Maximizing Returns to Water Use in Southwest Kansas Irrigated Corn / Cotton Production

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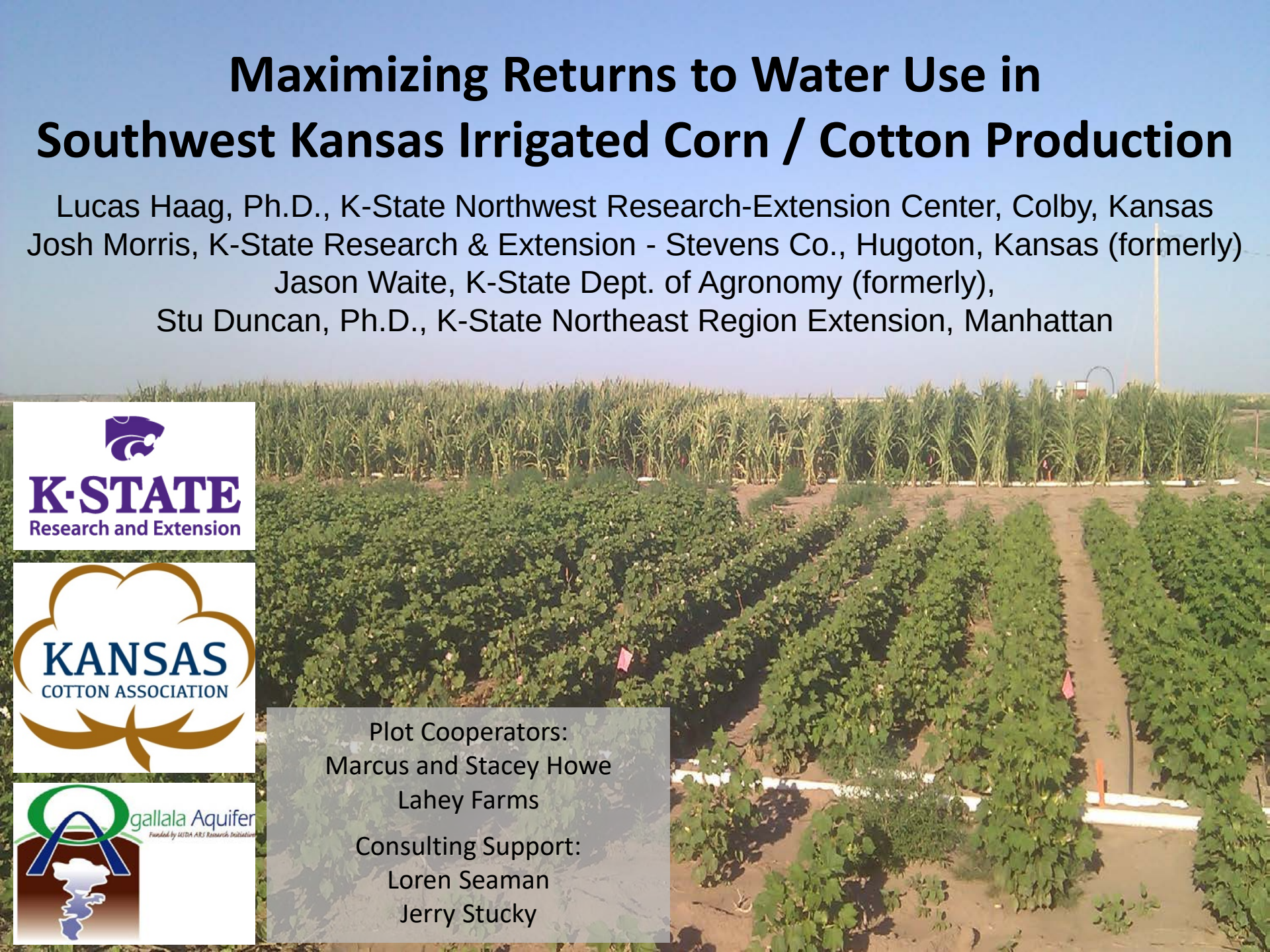

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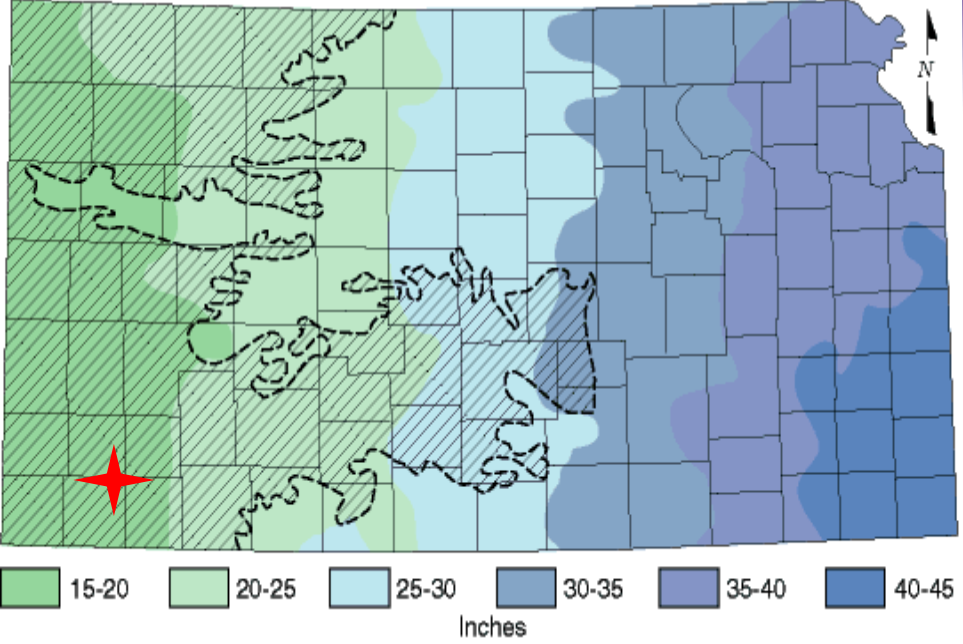
Corn / Cotton Irrigation Study



- Moscow, Kansas
- Producers and Consultants are “comfortable” with their management of irrigated corn from decades of experience
- Less experience and thus comfort with cotton irrigation
- Affects their irrigation decision making
- Can we improve cotton yields without drastically hurting corn yields by shifting water when needed?

Can We Better Target Irrigation?

- Producer / consultant observations of many aborted squares laying on the ground coming from the "money" areas of the plant in terms of yield and quality
- In a thermally limited cotton environment such as SW Kansas we can't afford to give these up
- Squares / plant is like kernels / ear in corn, it's what drives yield
- **Question: Can we better manage our water to maximize this important determinant of yield**

Materials and Methods

- Corn – Cotton rotation, Strip-Till Tillage System
- 30” Row-spacing
- Separate winter or spring strip-till operation
- P35F40 or P1151 corn seeded at 27,500 seeds acre^{-1}
- NexGen 1551RF seeded at 55,000 seeds acre^{-1}
- Fertility managed to be non limiting. N and P applied with strip-till operation.
- Split-plot design with 4 replications
  - Whole plot: Crop
  - Subplot: Irrigation

Treatment Structure

- Treatments are paired between corn and cotton plots with a fixed gallonage, i.e. we can water one or the other but not both.
- Target application depth of 1”

