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Addressing Key Questions for Cotton Irrigation

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Collaborators: Drs. C. Main and B. Leib

- When should I begin and end irrigating?
- How much should I irrigate?
- Should I increase N application for irrigated cotton?

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Water Stress Tolerance of Cotton Fruit

- Highly susceptible
  - Young squares (esp. 2nd and 3rd positions)
  - Young bolls (<14 days old)
- Somewhat susceptible
  - Large squares
  - Large bolls (>30 days old)
- Somewhat resistant
  - Flowers
  - Open bolls

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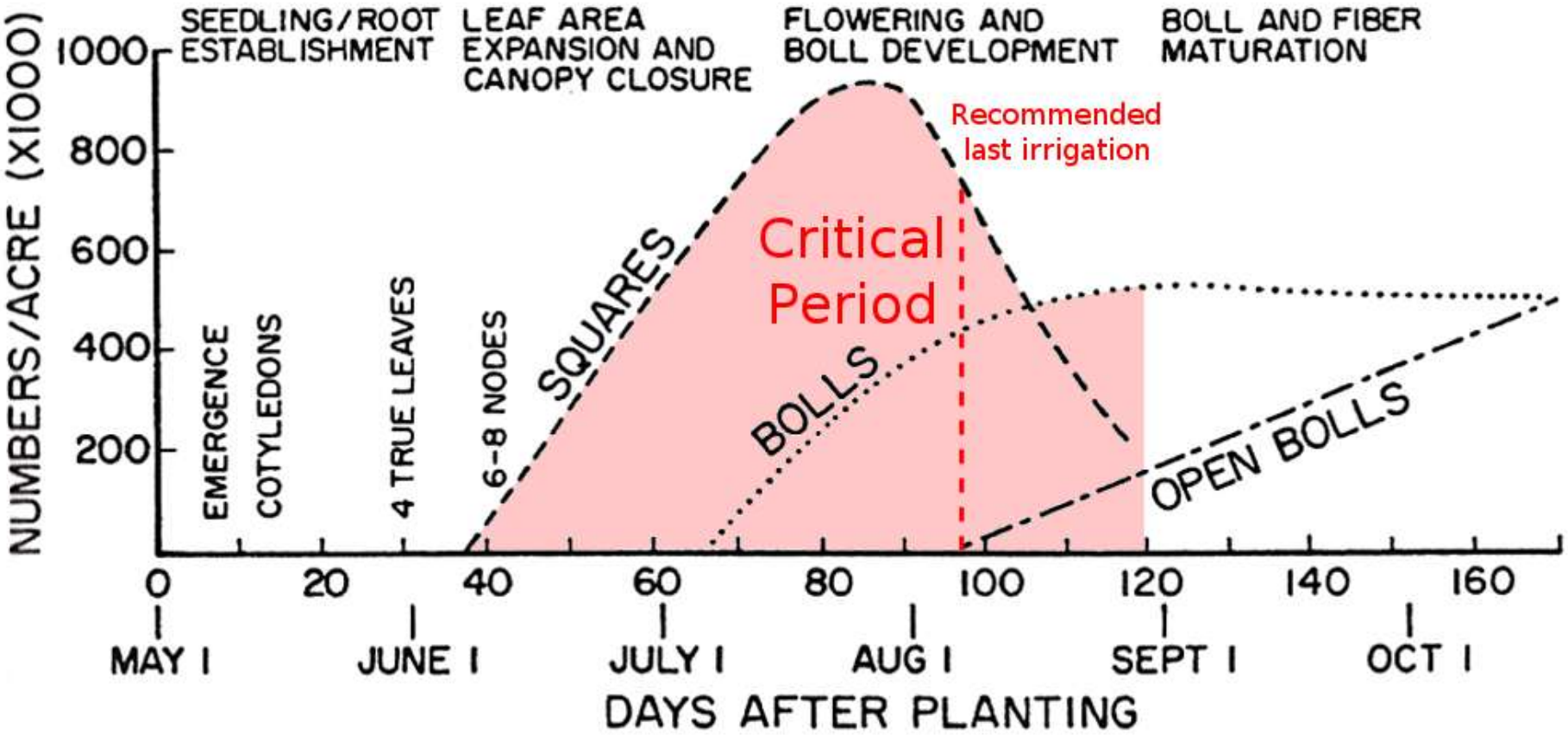
Development of Cotton in the Mid-South



