

Deficit Irrigation of Corn and Sorghum

J. Dahlberg, R. Hutmacher, S. Wright, M. Keeley, G. Banuelos, J. Sievert, S. Rios, and R. Delgado

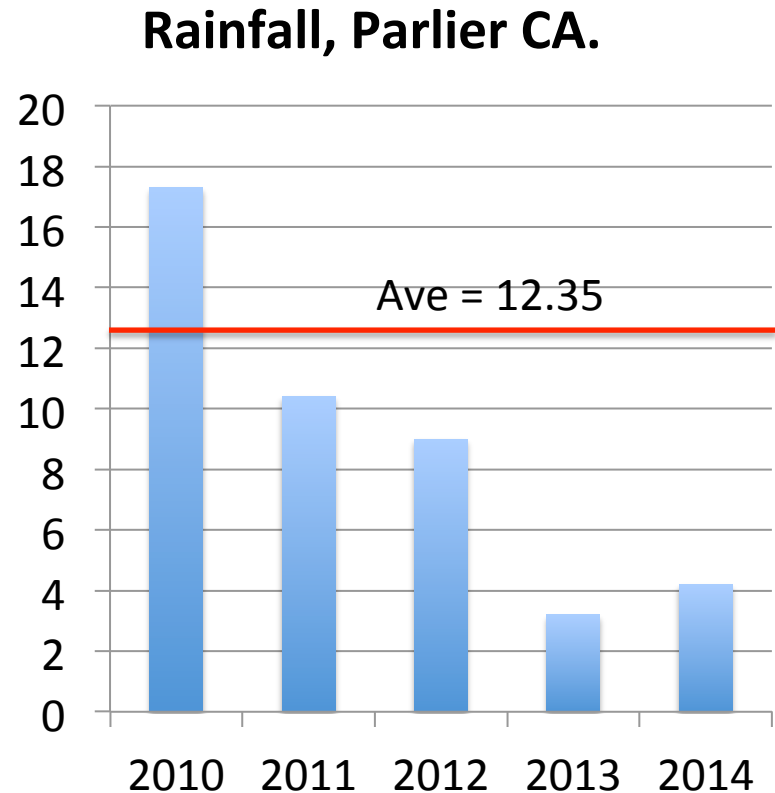


University of California

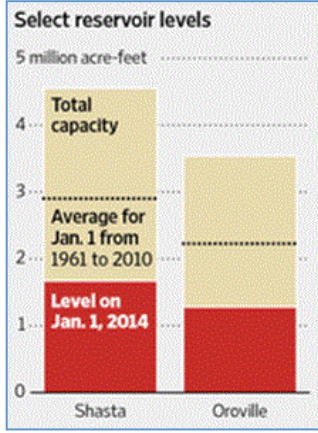
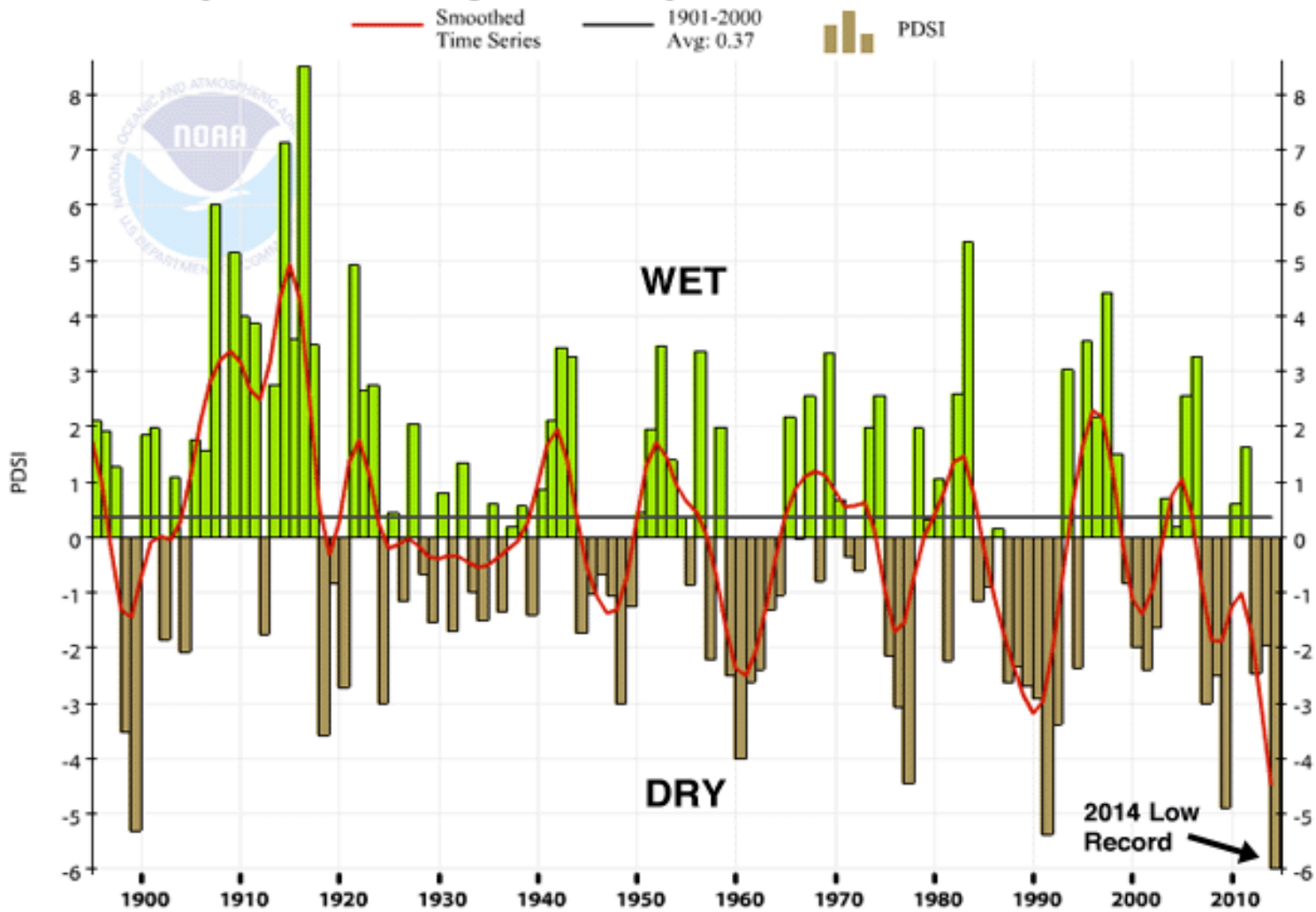
Agriculture and Natural Resources | Research and Extension Center System

