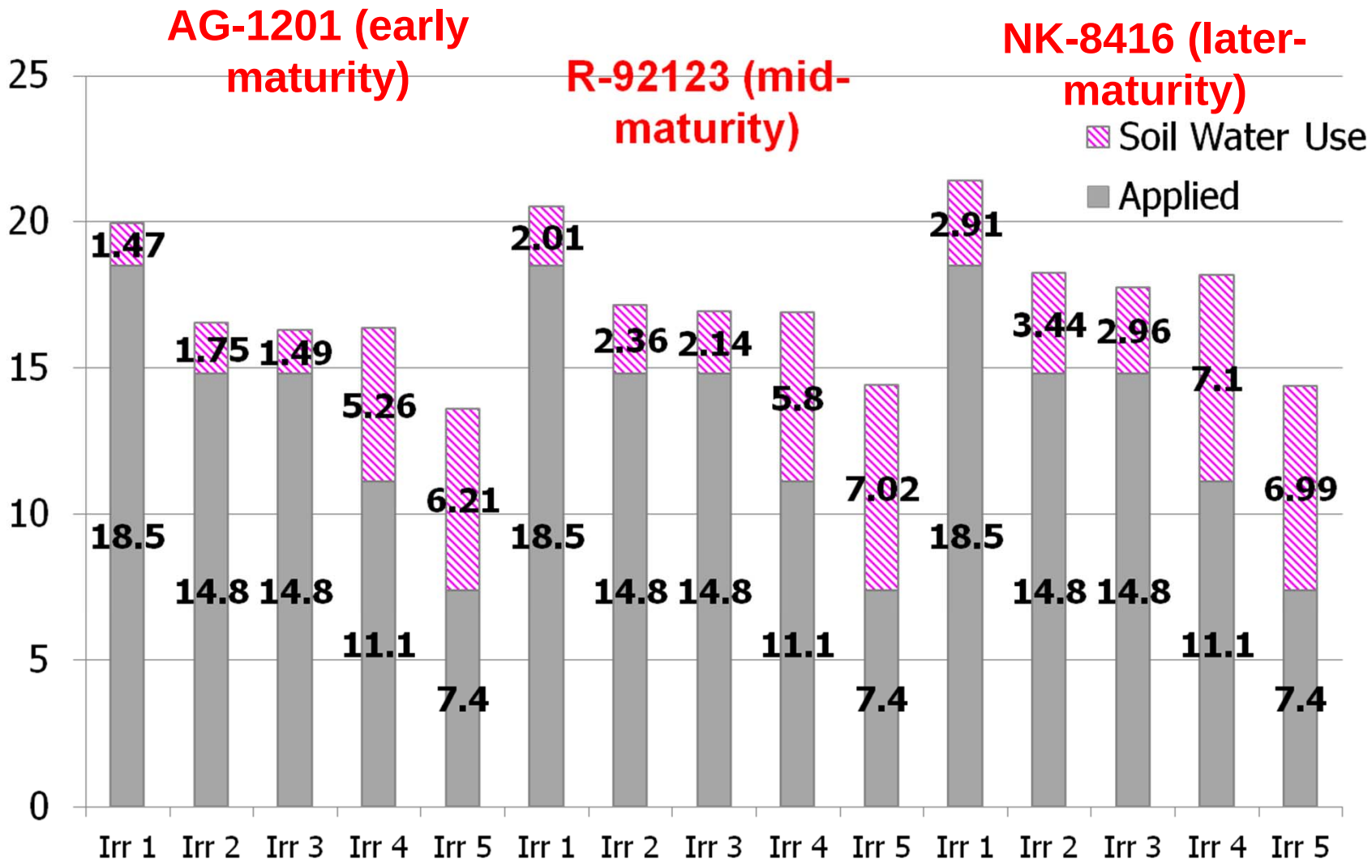


Forage Sorghum/corn Applied Irrigation plus Soil Water Use year 1- Study B – WSREC site *(inches applied & soil water use)*