Source: Oosterhuis, D.M. 1990. Growth and development of the cotton plant. In: W.N. Miley and D.M. Oosterhuis (eds) Nitrogen Nutrition in Cotton: Practical Issues. Proc. Southern Branch Workshop for Practicing Agronomists. Publ. Amer. Soc. Agron., Madison, WI

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TN Irrigation Recommendation

"Rule-of-thumb" for silt loam soils:

- **1"/week of rain + irrigation from 1st square – 1st open boll.**
  - On clayey soils, start a little later and/or end a little earlier
  - On sandy soils, start a little earlier, end a little later and/or irrigate up to 1.5"/week
- **We believe you can over-irrigate cotton!**

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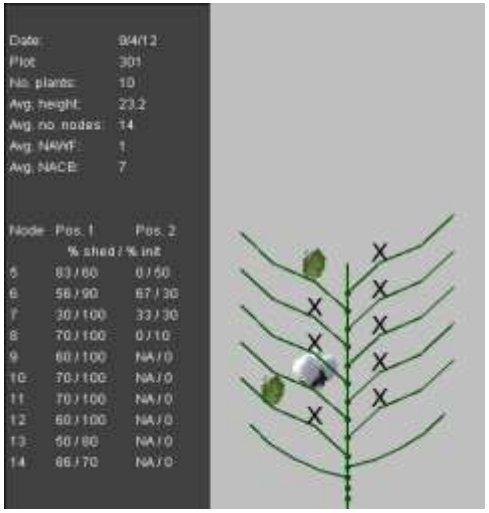
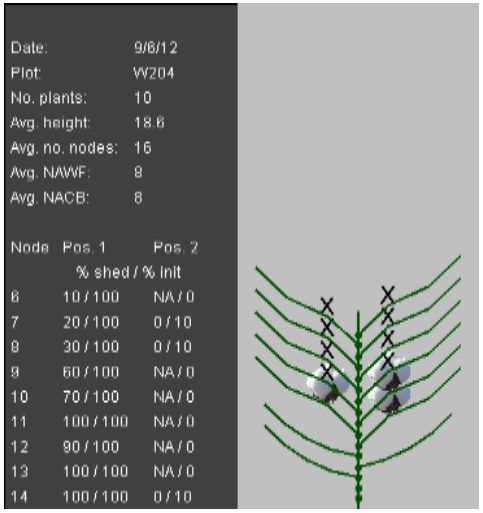
2012 Surface Drip Study