Corn	Cotton
Supplimented Dryland (approx 4 inches)	Water @ emergence, then dryland
Fully Irrigate @ 0.10"/day (every 10 days)	Fully Irrigate @ 0.20"/day (every 5 days)
Fully Irrigate @ 0.15"/day (every 7 days)	Fully Irrigate @ 0.15"/day (every 7 days)
Fully Irrigate @ 0.20"/day (every 5 days)	Fully Irrigate @ 0.10"/day (every 10 days)
Full @ 600 gpm until 1 Early on Cotton	Water to establish, then 1" early
Full @ 600 gpm until 1 Early + 1 Flowering on Cotton	Water to establish, then 1" early + 1" flowering
Full @ 400 gpm until 1 Early on Cotton	Water to establish, then 1" early (400 gpm)
Full @ 400 gpm until 1 Early + 1 Flowering on Cotton	Water to establish, then 1" early + 1" flowering (400 gpm)
Full @ 400 gpm, pull off at cotton critical stage	1" Early vegetative, then at critical stage

Early application is at matchhead square
Late application is at mid flowering

Irrigation System

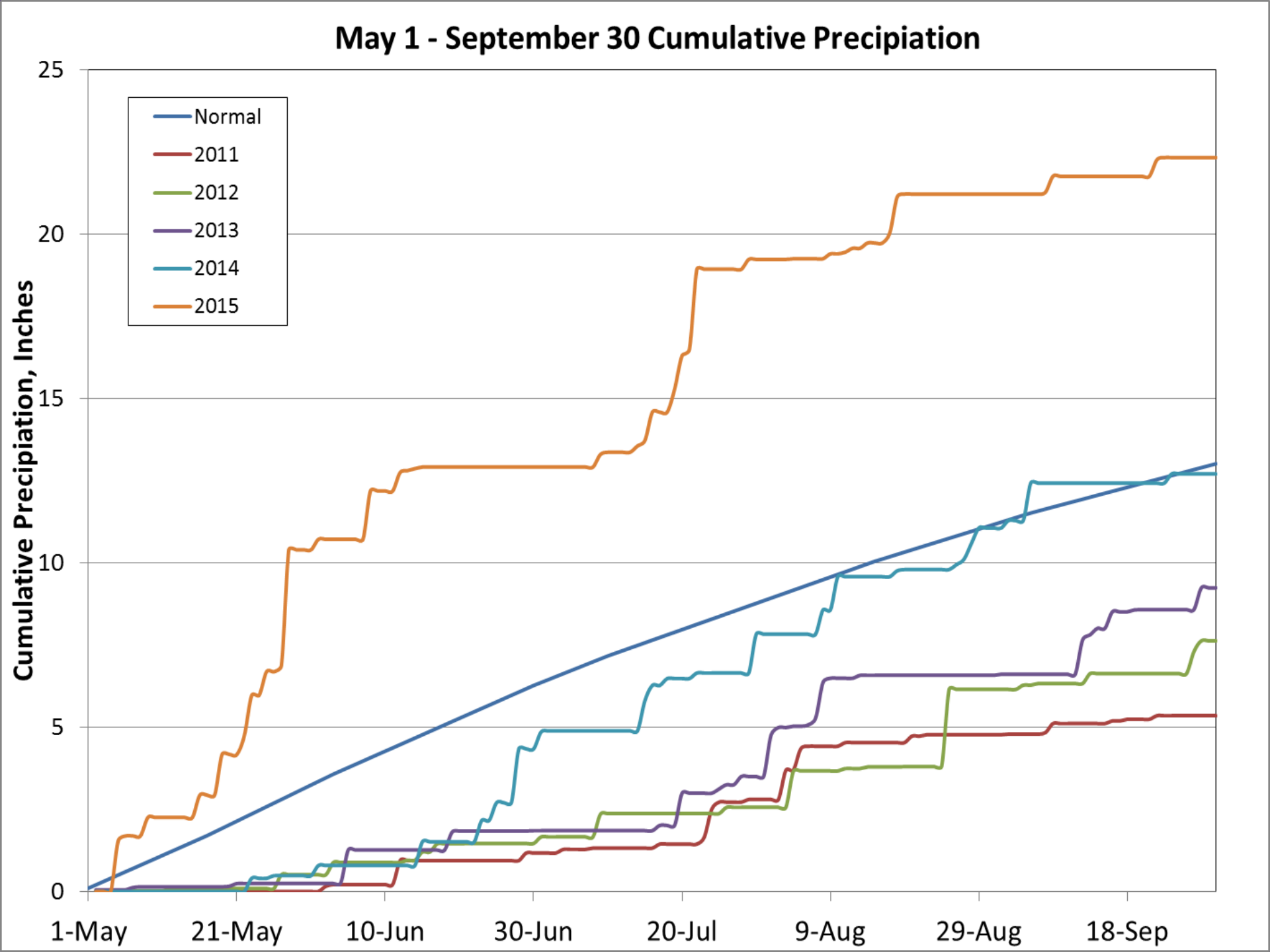
- Custom manufactured drip tape to achieve same application rate as the plots would experience halfway down a 500 gpm sprinkler
- Each 4 row x 40’ plot is on its own valve
- Flow meter per each rep

Irrigation

- Preseason irrigation is applied consistent with producer practice for any given year.
  - 2011 – 4 inches
  - 2012 – 4 inches
  - 2013 – 5 inches
  - 2014, 2015 – No preseason applied