Select Grain Sorghum Applied Irrigation plus Soil Water Use

year 1-study B – WSREC site *(inches applied & soil water use)*



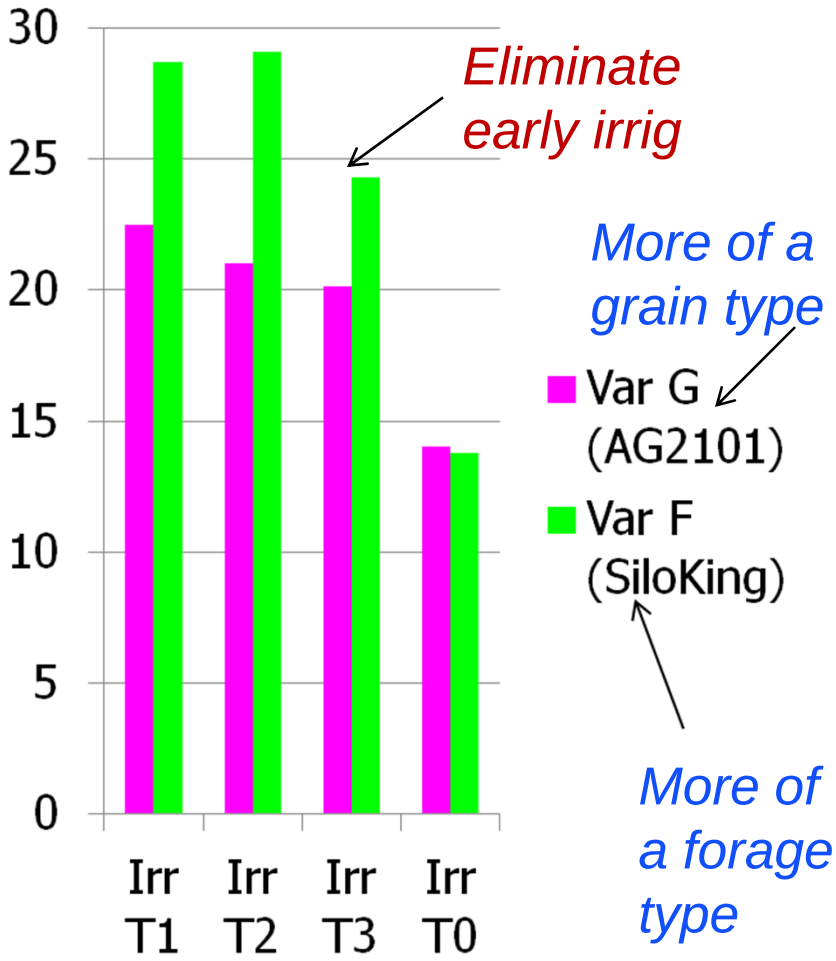
HARVEST OPERATIONS

1) At REC sites = machine harvest silage, hand harvest grain trials

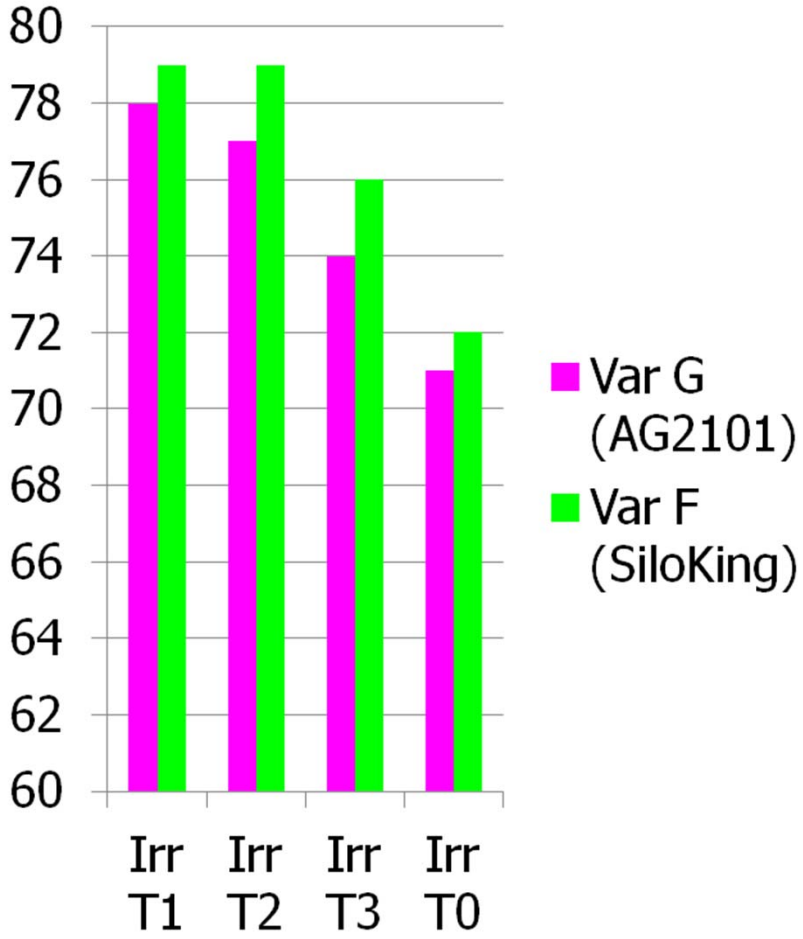
Subsamples by hand for moisture %

Sorghum Silage Yields and Average Moisture Content 2012 – Kearney REC site

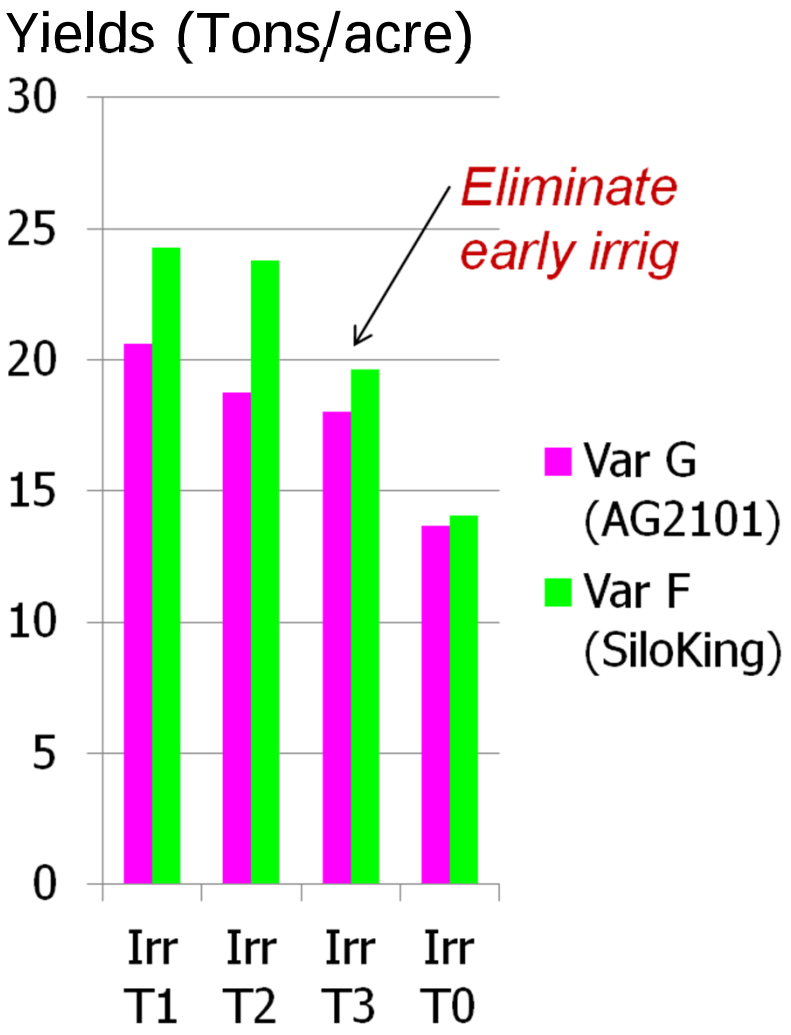
Yields (Tons/acre)