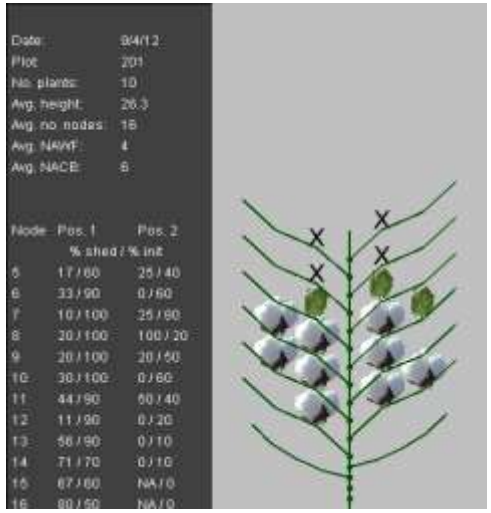
Shallow/sandy soil



rainfed - 506 lb/A

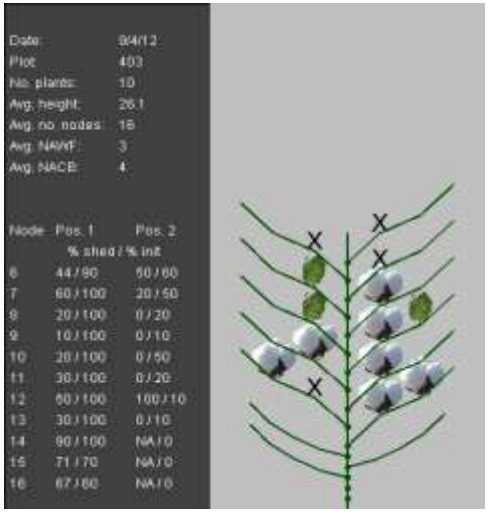


1”/wk - 703 lb/A

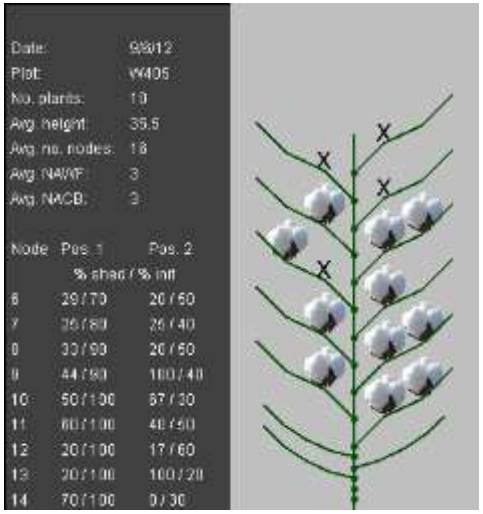


1.5”/wk - 1635 lb/A

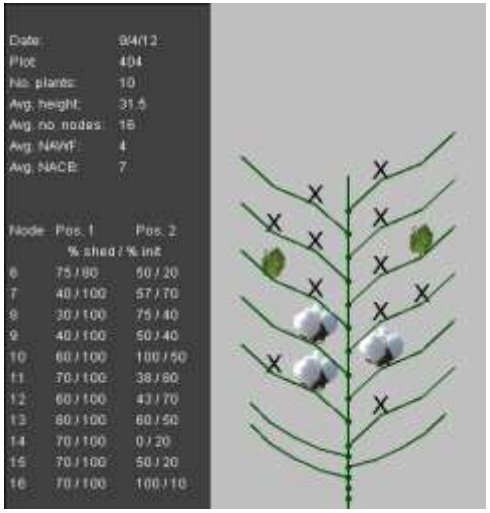
Deep silt loam



rainfed - 1579 lb/A



1”/wk - 1982 lb/A



1.5”/wk - 1466 lb/A

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2012 Sub-surface Drip Study

Field/Zone	Drip Spacing	No. Irrigation Regimes	Nitrogen Rates	No. Varieties
Zone 1 West	76”	6	80, 120	PHY499WRF, PHY367WRF
Zone 1 East	76”	5	0, 40, 80, 120	PHY499WRF
Zone 2 West	38”	4	80, 120	PHY499WRF, PHY367WRF

- Planted 41,200 seeds/A on 38” rows
- Plots were 4 rows wide by 26’ long
- 1 pint of Pix at 1st bloom
- Picked middle two rows for yield

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Sub-surface Drip Study Lint Yields