Why are We Talking about Deficit Irrigation

- In the midst of a 4-year drought
- Water restrictions being implemented
- Restrictions are impacting different areas of farming



January Palmer Drought Severity Index for California, 1895 - 2014



University of California

Agriculture and Natural Resources

Research and Extension Center System

Sources: NOAA 2014, WSJ 2014

What You Might be Hearing!

- Drought Tolerance: refers to the degree to which a **plant** is adapted to arid or drought conditions

- Vegetative
- Pre-flowering
- Post Flowering



- Drought Avoidance: refers to what a **plant** might do to avoid drought



What You might Do!!

- Plant a more drought tolerant crop
- Deficit Irrigation: (DI) is a watering strategy that can be applied by different types of **irrigation** application methods. The correct application of DI requires thorough understanding of the yield response to water (crop sensitivity to drought stress) and of the economic impact of reductions in harvest (en.wikipedia.org/wiki/Deficit_irrigation)

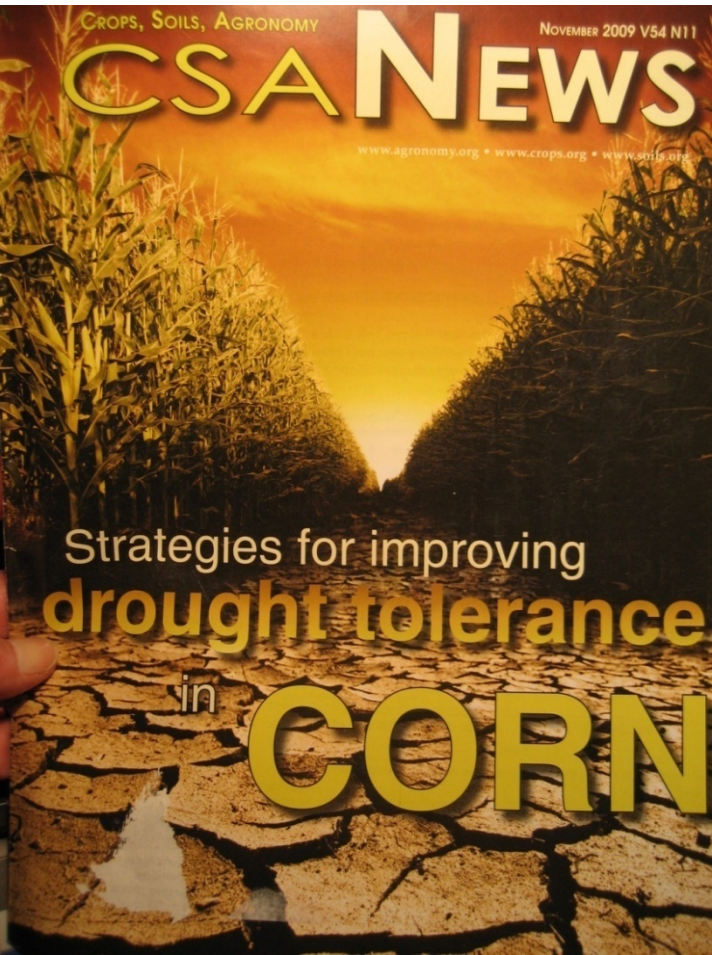


Corn

- For the most part, it is not a very good drought tolerant crop
 - Corn breeders working on selecting for drought tolerance
 - Exploring GMO strategies to introduce drought tolerance
- Deficit Irrigation might be an answer!



Improved Genetics

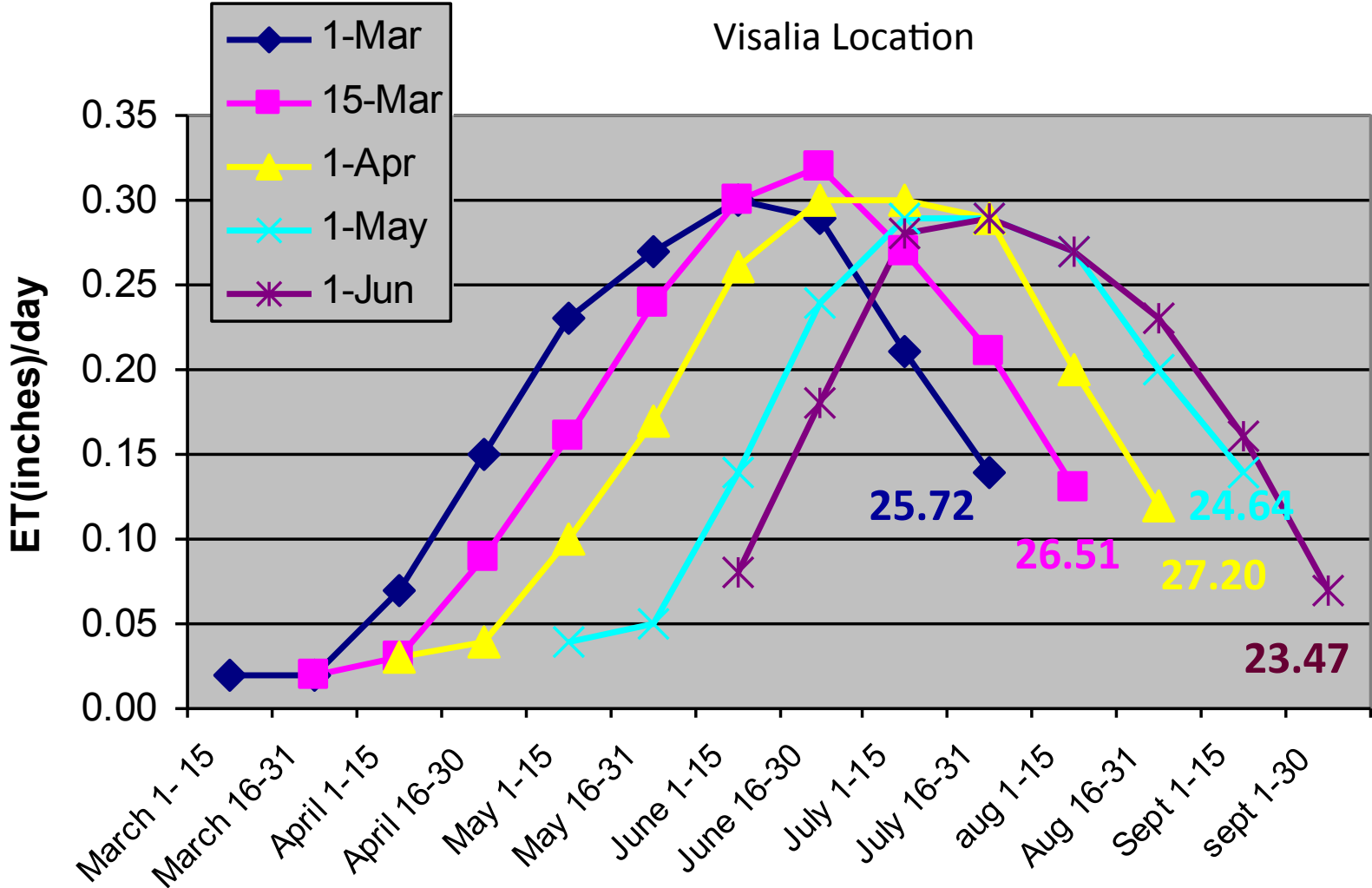


Grain Yield (bu/acre)			
Hybrid	Irrig	Drought	% Loss
tolerant	221	164	26
intermediate	251	133	47
Suscept.	233	110	53