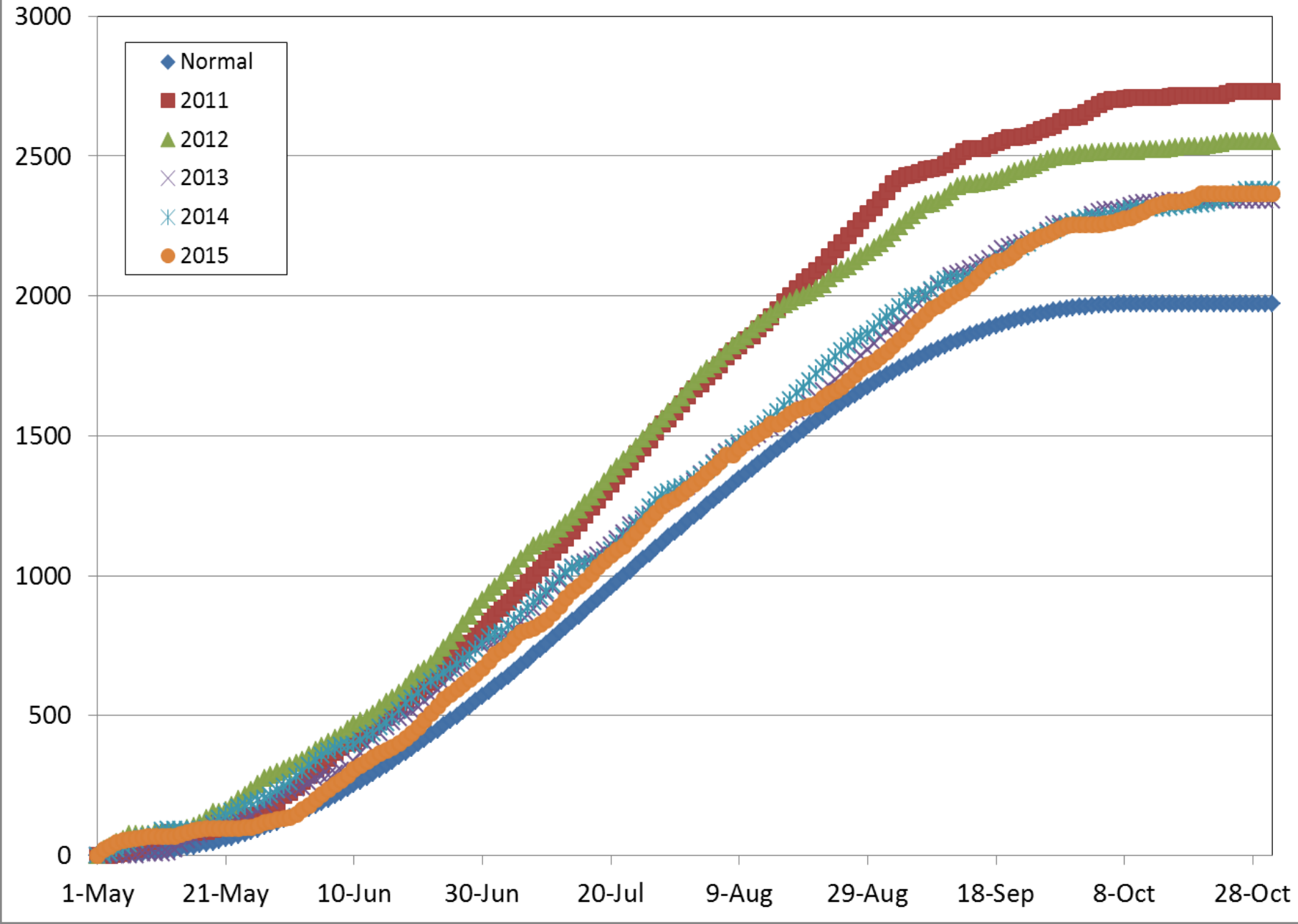
Drought driven

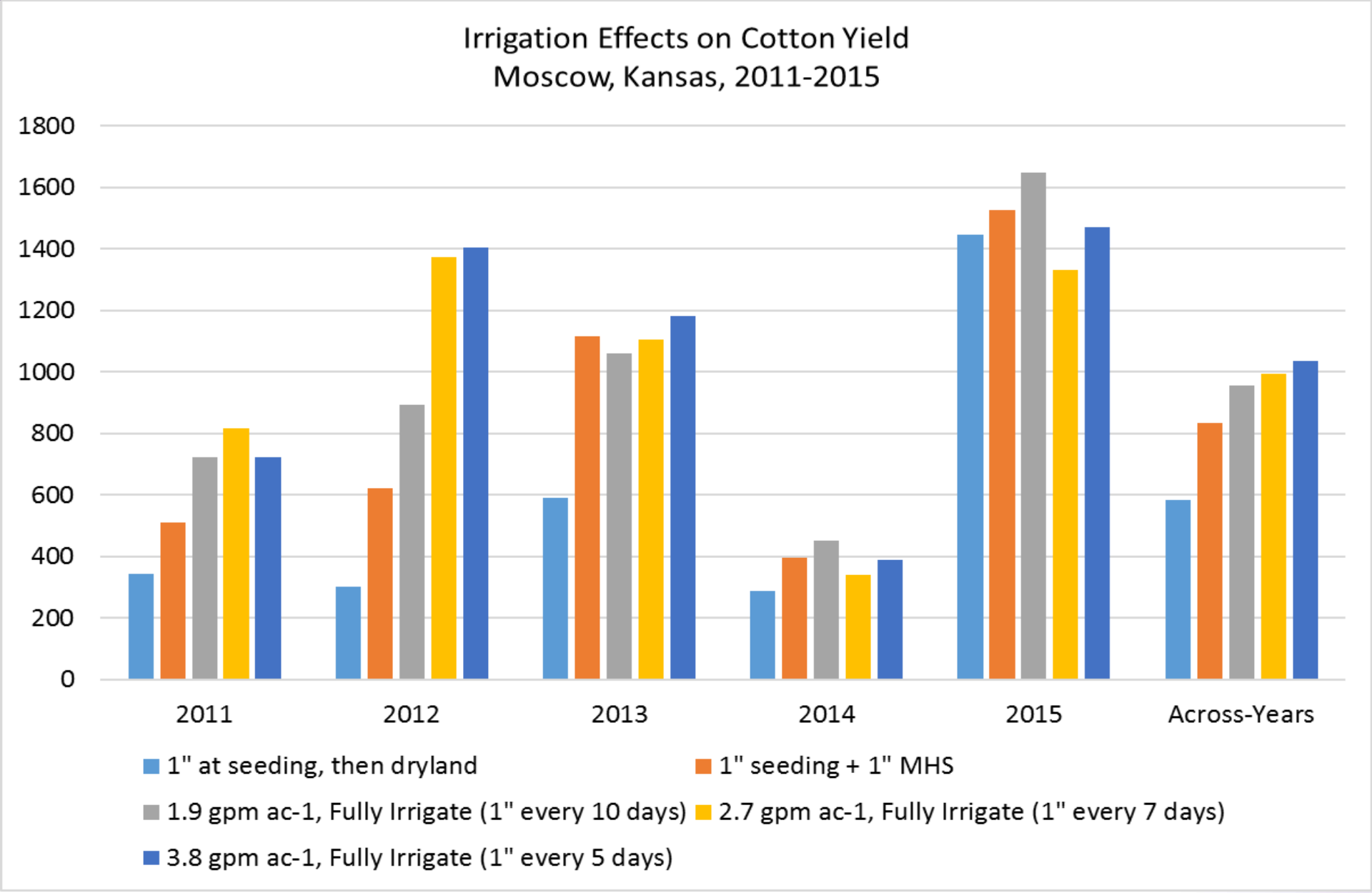
- Typical seasonal irrigation application
  - Fully Irrigate Corn or Cotton @ 0.10”/day = 8”
  - Fully Irrigate Corn or Cotton @ 0.15”/day = 12”
  - Fully Irrigate Corn or Cotton @ 0.20”/day = 16”
  - Full Irrigate Corn @ 600 gpm until 1” @ MHS = 16”
  - Full Irrigate Corn @ 400 gpm until 1” @ MHS = 10”


May 1 - September 30 Cumulative Precipiation
Cumulative Precipiation, Inches
25
20
15
10
5
0
Normal
2011
2012
2013
2014
2015
1-May
21-May
10-Jun
30-Jun
20-Jul
9-Aug
29-Aug
18-Sep