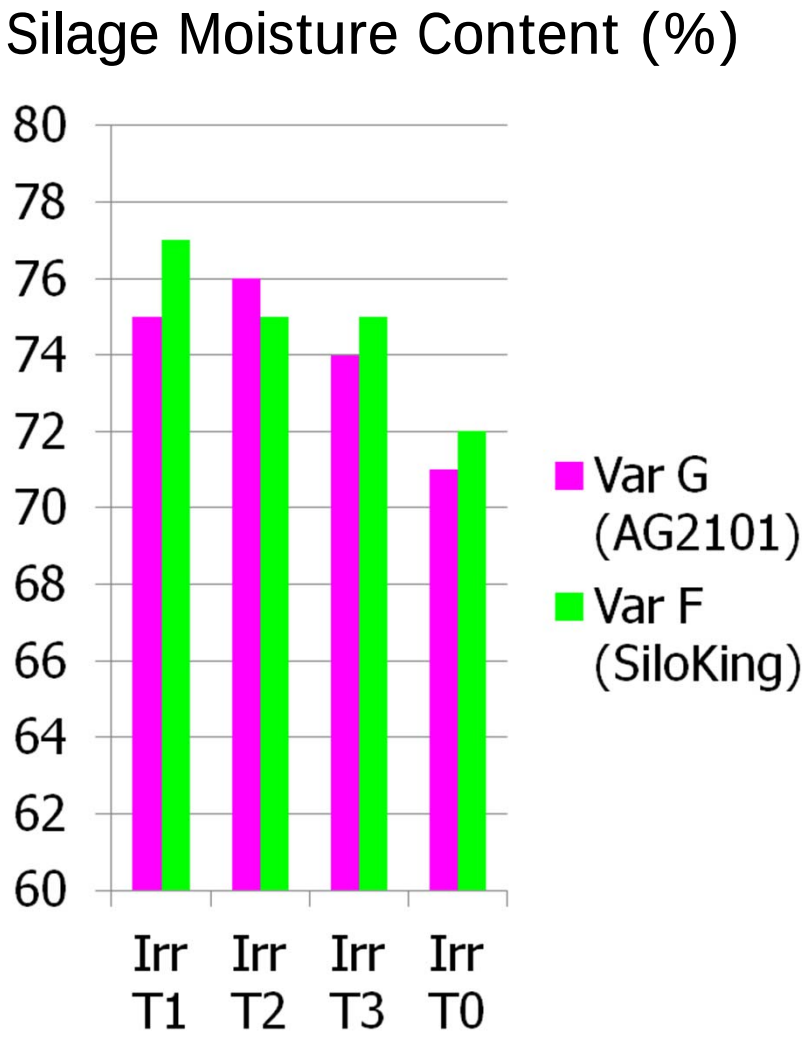


Silage Moisture Content (%)



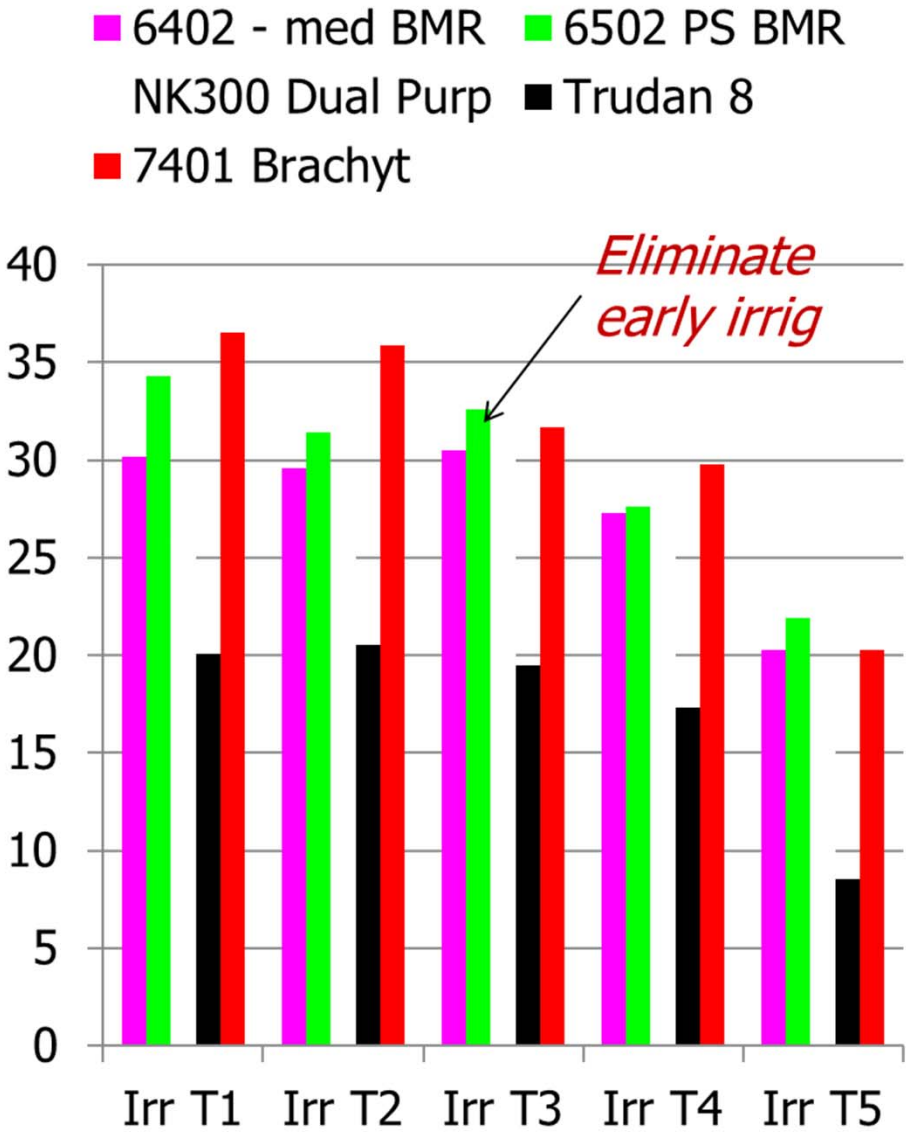
Sorghum Silage Yields and Average Moisture Content
2012 – West Side REC site