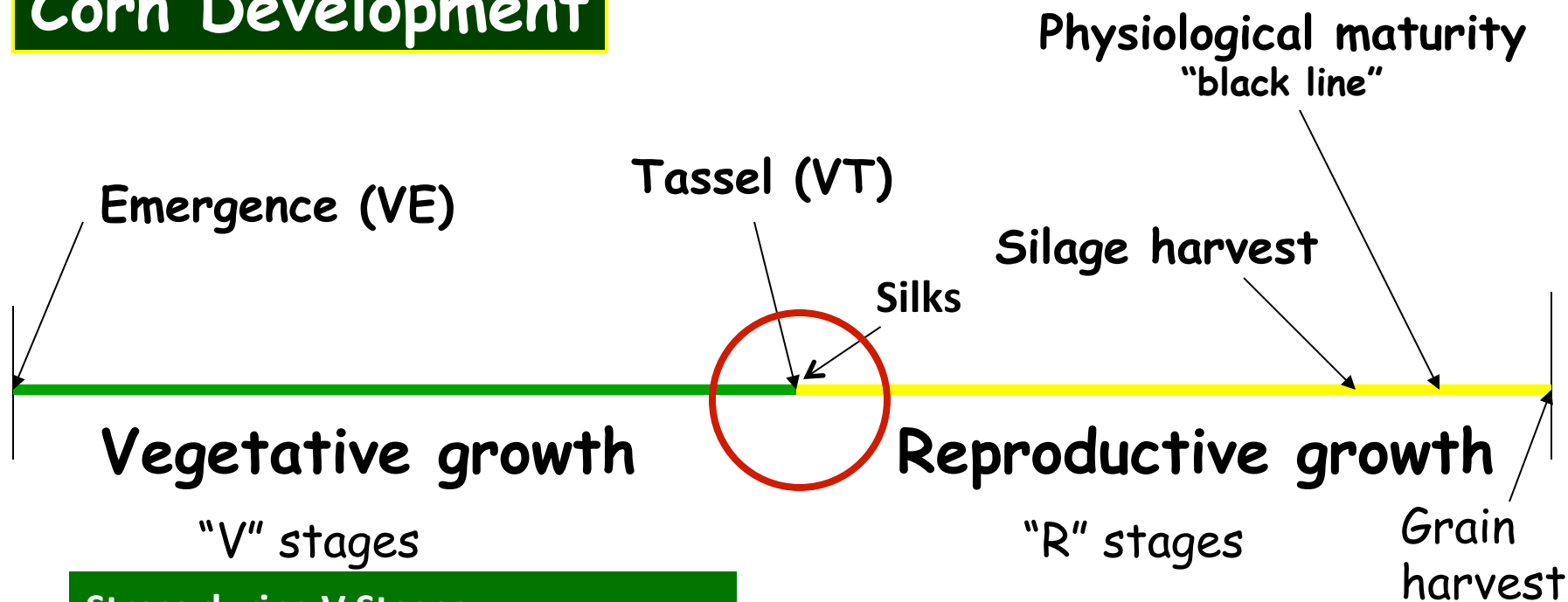
Many companies developing
Not readily available yet
Adapted to CA?