Cumulative Cotton GDU, May 1 - October 31

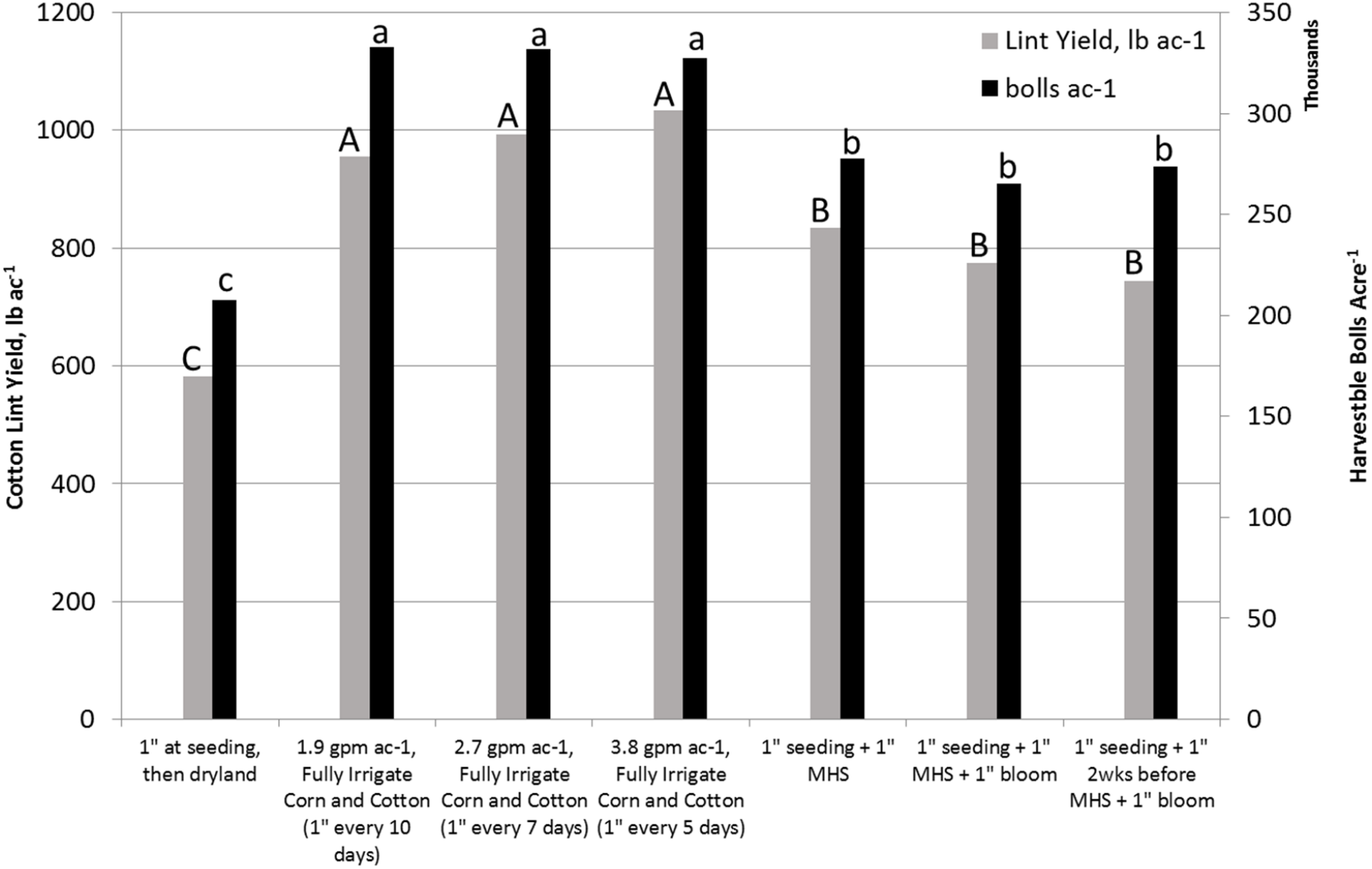
K-State Corn-Cotton Irrigation Study, Moscow, Kansas




Irrigation Effects on Cotton Yield
Moscow, Kansas, 2011-2015
1800
1600
1400
1200
1000
800
600
400
200
0
2011
2012
2013
2014
2015
Across-Years
1" at seeding, then dryland
1" seeding + 1" MHS
1.9 gpm ac-1, Fully Irrigate (1" every 10 days)
2.7 gpm ac-1, Fully Irrigate (1" every 7 days)
3.8 gpm ac-1, Fully Irrigate (1" every 5 days)

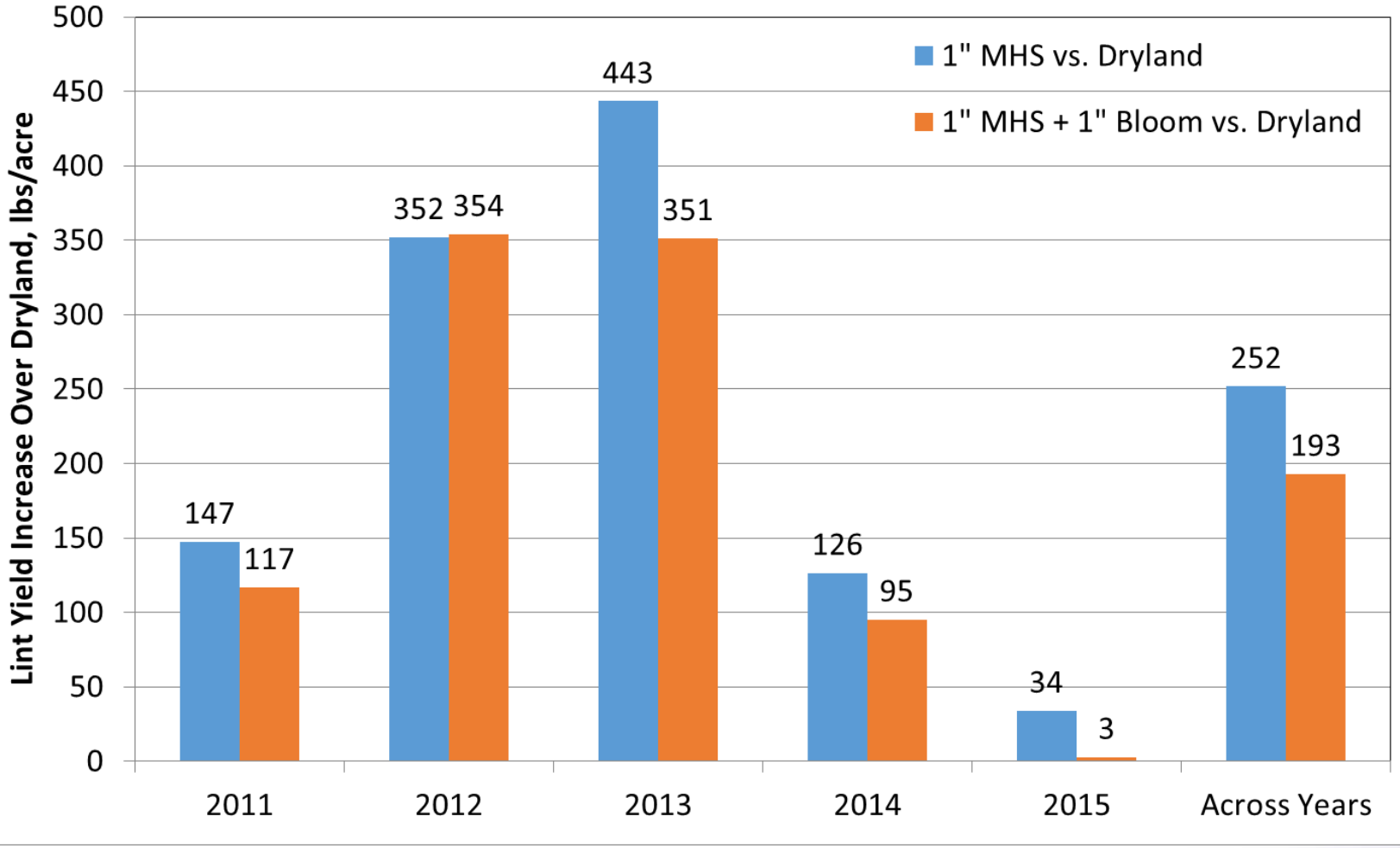
Irrigation Strategy Effect on Cotton Lint Yields and Bolls Acre^{-1} Yield Component Across Years, 2011-2015