Lint yield (lb/A)			
Cultivar	**Z1W (76")**	**Z1E (76")**	**Z2W (38")**
PHY367WRF	1472.2 b	NA	1024.1 b
PHY499WRF	1671.7 a*	NA	1208.3 a
Irrigation Regime			
no irrigation	1191.1 b	1593.1 a	NA
0.0" mid square, 0.5" mid bloom, 1.0" late bloom	1502.3 ab	1495.6 a	1015.3 a
0.5" mid square, 1.0" mid bloom, 1.0" late bloom	1448.3 ab	1763.4 a	NA
0.5" mid square, 1.0" mid bloom, 1.5" late bloom	1778.1 a	1757.8 a	1145.9 a
0.5" mid square, 1.5" mid bloom, 1.5" late bloom	1704.3 a	1774.3 a	1187.3 a
0.5" mid-square, 1.5" mid bloom, 1.0" late bloom	1807.8 a		
Nitrogen Application Rate			
0 lbs N/A	NA	1467.4 c	NA
40 lbs N/A	NA	1755.9 ab	NA
80 lbs N/A	1557.8 a	1826.8 a	1120.3 a
120 lbs N/A	1586.2 a	1657.2 b	1112.0 a

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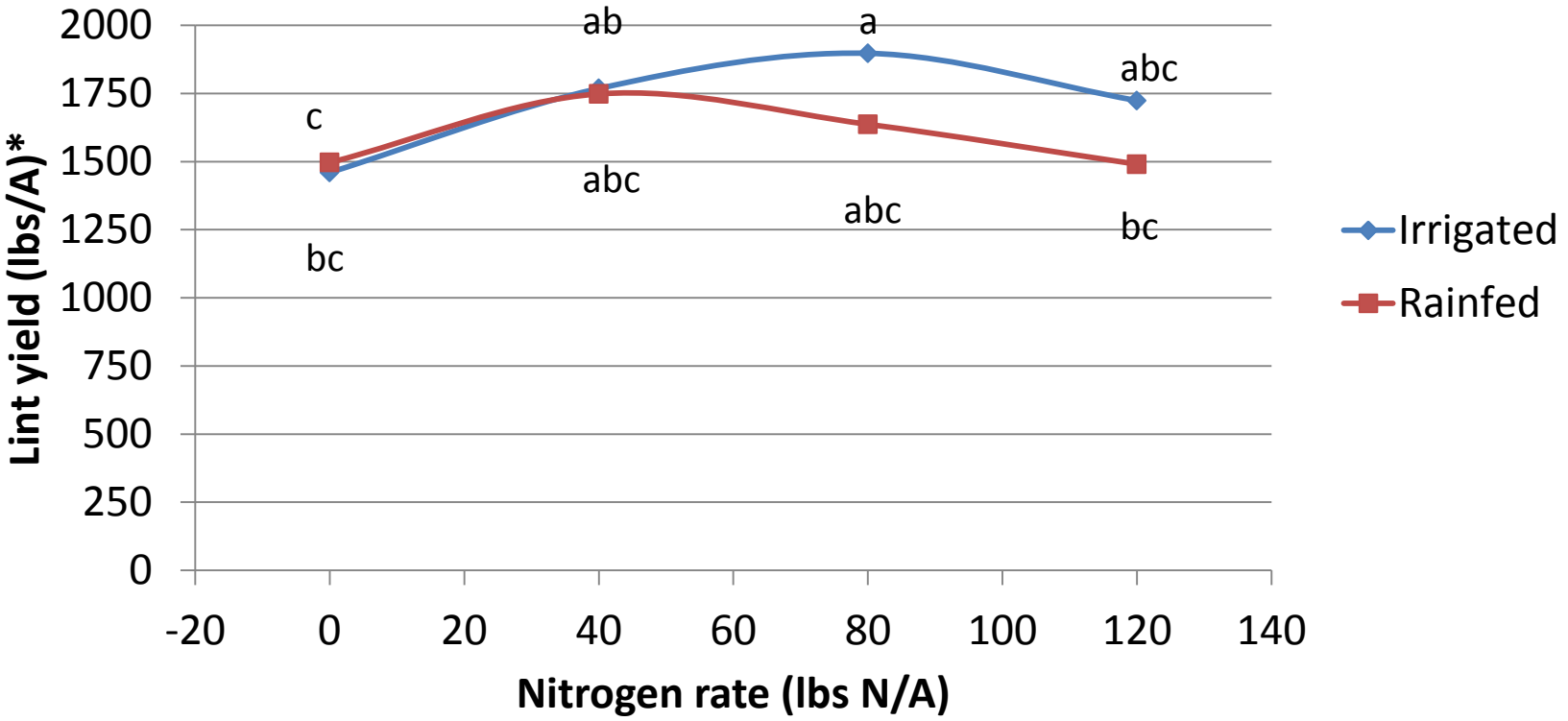
Effects of Nitrogen in Cotton