Corn ET by Planting Date

Visalia Location



Corn Development



Stress during V Stages

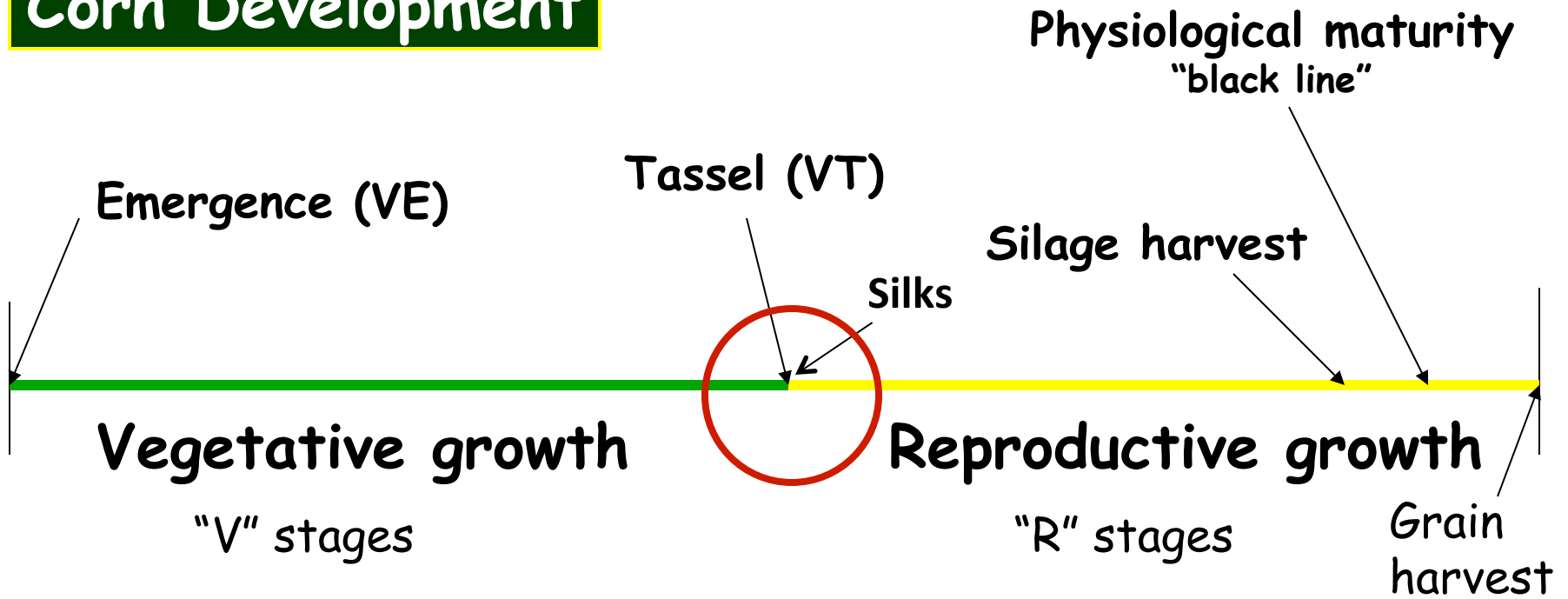
- Slow new leaf appearance
- Reduce leaf area expansion
- Delay crop maturity
- Corn may be shorter
- Can reduce size of the ear
- If prolonged, can reduce roots system

Stress during R Stages

- Reduce kernel size
if severe kernels shrivel
- Promote stalk rots



Corn Development



The most critical time for corn to have water and not stress are the 2 weeks before and the 2 weeks after tassel/silking!



University of California

Agriculture and Natural Resources | Research and Extension Center System

2-Yr Arizona Study

- Sandy clay loam
- First irrigation at 2, 4 or 6 leaf
- With and without irrigation at pollination



A. O. Jama and M. J. Ottman, Timing of the first irrigation in corn and water stress conditioning, *Agron. J.* 85 (1993), pp. 1159-1164.



Arizona Study - Results

Delaying the first irrigation:

Did not condition the plant for later stress

Did not improve root development

Decreased water use

Did not promote deep water uptake

Delayed leaf emergence, silking and maturity by a few days

Decreased biomass (dry matter) up to the milk stage

And in 1 year out of 2 decreased grain yield



Arizona Study - Results

Water Stress during pollination:

Reduced kernel weight by ~ 8%

Reduced kernel number by ~ 26%

Reduced grain yields by ~ 35%

Is there a safe time to stress corn?

- General wisdom is “no”
- Some papers say mild stress in early season “conditions” corn for later stress
 - Not all the literature agrees
 - Many trials conducted in humid locations

If you are going to stress corn, do not do it 2 weeks before and after tasseling and silking!



Summary

- There is really no good time to stress corn

But if you must.....the impact of stress on corn is:

- Greatest the 2 weeks prior to and after silking
- Less during grain fill
- Least during vegetative stages



What is Sorghum?

- Hybrid Grain Sorghum-used primarily for animal and human consumption
- Hybrid Forage Sorghum-used for silage, green chop
- Hybrid Sudangrass-used primarily for hay production and some grazing
- Sweet Sorghum-used for molasses or syrup production
- Biomass sorghum-developed for renewable bio-products





University of California

Agriculture and Natural Resources | Research and Extension Center System

What Makes Forage Sorghums Different?