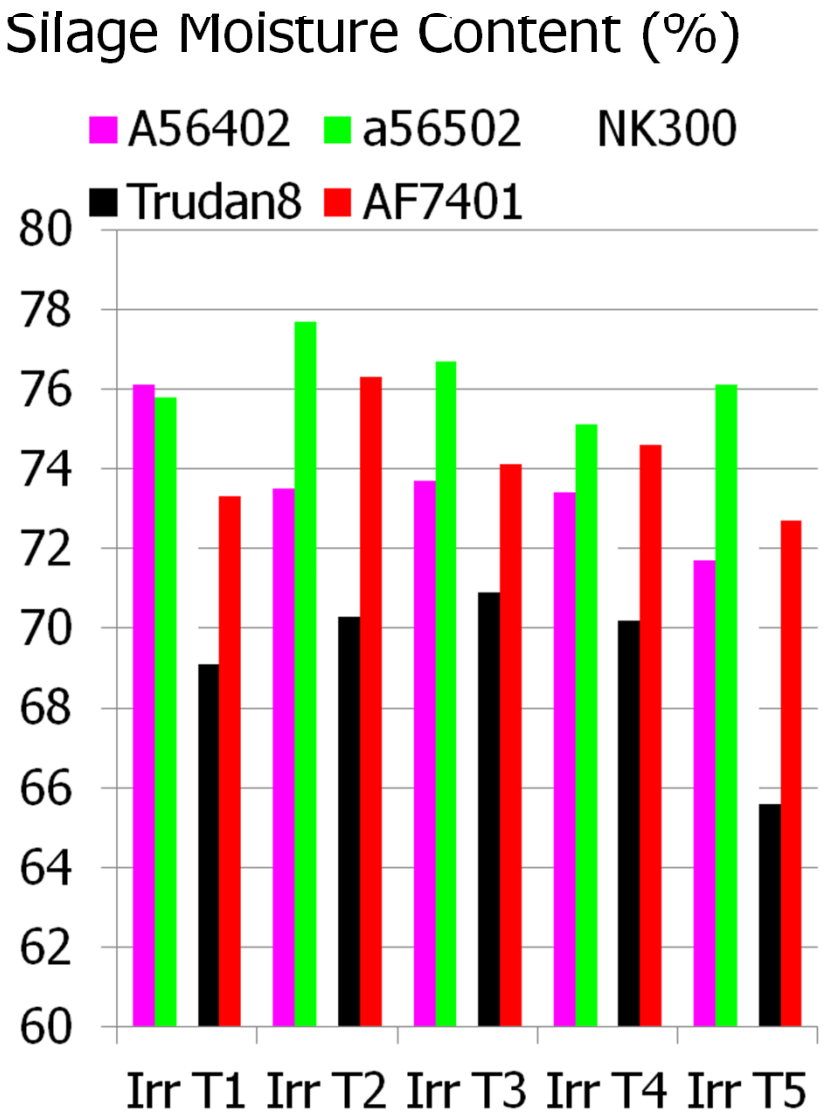




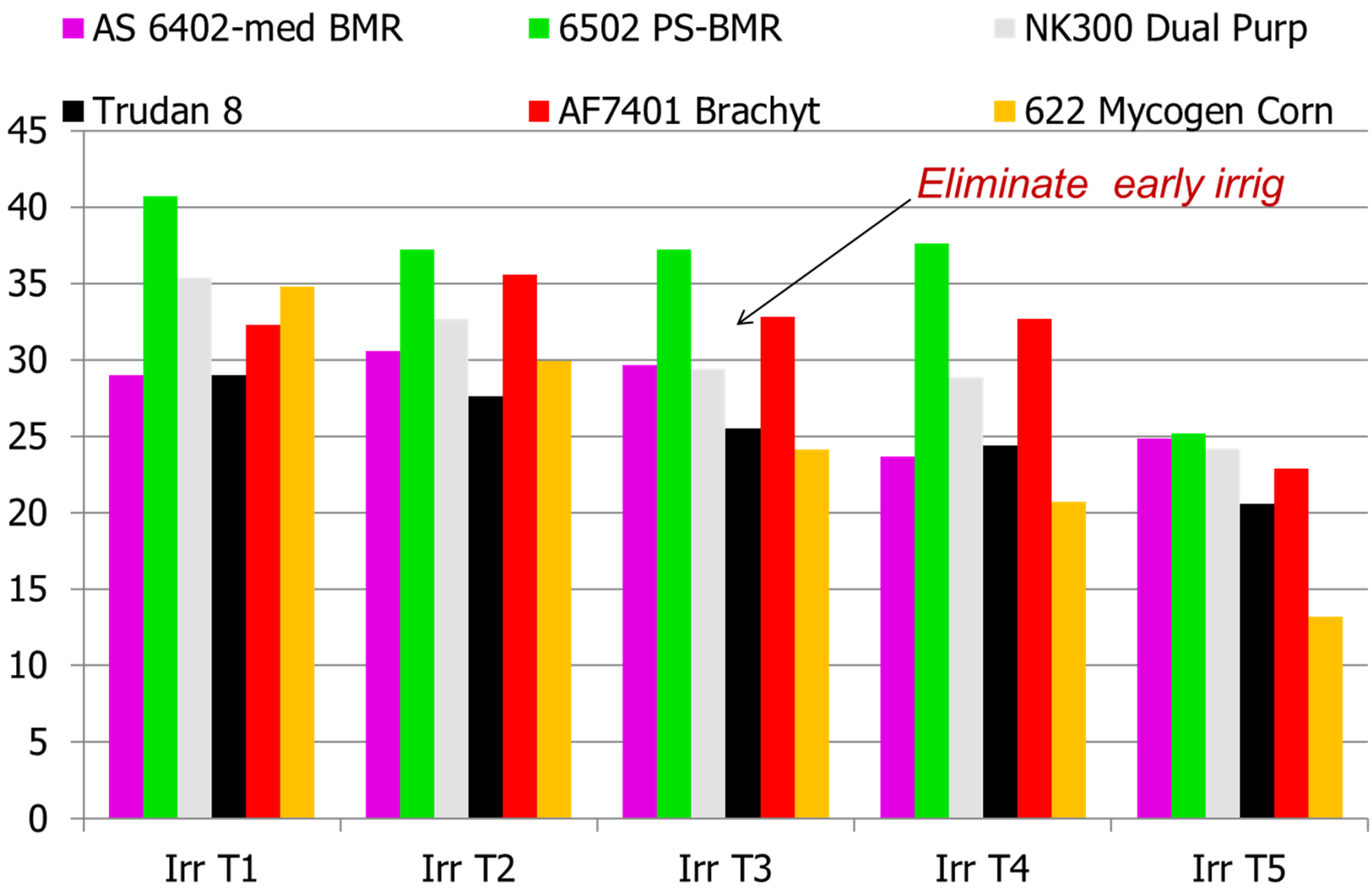
FORAGE SORGHUM Yields, Moisture Content-yr 1– study B