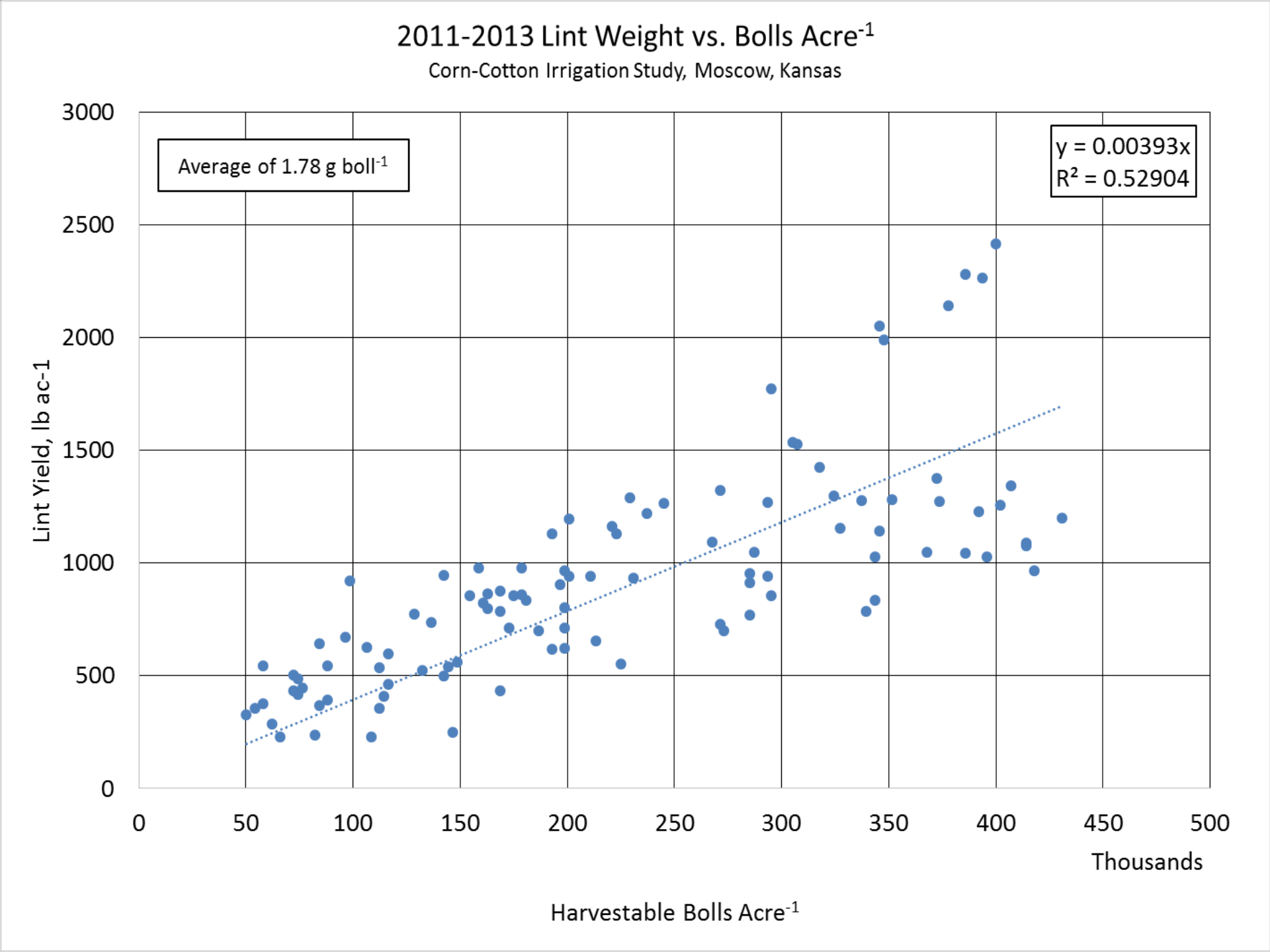
K-State Corn-Cotton Irrigation Study, Moscow, Kansas



Lint Yield Increase from Timed Irrigation Relative to Dryland 2011-2015 Across Years

K-State Corn-Cotton Irrigation Study, Moscow, Kans.




2011-2013 Lint Weight vs. Bolls Acre-1
Corn-Cotton Irrigation Study, Moscow, Kansas
Average of 1.78 g boll-1
y = 0.00393x
R² = 0.52904
Lint Yield, lb ac-1
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250
300
350
400
450
500
Thousands
Harvestable Bolls Acre-1

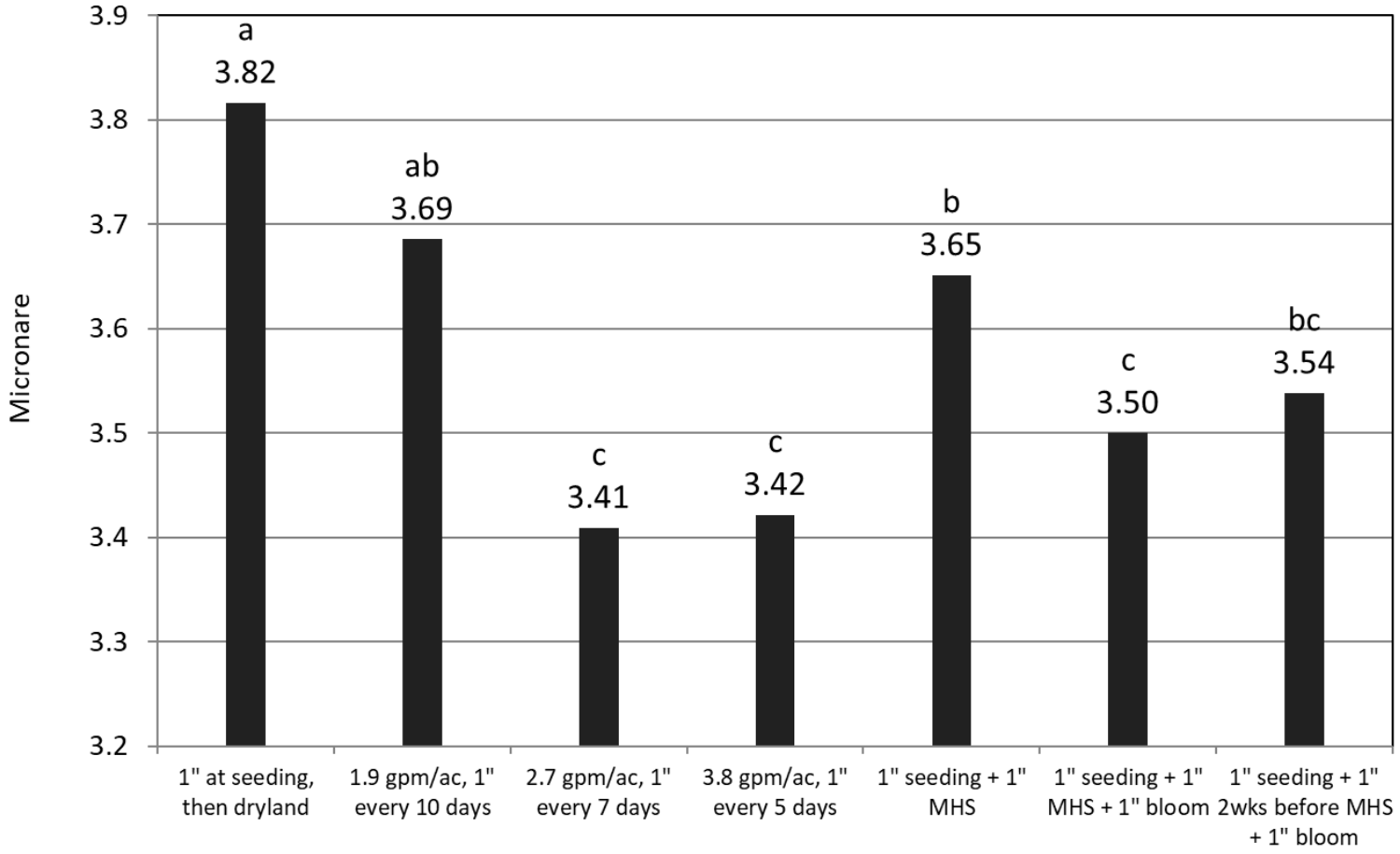
Lint Quality

Effect of Irrigation Treatment on Lint Quality, Moscow 2011-2015

	2011	2012	2013	2014	2015	Across Years
Mic	0.1729	**<0.0001**	0.1821	**0.0442**	**0.0268**	**<0.0001**
Length	**<0.0001**	**0.0003**	0.4869	**0.0527**	0.7316	**<0.0001**
Unif	**<0.0001**	**0.0228**	0.1564	0.2731	0.7061	**0.0243**
Strength	**0.0262**	**0.004**	0.6775	0.2749	0.6486	0.1645
Leaf	0.7751	0.5681	0.1752	0.162	0.4297	0.1242
Loan	0.1589	**0.0009**	**0.0537**	0.3556	0.3941	0.8049