- Have been in California since the late 1800s
- Seed industry has been developed around forages
- Hybrids have been specifically bred for forage quality
- Introduction of novel genes for improvement



Height Genes



1.5 ft



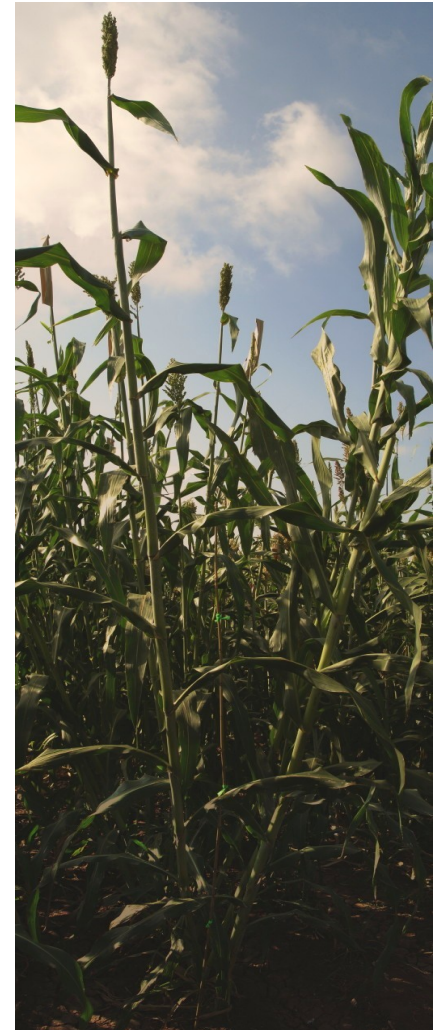
4 ft



6 ft



8 ft



10 ft



University of California

Agriculture and Natural Resources

Research and Extension Center System

Photoperiod and Maturity Genes



University of California

Agriculture and Natural Resources | Research and Extension Center System

bmr Genetics



University of California

Agriculture and Natural Resources | Research and Extension Center System

Issue with some bmr forages



University of California

Agriculture and Natural Resources | Research and Extension Center System

New Genetics



- Brachytic genes
 - Shortens internode length
- Has potential to resolve lodging issues with bmr forages



Signs of Water Stress in Sorghum

- Pre-flowering
 - Leaf rolling
 - Excessive leaf erectness
 - Leaf bleach, tip and margin burn
 - Delayed flowering
- Post-flowering
 - Premature leaf & stem death
 - Stalk disease and lodging
 - Significant reduction in seed size