- Nitrogen rates up to 40 lbs N/A:
  - Increased node count and no. of fruiting branches
  - Increased % of initiated position 2 bolls
  - Increased height
  - Decreased NACB
- No significant effects above 40 lbs N/A
- No significant interaction between irrigation regime and nitrogen application rate

Nitrogen and Irrigation Interaction

Lint yield response to nitrogen under sub-surface irrigation in 2012 at WTREC



* All lint yields were determined using 10-saw gin which may overestimate turnout

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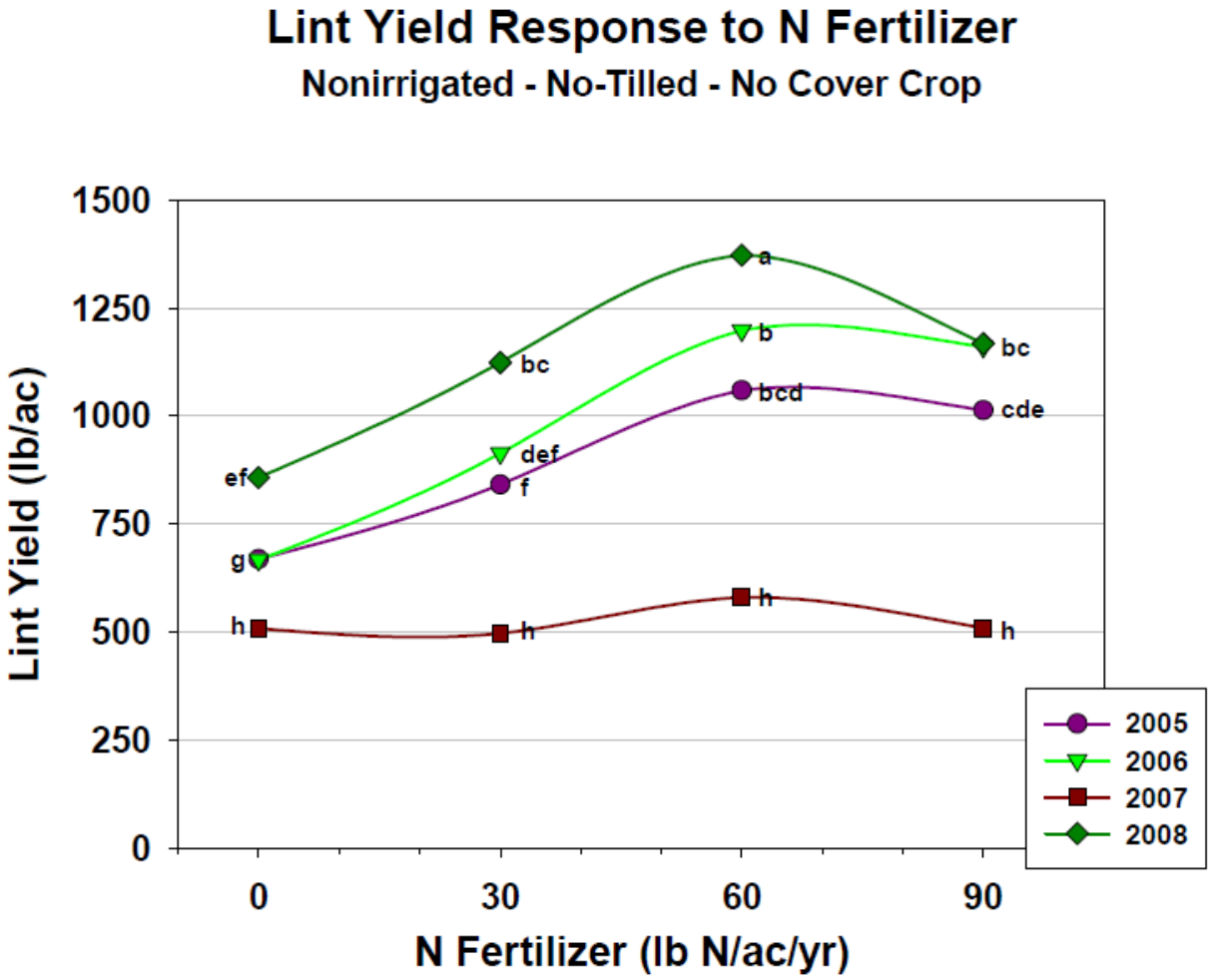
Nitrogen Response