Irrigation Strategy Effect on Cotton Fiber Micronare

K-State Corn-Cotton Irrigation Study, Moscow, Kansas, 2011-2015



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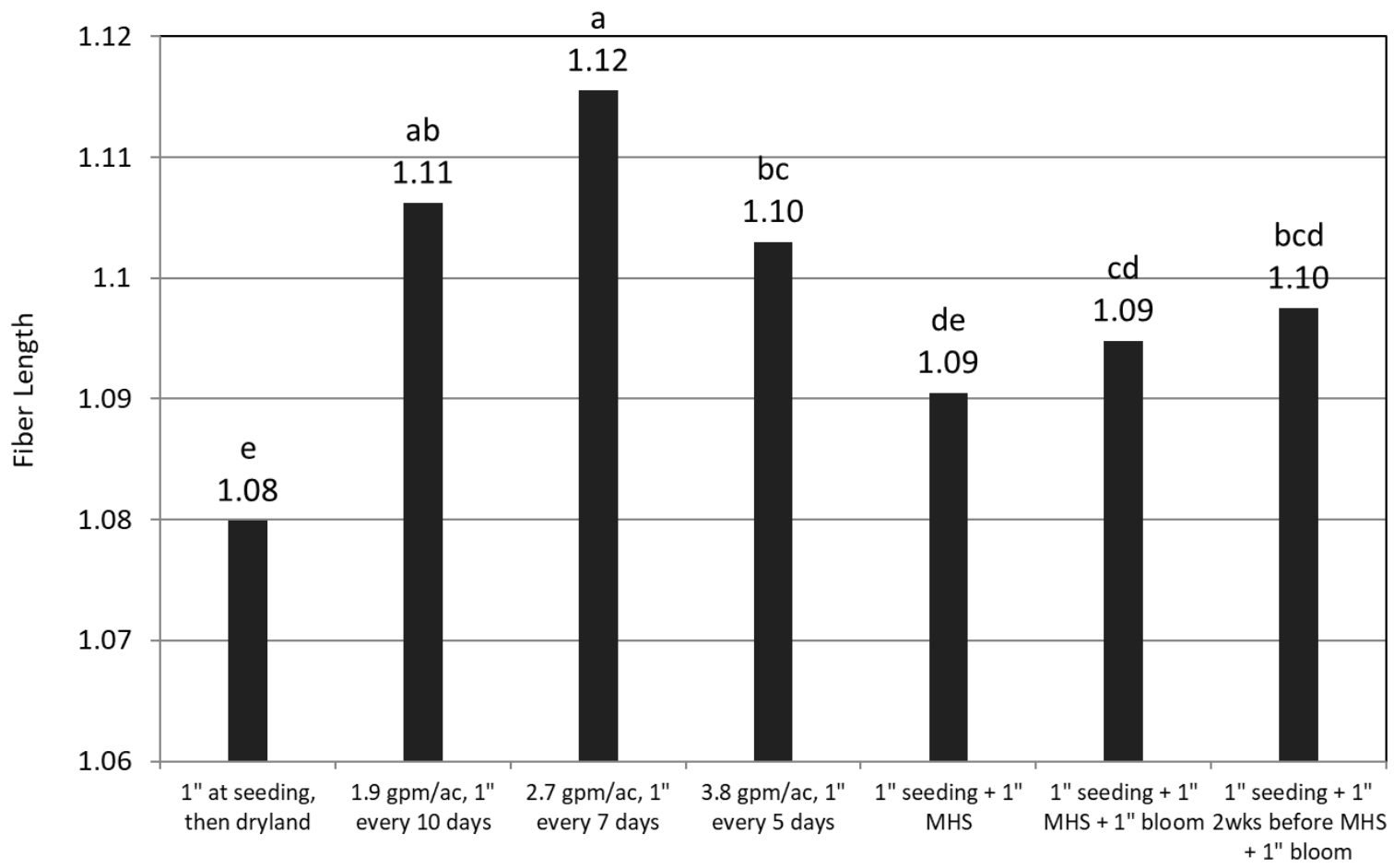
Irrigation Strategy Effect on Cotton Fiber Length

K-State Corn-Cotton Irrigation Study, Moscow, Kansas, 2011-2015



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Key Findings

- The largest marginal return to irrigation was obtained with 1” applied at MHS. The return over dryland ranged from 34 (2015) to 443 (2013) lbs/ac and **averaged 252 lbs/ac for 1” of water over** the 5 year study.
- An additional 1” of water at bloom did not improve yields over using only 1” at MHS
- Other than in the 2012 drought year, no yield advantage was observed for full-season irrigation of cotton at 3.8 or 2.7 gpm/ac compared to 1.9 gpm/ac