Drought Tolerance



University of California

Agriculture and Natural Resources | Research and Extension Center System

PRE -

POST-



SCENECENT

STAY-GREEN



University of California

Agriculture and Natural Resources | Research and Extension Center System

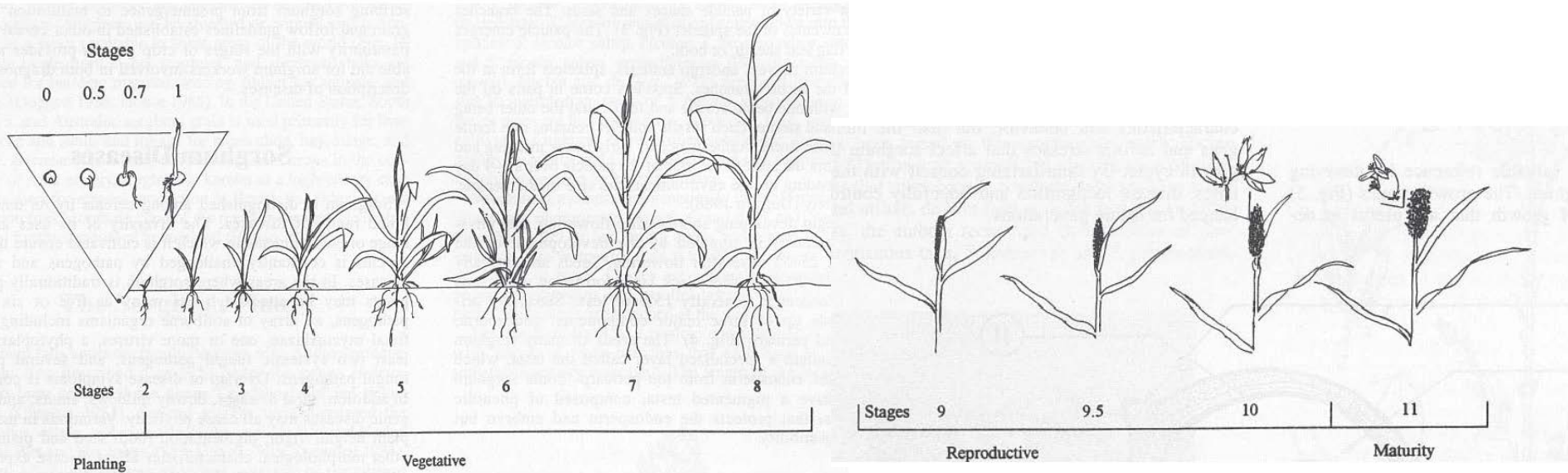
Roots are Important in Sorghum



University of California

Agriculture and Natural Resources | Research and Extension Center System

Growth & Development



University of California

Agriculture and Natural Resources | Research and Extension Center System

When to Water Sorghum in DI

- Grain sorghum
 - 30-35 days after emergence when panicle differentiation occurs
 - 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
 - Good 1 inch irrigation at planting to encourage emergence



Evaluating Forages in California

- Starting our 4th year of hybrid evaluations
- Grown at both Westside and Kearney Agricultural Research and Extension Centers
- Typically grown on less than 19 applied inches of water at both sites
- Approximately 125 lbs of N



Data Collection

- Agronomic Data
 - Height
 - Flowering
 - Lodging
 - Yield
- Nutritional
 - Sent to Dairyland Labs



University of California

Agriculture and Natural Resources | Research and Extension Center System

Top Agronomic Performers 2011-2012

Hybrid	Company	Maturity	Height (ft)	% Lodging	Ton ac ⁻¹ 65% Moist
SS 506	Sorghum Partners, LLC.	L	10.5	40.8	36.4
1990	Sorghum Partners, LLC.	PS	8.9	46.7	34.6
Pacesetter BMR-Red	Richardson Seeds	PS	9.3	60.8	31.7
SS 405	Sorghum Partners, LLC.	ML	9.9	35.8	31.7
SS 304	Sorghum Partners, LLC.	M	9.1	60.0	30.2
NK 300	Sorghum Partners, LLC.	ME	6.8	11.3	26.3
Silo 700D	Richardson Seeds	L	7.2	5.0	24.9
AS781	AR-B-Seeds	ML	6.1	1.3	24.9
BH211 SBD	B-H Genetics	L	8.1	4.2	22.8
Alta 7401	Advanta	L	6.1	2.5	22.0
BH312 FBD	B-H Genetics	ML	6.2	5.8	21.8



Nutrition Data

Hybrid	Company	Maturity	% ADF	% NDF	% TDN	Milk Lbs ton ⁻¹
SS 506	Sorghum Partners, LLC.	L	43.0	63.1	53.3	1711.8
1990	Sorghum Partners, LLC.	PS	45.3	66.7	52.3	1579.8
Pacesetter BMR-Red	Richardson Seeds	PS	43.0	65.7	54.6	1975.1
SS 405	Sorghum Partners, LLC.	ML	40.9	59.9	54.6	1819.4
SS 304	Sorghum Partners, LLC.	M	39.2	57.8	55.7	1910.2
NK 300	Sorghum Partners, LLC.	ME	35.1	51.4	58.5	2162.4
Silo 700D	Richardson Seeds	L	34.3	50.8	59.0	2071.2
AS781	AR-B-Seeds	ML	33.7	49.3	59.6	2360.4
BH211 SBD	B-H Genetics	L	37.6	55.4	58.0	2251.1
Alta 7401	Advanta	L	34.9	51.4	58.7	2251.1
BH312 FBD	B-H Genetics	ML	35.1	51.6	57.8	2296.3



Lessons to be Learned

- Plant populations, not pounds per acre are necessary
- Managing N fertility is important
 - Different for Forage and Grain!!
- Sorghum forages can be both high yielding and good quality
- Sorghum forages can be managed on less water than most other crops



Bottom Line:

Sorghum is Not Corn!!

- Grain is smaller
 - Processing is different
- Forages are not the same as grain
- Different agronomic practices to optimize yields
 - Require less water and fertilizer
 - Shorter growing season
- Different nutritional qualities which require different feed strategies
 - PS sorghum have no grain
 - Dual purpose sorghums need to be harvest at correct time or need the grain processed
 - Bmr have high digestibility, lower lignin



Why Sorghum??