Source: Gwathmey, C.O. 2009. Cotton Response to Nitrogen and Potassium Fertility. *Cotton Focus* meeting, UT Extension, 12 Feb 2009, Jackson TN.

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TN Nitrogen Recommendation

Max. 60 lbs N/A on bottom soils

Max. 80 lbs N/A on upland soils

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2013 Cotton Research Projects

- "Optimizing cotton irrigation timing and amount for different maturity cultivars and soil types"
  - Collaboration with Dr. Brian Leib
  - Funded by Cotton Incorporated
- "On-farm water and nitrogen use efficiency in cotton under center-pivot irrigation"
  - Funded by Cotton Foundation

Acknowledgements

- Dr. Chris Main and staff for crop management support
- Dr. Brian Leib and staff for sensor support
- Dr. Bob Hayes and Farm Crew at WTREC
- Cotton Incorporated for funding surface drip irrigation research
- John Deere Water for donating sub-surface drip irrigation system
- Tennessee Tractor for installing sub-surface drip irrigation system
- Sensor donation and/or tech support
  - John Deere Water
  - Greenway Equip. Inc.
  - SmartField
  - Solstice Crop
- UT Crop Phys Group at WTREC

Addressing Key Questions in Soybean Production

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Collaborators: Drs. A. McClure and H. Kelly

- When and how much to irrigate?
- What is the optimal row spacing and planting density for a given maturity group?
- How can we reduce lodging under irrigation?

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Effects of Water Stress on Soybeans

- Planting – 1st bloom (R1)
  - Rainfall is “normally” adequate for to meet PET for full season group IV
- 1st bloom (R1) – begin pod (R3)
  - Water stress will reduce pod count
  - Soil moisture reserve may be adequate on fine soils but should start irrigating to not get behind
- Begin seed (R5) – full seed (R6)
  - Water stress will reduce seed size
  - Stop irrigating when 50% pods have seeds touching

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When and How Much to Irrigate Soybeans?

Growth stage	Sensitivity to water stress	Weekly water use*
Planting – V2	Insensitive	0.4” – 0.7”
V3 – R1	Somewhat sensitive	0.7” – 1.4”
R1 – R6	Very sensitive	1.4” – 2.1”
R7 – harvest	Insensitive	0.4” – 1.4”

“Rule-of-thumb” – 1.5”/week rain + irrigation from 1st bloom (R1) until 50% pods have seeds touching (R5-R6) for silt loam soils

*Adapted from “Soil and Water Management Soybeans - Crop Irrigation”. 2006. University of Arkansas. http://www.aragriculture.org/soil_water/irrigation/crop/soybeans.htm

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2012 Soybean Research

- Trial under full center-pivot irrigation in Milan
- Evaluated 6 Pioneer varieties from different maturity groups at 15” and 30” row spacing
- Planting density: 130,000 seeds/A