Kearney REC site *(yields corrected to 70% moisture, T/acre)*

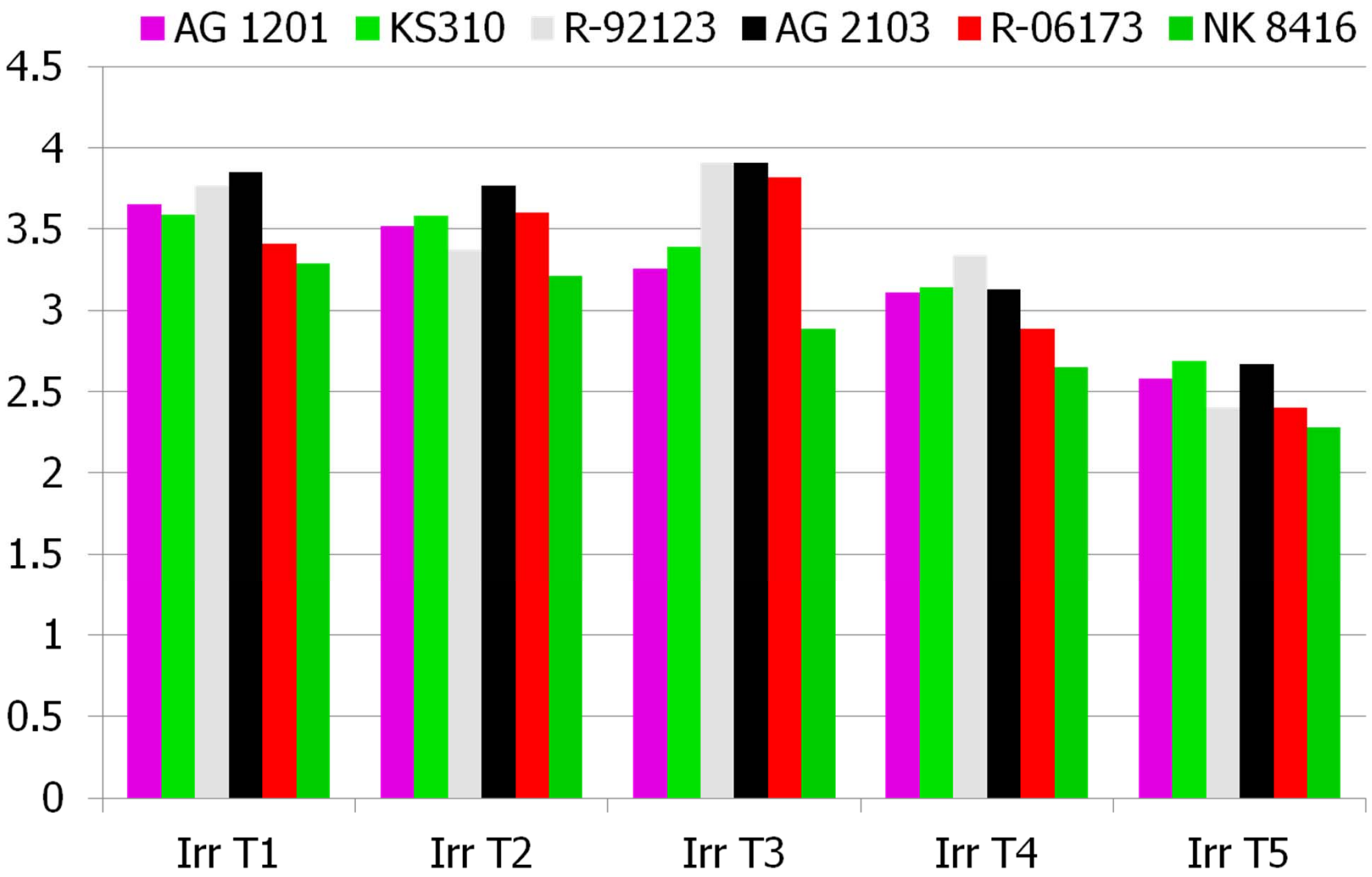




FORAGE SORGHUM Yields year 1 – study B– West Side REC site *(yields corrected to 70% moisture, T/acre)*



GRAIN SORGHUM Yields (T/acre) year 1 – study B – West Side REC site *(yields corrected to 14% moisture)*



Generalizations regarding When to Water Sorghum if you are deficit irrigating

- **Grain sorghum**
  - Don't impose moderate to severe stress plants during first 30-35 days after emergence when panicle differentiation occurs
  - If water available, irrigate again prior to boot
  - During grain fill
- **Forage sorghums**
  - Similar to grain sorghum, but can get away with the first irrigation if planting a photoperiod sensitive sorghum
  - Under very dry conditions after planting, may need 2-3 inch irrigation at planting to encourage emergence and root system development

** What you can get away with is strongly influenced by depth of stored soil water and how that impacts the root system development*

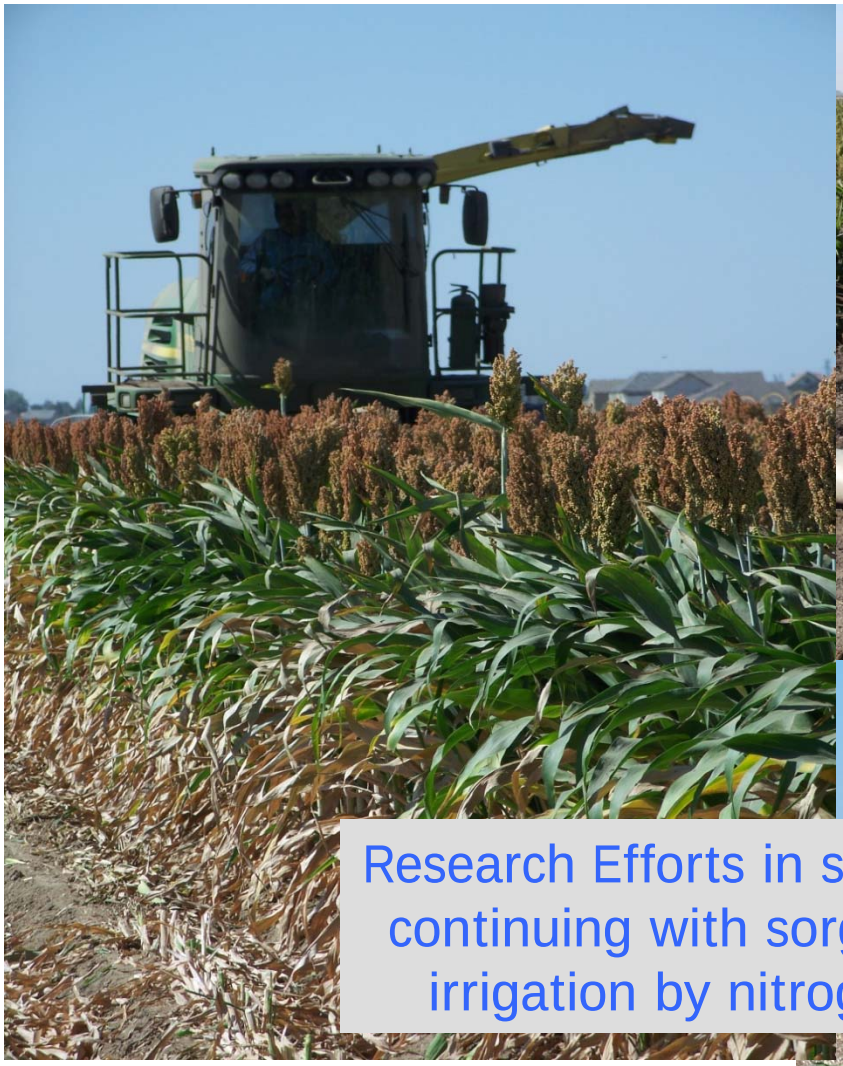
SUMMARY – earlier trials:

All test sites had significant pre-plant irrigations combined with some rainfall to provide stored soil moisture in upper 4-5+ feet of profile

Forage sorghum entries used about 12-14” inches in lowest water treatments, about 19-23” in highest irrigation trts. (more with longer maturity types, non-flowering types under our environment)

Some evidence that eliminating or reducing early season irrigations reduced yields more than eliminating late season irrigations (useful for planning deficit irrigations when needed)

Most grain sorghum entries had about 2-4+” lower calculated total water use in same irrig. trts used for forage sorghum entries



Research Efforts in sorghum are continuing with sorghum:corn irrigation by nitrogen trials

Sorghum/Corn Irrigation by Nitrogen Study – 2016 – West Side REC

SDI study initiated (one drip line 12-14” deep / 60” beds; with 30” plant row spacing)

2016 starting conditions (full soil water profile to 5 to 5.5 ft @ planting; aver. 53 lbs NO3-N/ac top 3 ft; 39 lbs/ac 3-8 ft zone)

N Trts (injected): N0=0 lbs/ac; N1=115 lbs/ac; N2=225 lbs/ac

CULTIVARS TESTED IN EXPERIMENT	
Sorghum Cultivars	**Corn Cultivars**
AF-7401	2H 919 hybrid
Nutra King	2L 538 hybrid
AF-7102	
NK-300	