Type	Brand	Plant Height (ft)	% DM at Harvest	Tons Acre ⁻¹ at 30% DM	# of Irrigations
Grain	HyTest 850	5.3	28.9	22.8	3
Forage	SorgoMax FS 430	8.6	26.2	28.4	3
Corn Silage	Average Values	12.5	32.0	30.0	8

Relative yields of forage and grain type sorghums and irrigation events compared to corn silage (UCCE Kings County, Carol Collar and Peter Robinson)

Bob Hutmacher's research on ET of sorghum is showing similar results

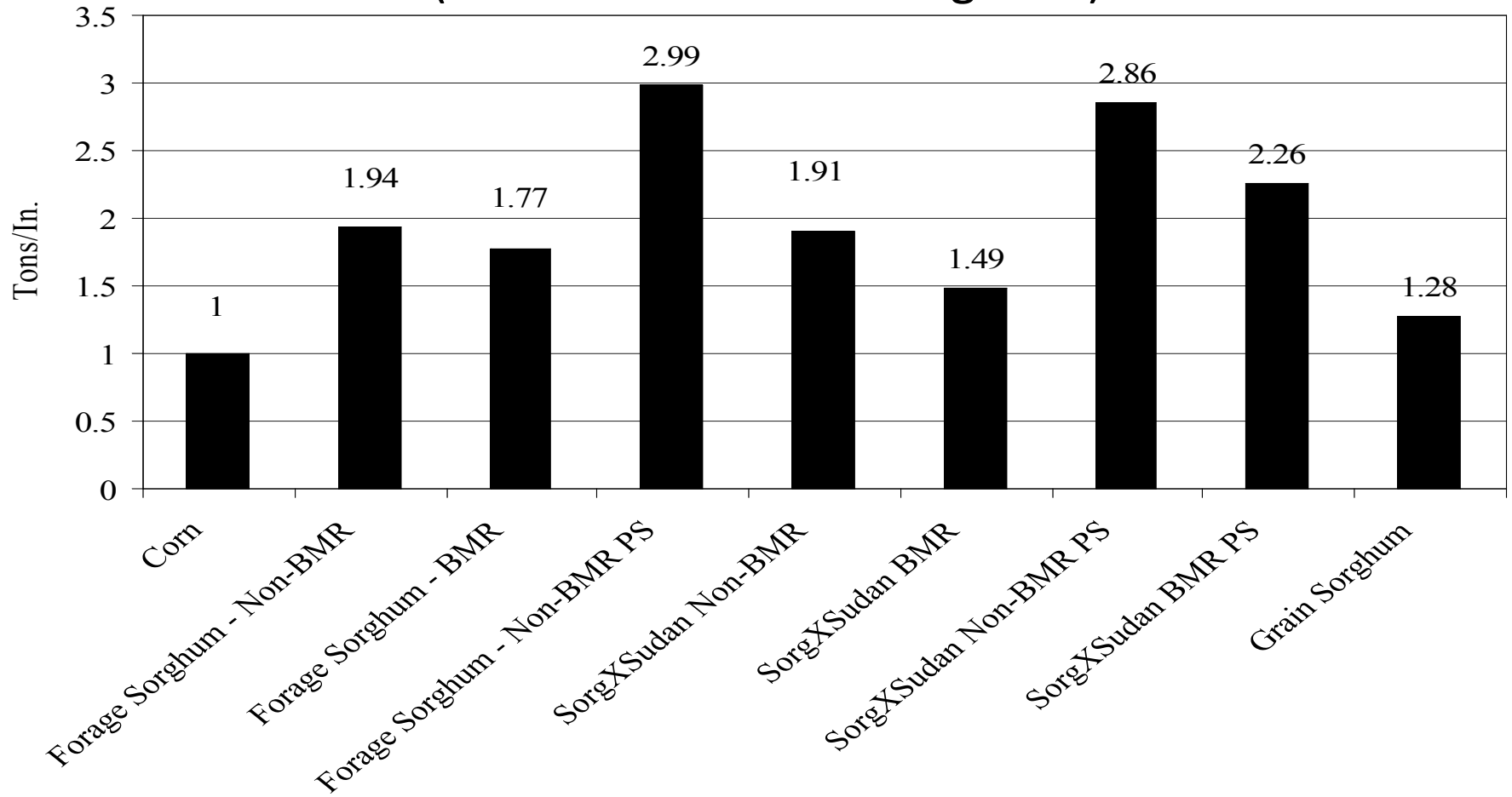


University of California

Agriculture and Natural Resources | Research and Extension Center System

Water is the Key!

(Research from Texas AgriLife)



University of California

Agriculture and Natural Resources

Research and Extension Center System

Questions

Look us up at: sorghum.ucanr.edu



University of California

Agriculture and Natural Resources | Research and Extension Center System