Cotton Irrigation in Thermally Limited Environments

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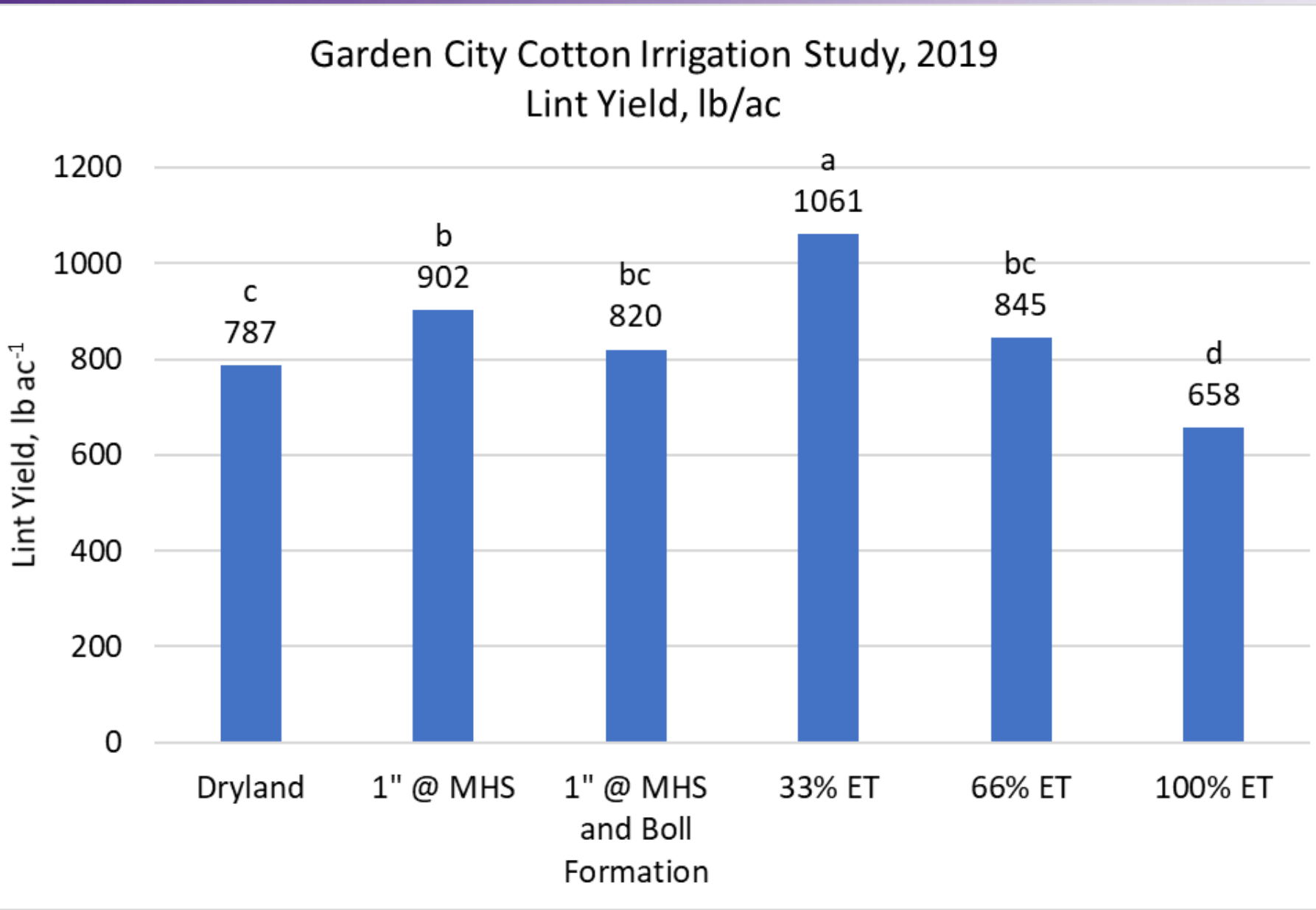
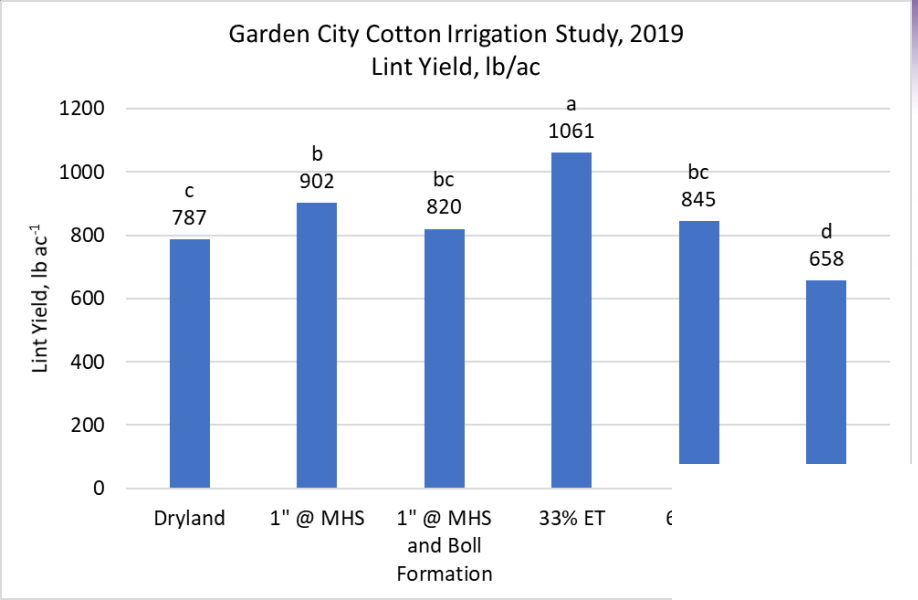
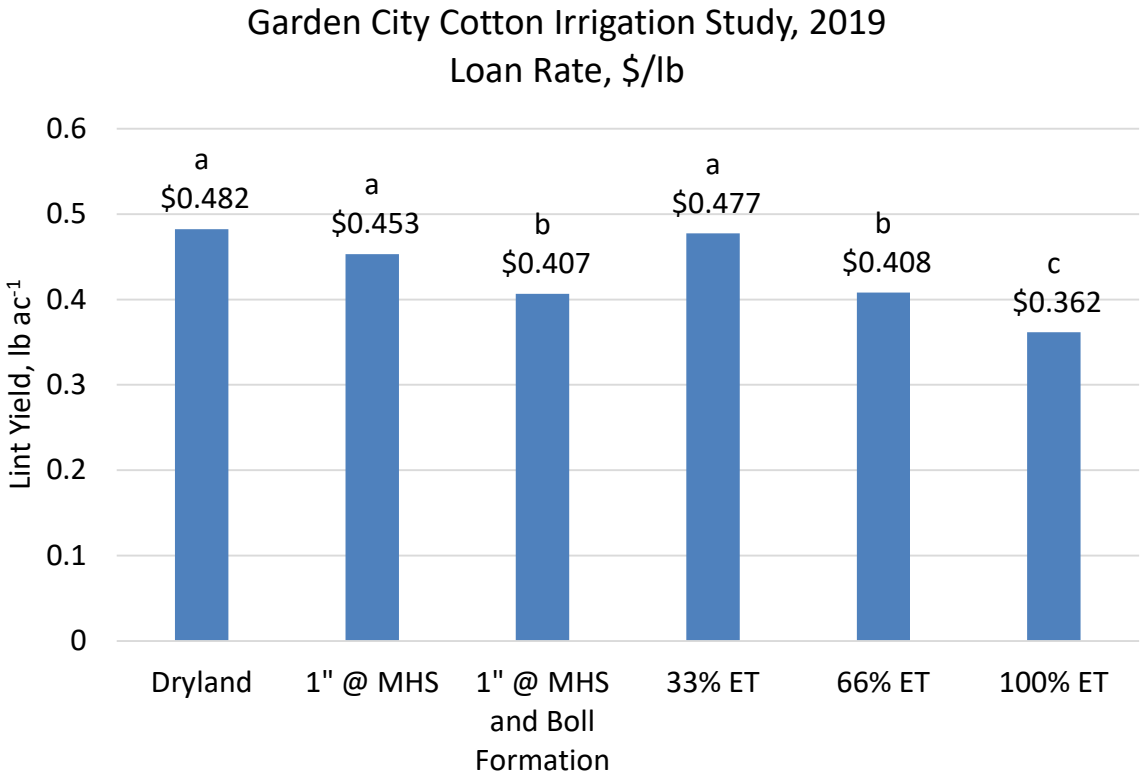


Aguilar et al., 2019. Unpublished data.