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Maturity, Row Spacing, and Yields

Variety	Maturity	Days to Harvest	Row spacing (in)	Yield (bu/A)*	
Pioneer 94Y80	4.8	149	30	82.5	a
Pioneer 94Y23	4.2	144	15	78.3	ab
Pioneer 94Y80	4.8	149	15	77.1	abc
Pioneer 94Y70	4.7	144	15	71.9	abcd
Pioneer 93Y84	3.8	144*	15	68.8	abcd
Pioneer 95Y01	5.0	156	15	68.7	abcd
Pioneer 95Y01	5.0	156	30	66.4	bcd
Pioneer 93Y92	3.9	133	15	65.6	bcd
Pioneer 94Y70	4.7	144	30	63.9	bcd
Pioneer 94Y23	4.2	144	30	63.1	cd
Pioneer 93Y84	3.8	144*	30	60.6	d
Pioneer 93Y92	3.9	133	30	60.5	d

Early maturing varieties (<=4.7) had 8-24% higher yields on 15” rows

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Row Spacing and Canopy Development

Variety	Maturity	Row spacing (in)	Leaf area index (m^2/m^2)		Light intercept. (%)	
95Y01	5.0	15	5.5	a	0.82	a
94Y70	4.7	15	5.5	a	0.79	ab
93Y84	3.8	15	5.2	ab	0.73	abc
94Y80	4.8	15	5.0	abc	0.74	abc
93Y92	3.9	15	4.6	abcd	0.71	abc
95Y01	5.0	30	4.4	bcd	0.70	abc
94Y23	4.2	15	4.2	cde	0.69	abc
94Y70	4.7	30	4.0	de	0.72	abc
93Y92	3.9	30	4.0	de	0.71	abc
94Y80	4.8	30	3.9	de	0.69	abc
93Y84	3.8	30	3.4	e	0.61	c
94Y23	4.2	30	3.3	e	0.62	bc

Planting early maturing varieties on narrower rows may improve sunlight interception prior to grain filling, thereby increasing yields

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Maturity and Plant Height

Variety	Maturity	Row spacing (in)	Height (in)	
Pioneer 94Y70	4.7	30	54.7	a
Pioneer 94Y80	4.8	30	54.1	a
Pioneer 94Y80	4.8	15	54.0	a
Pioneer 95Y01	5.0	30	53.9	a
Pioneer 95Y01	5.0	15	52.9	a
Pioneer 94Y70	4.7	15	51.1	ab
Pioneer 93Y92	3.9	30	47.7	bc
Pioneer 93Y92	3.9	15	47.1	cd
Pioneer 94Y23	4.2	15	43.6	de
Pioneer 94Y23	4.2	30	43.6	de
Pioneer 93Y84	3.8	15	41.2	e
Pioneer 93Y84	3.8	30	40.6	e

- **Planting earlier maturing varieties (<=4.2) with acceptable yields may reduce plant height and lodging potential under full irrigation.**
- **Height is unaffected by row spacing.**

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Row Spacing and Population Density

Row spacing (in)	End of season pop. density (plants/A)	
15	119,427	a
30	102,330	b

Planting 130,000 seeds/A on 15” significantly increases end of season population density by reducing a crowding affect which may contribute to yield.

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2013 Soybean Research Projects

- "Effect of planting date, latitude, and environmental factors on choice of maturity group in mid-south soybean production"
  - Multistate collaborative soybean project
  - Funded by United Soybean Board
- "Improving soybean irrigation scheduling for optimal yield"
  - Collaboration with Drs. A. McClure and H. Kelly
  - Proposed to the TN Soybean Promotion Board

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- Dr. Angela McClure and staff
- Dr. Blake Brown and Farm Crew at Milan REC
- TN Soybean Promotion Board
- UT Crop Phys Group at WTREC


Questions?