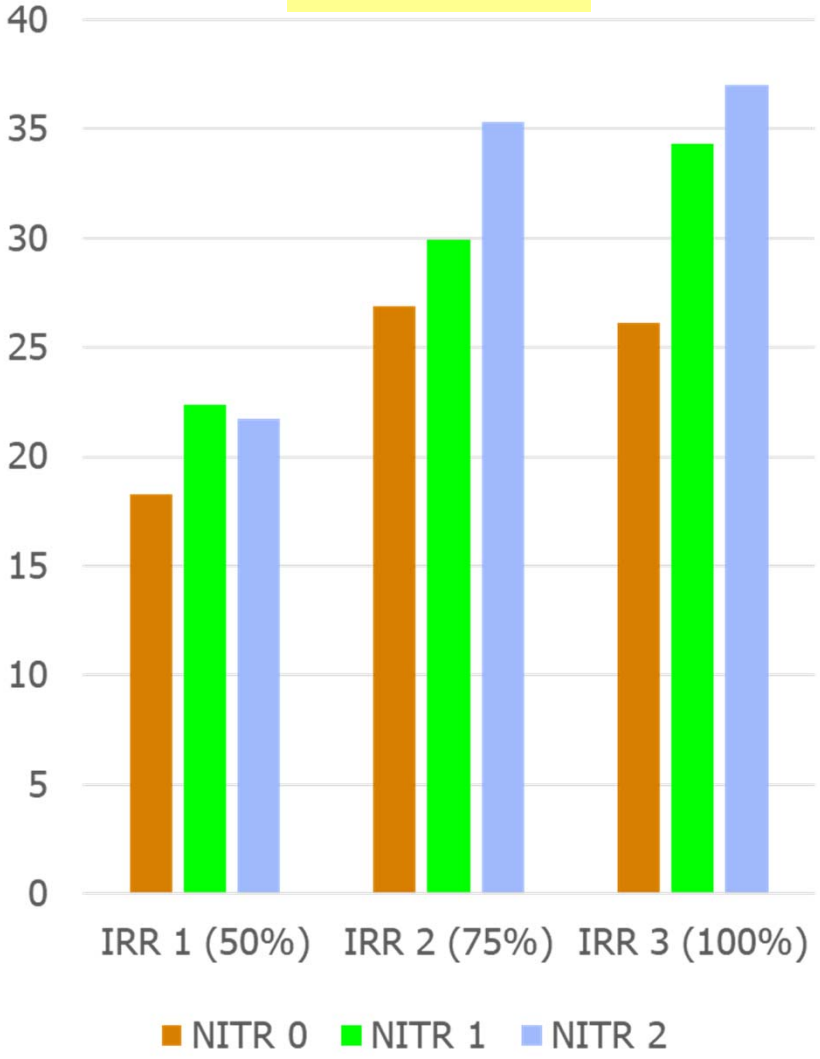
Sorghum/Corn Irrigation by Nitrogen Study – 2016 – West Side REC

IRRIGATION TREATMENTS	Water applic. amount in % of estimated ETc for corn	Total in-season applied irrigation water (inches)	**AVERAGE** Soil water depletion during season in 8 ft profile (inches)		**AVERAGE** Total crop estimated water use (in-season applied water plus total soil water depletion (inches)	
			sorg	corn	sorg	corn
IRRIG 1	50%	12.2	- 7.4	- 6.8	19.6*	19.0
IRRIG 2	75%	17.6	- 4.1	- 6.9	21.7*	24.5*
IRRIG 3	100%	23.2	- 0.7	- 3.5	23.9*	26.7*

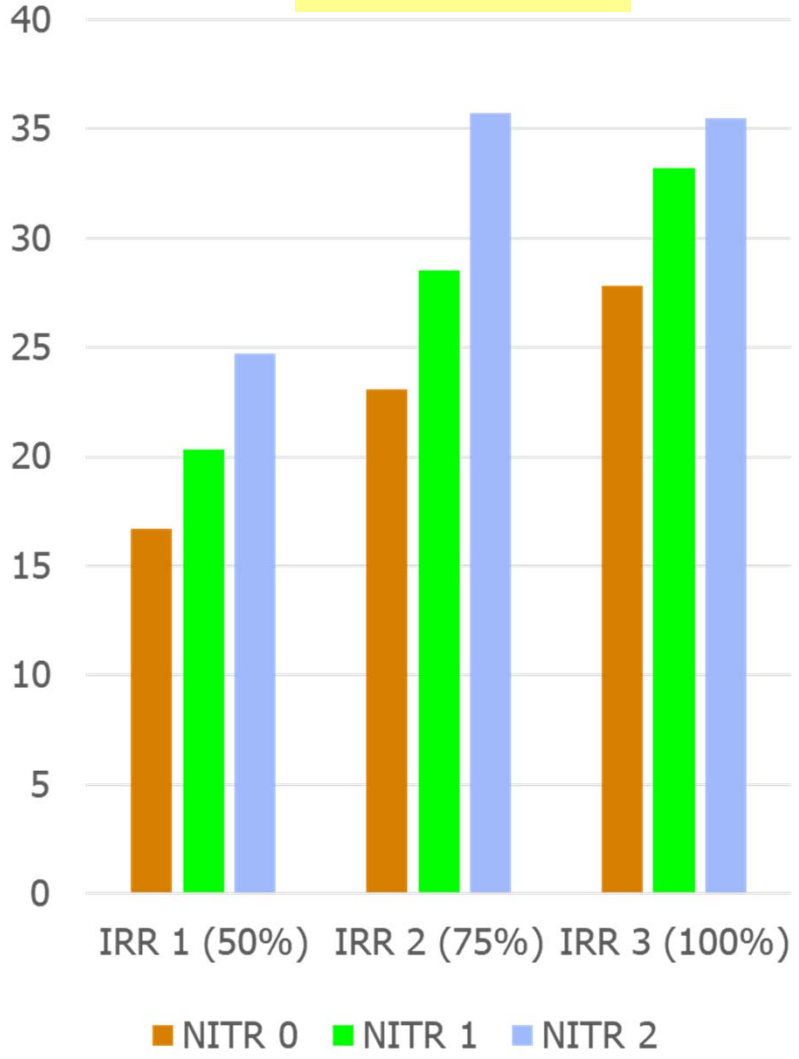
** Average shown – lower in earlier maturing types*

Yield (T/ac @ 70% moisture) responses to SDI Irrigation & Nitrogen treatments – Sorghum/Corn Study – WSREC – 2016 *(#1 of 3)*