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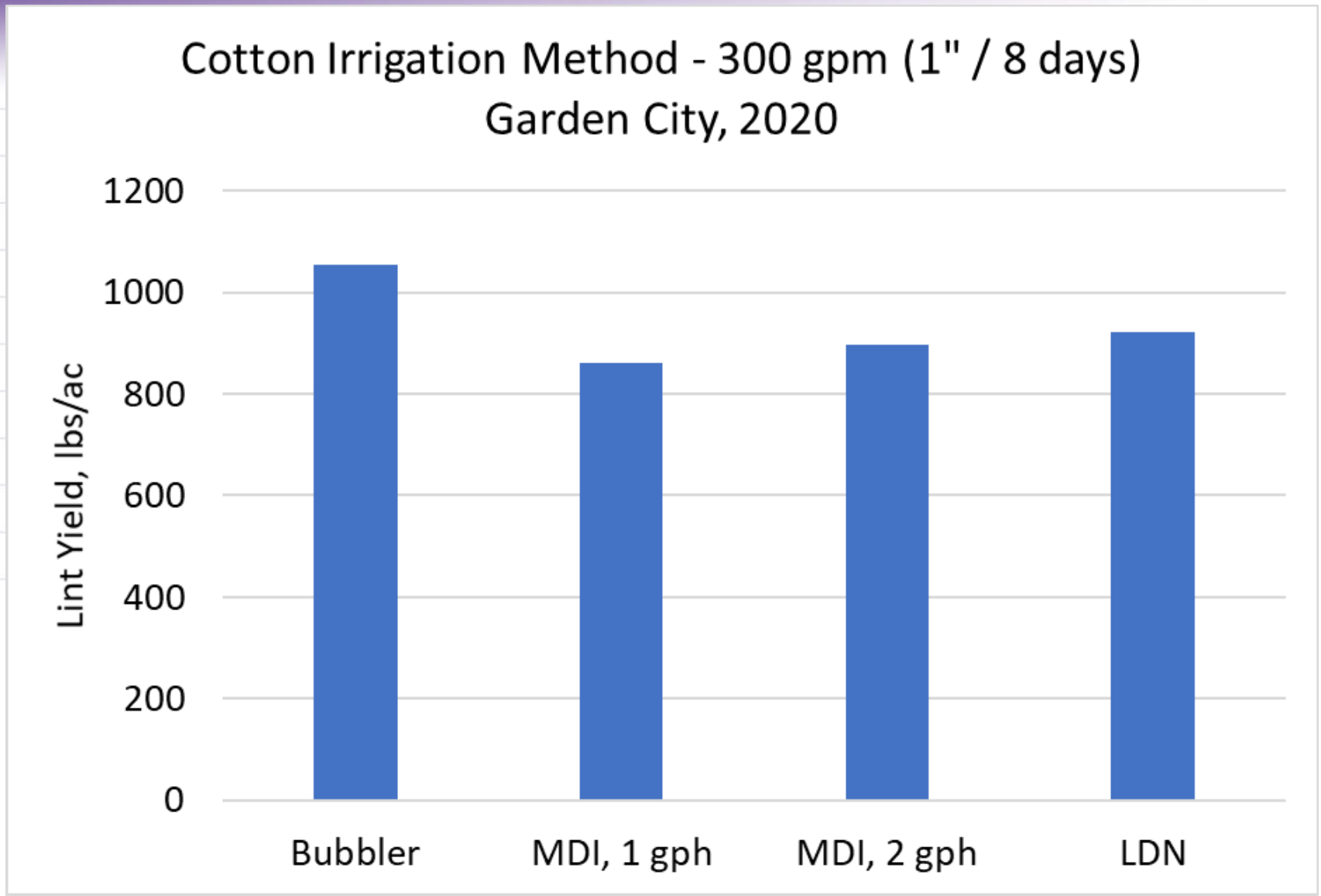
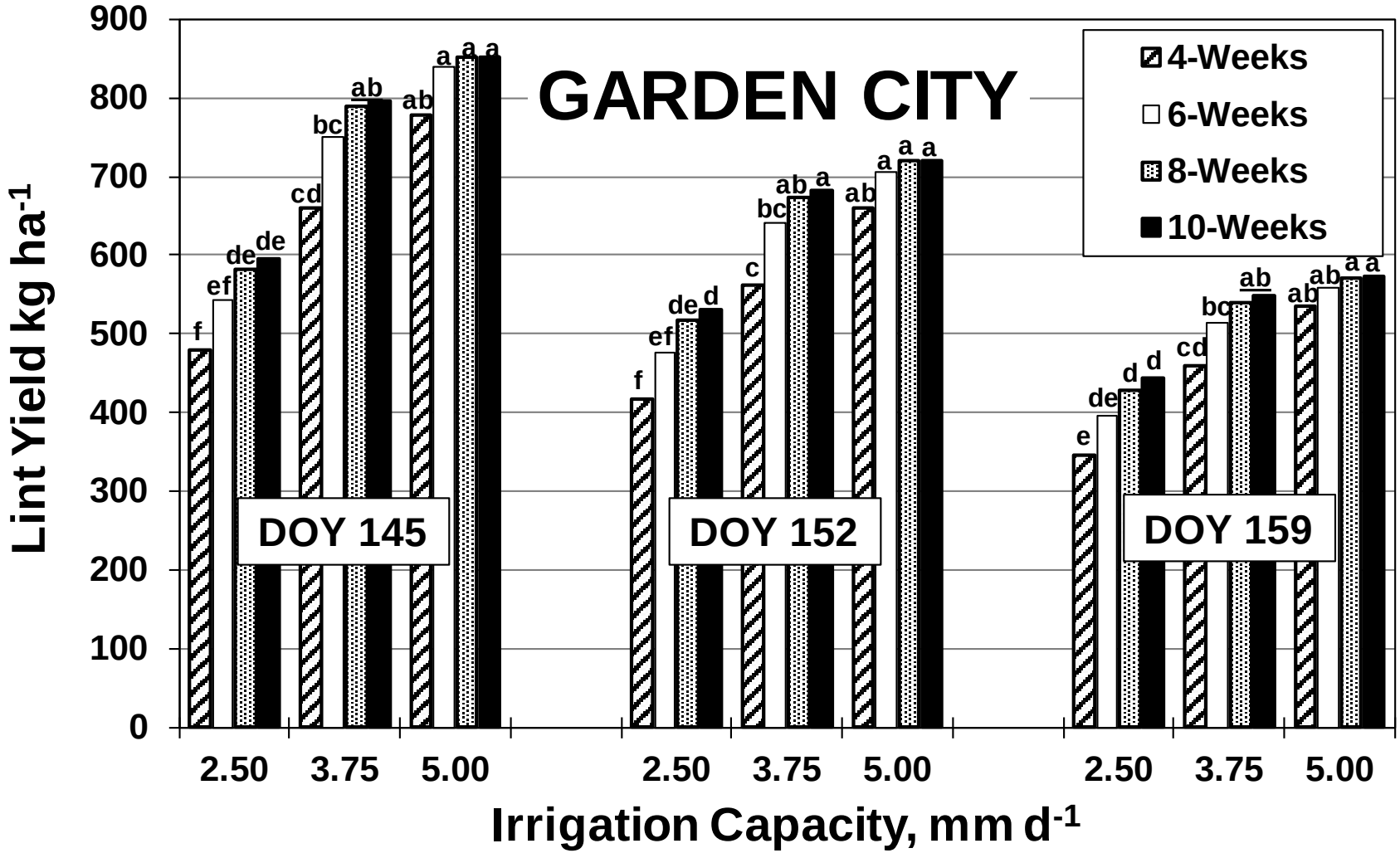

Cotton Irrigation Method - 300 gpm (1" / 8 days)
Garden City, 2020
Lint Yield, lbs/ac
1200
1000
800
600
400
200
0
Bubbler
MDI, 1 gph
MDI, 2 gph
LDN

What's different here?

- With respect to Irrigation
  - Irrigated cotton is likely the only crop in Kansas where water is not the yield limiting factor
  - Management decisions revolve around matching inputs to our yield limiting factor (GDU's)
- With respect to heat unit / yield relationships
  - Lower night time temperatures, how much does that change things? Is GDD base 60 correct?

Modeling Irrigation Effects



Baumhardt, Haag, et al., 2021, Trans. ASABE 64:1-12

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Questions?

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