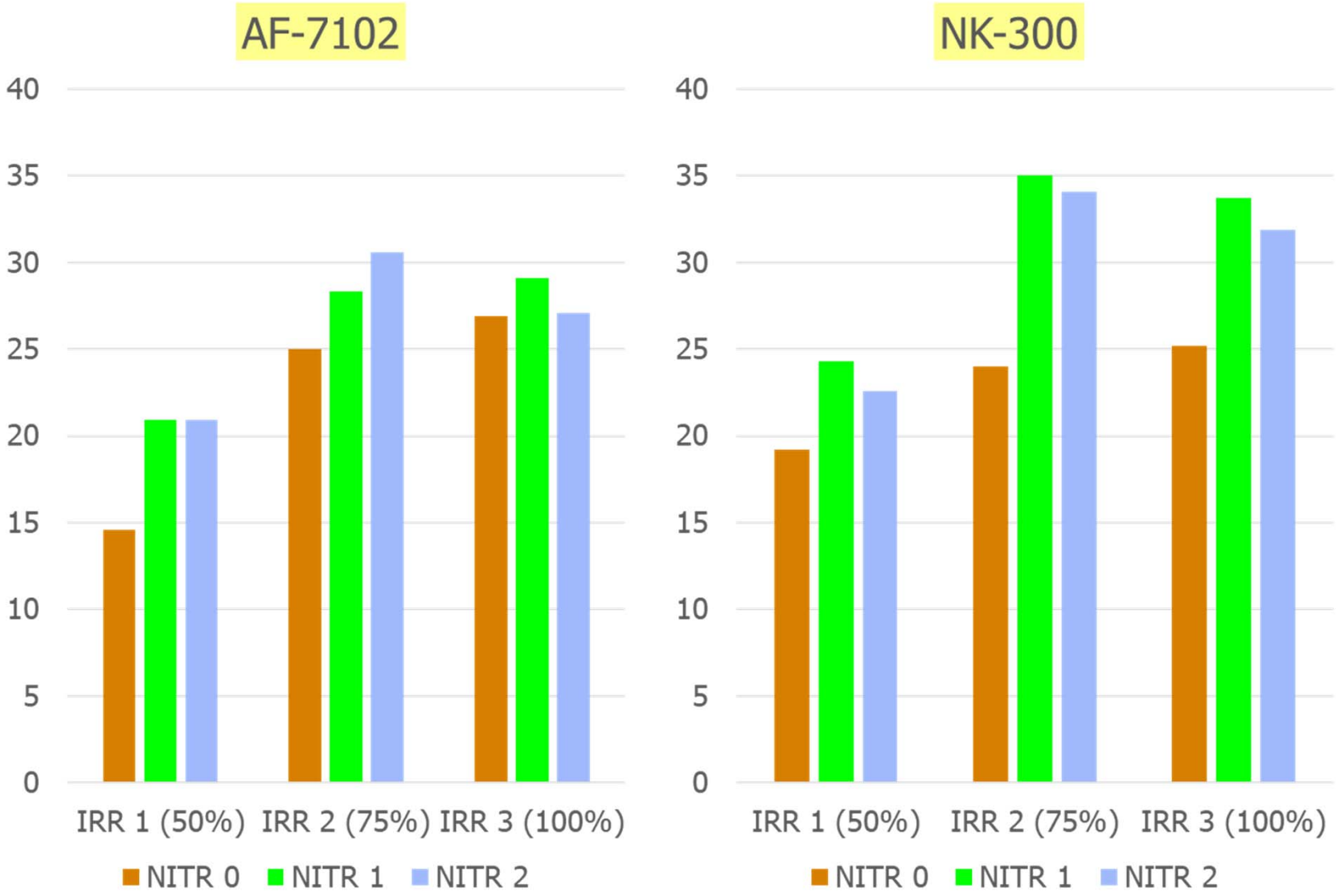
AF-7401



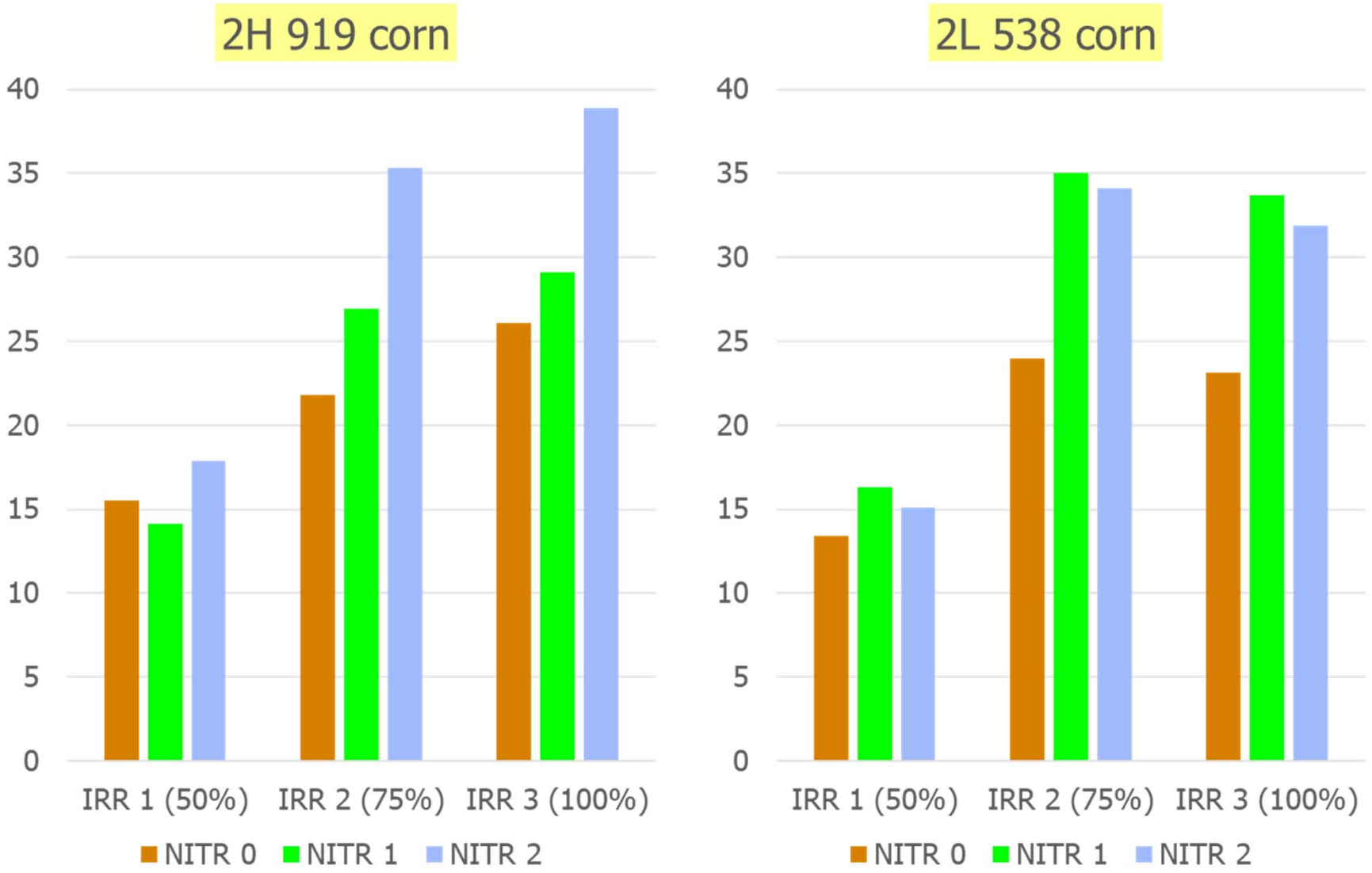
NutraKing



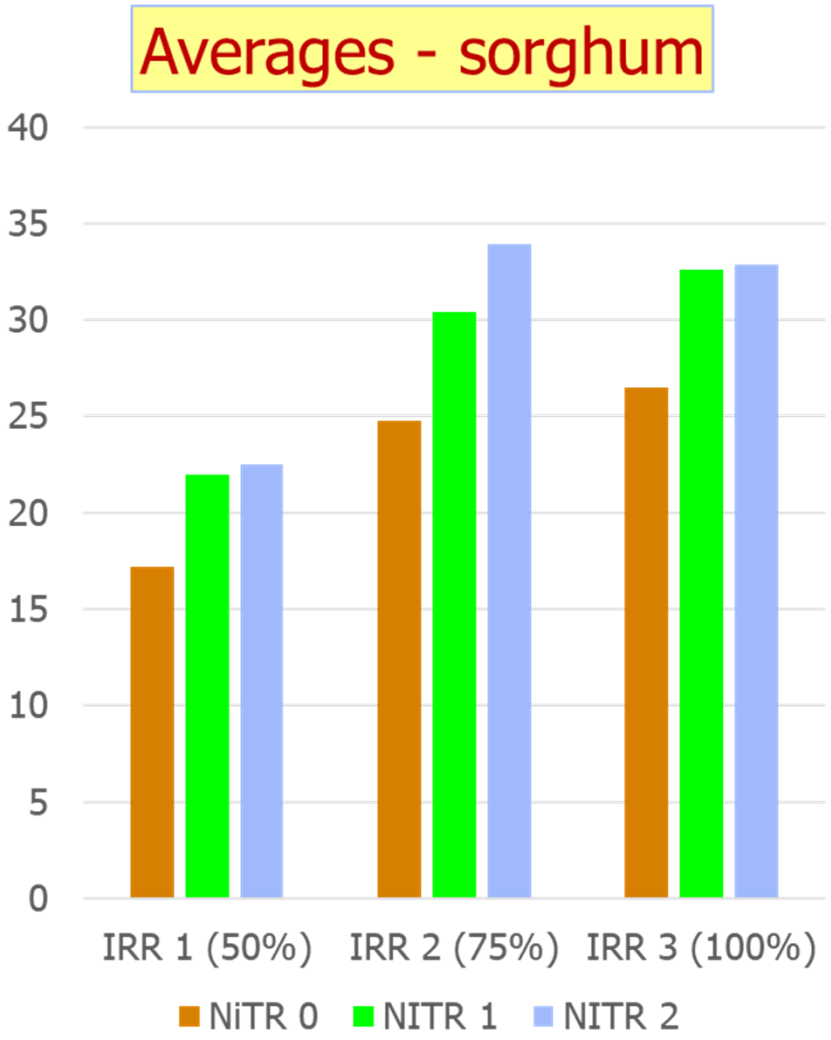
Yield (T/ac @ 70% moisture) responses to SDI Irrigation & Nitrogen treatments – Sorghum/Corn Study – WSREC – 2016 *(#2 of 3)*

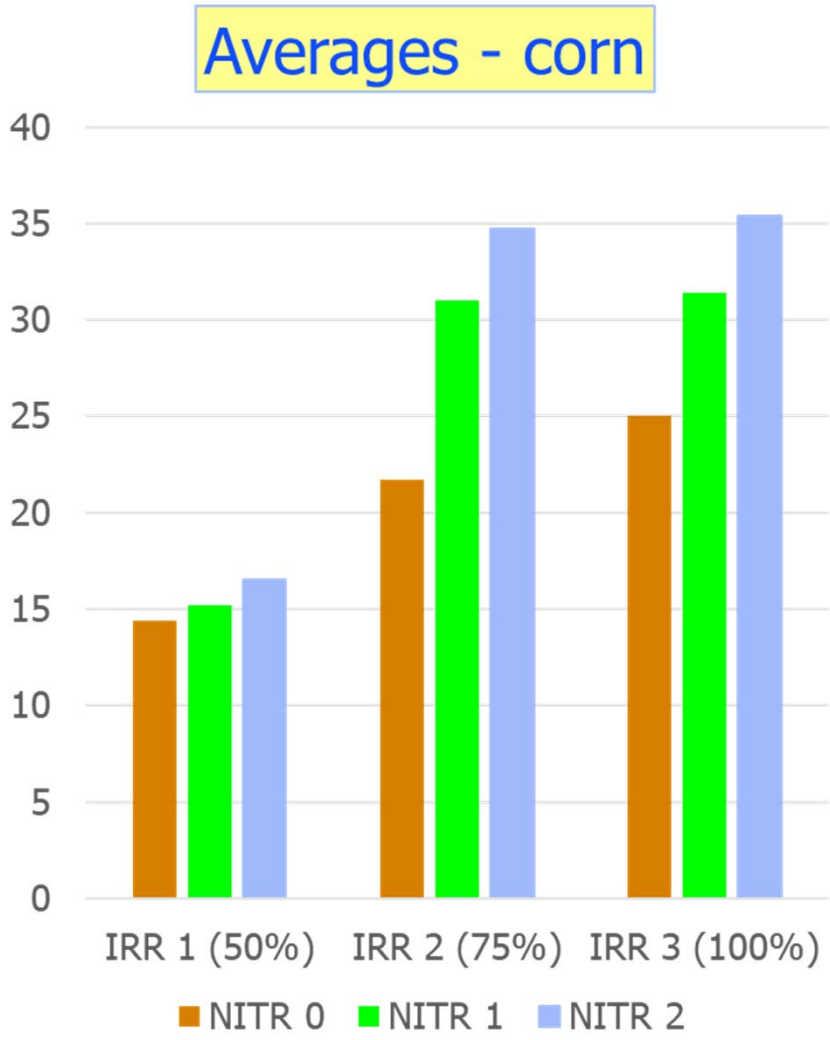


Yield (T/ac @ 70% moisture) responses to SDI Irrigation & Nitrogen treatments – Sorghum/Corn Study – WSREC – 2016 *(#3 of 3)*



Yield responses (T/ac) to SDI Irrigation & Nitrogen treatments – Sorghum/Corn Study – WSREC – 2016 *(**Averages** for sorghum entries and **averages** for corn entries)*





SDI Sorghum / Corn Study is continuing in 2017 at the West Side REC

Funds permitting, will do one more year in 2018 to conclude the trial