Deficit Drip Irrigation Management Practices

Role of Deficit Irrigation, Varieties

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Justification & Objectives

- Water limits real some years
- If water short, may be able to deficit irrigate some portion of acreage – allow more water for other acreage of cotton or other crops

Objectives :

- Describe some examples of deficit subsurface drip irrigation management practices that have potential for water savings
- Demonstrate impacts of these practices on yield and relative impacts on fiber hvi quality characteristics , if any

Variety Choices and deficit irrigation practices, options

- **Variety choices** can provide some differences in vigor, sensitivity to water deficits that can alter plant responses and desirability of deficit irrigation practices
- Public and commercial germplasm is available that has shown some significant differences in potential plant size and earliness – consider these growth habits when deciding how stress might affect growth, yield, etc.
- If more vigorous, potentially longer-season varieties are selected for yield potential, disease resistance, or fiber quality reasons, plants can be managed by combination of:
  - Growth regulator use and management
  - Irrigation management and use of delayed irrigations and water stress

To use or consider deficit irrigation requires:

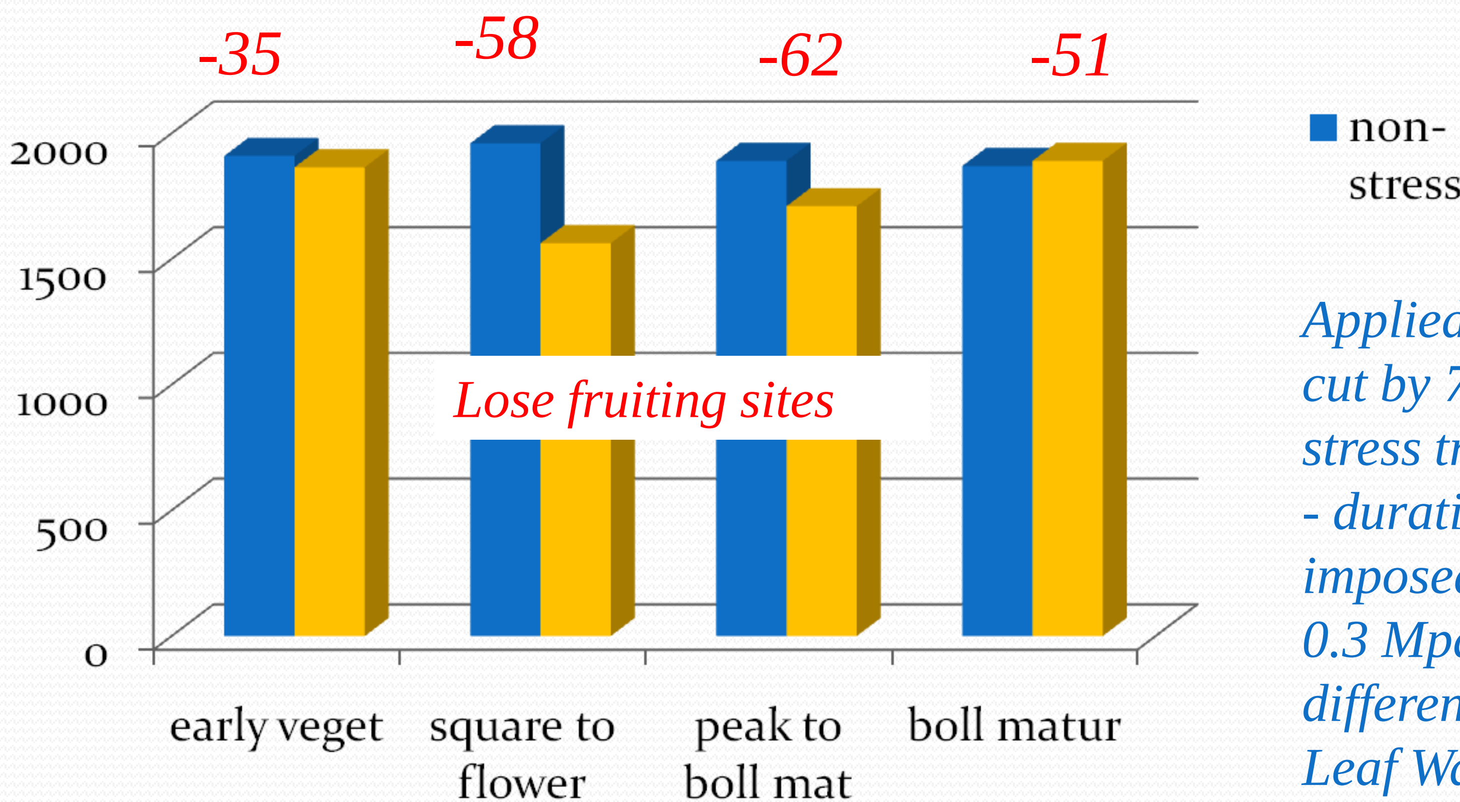
- Identification of crop growth stages sensitive to deficit irrigation, if any
- Development of irrigation scheduling approaches that are based on periods with a level of plant water stress considered acceptable
  - Irrigation levels in this situation will <u>not</u> meet full crop water requirements during some growth stage(s) … so some level of stress will be imposed
  - These efforts may include defining tools (plant or soil measurement) to monitor or make sure plant water stress is not excessive

Cotton sensitivity to water deficit periods

- Irrigation mgmt recommendations include scheduling that imposes only mild to moderate deficits to help manage vegetative growth and balanced fruiting, with most CA research (such as Hutmacher, 1995, Munk et al 1994, Grimes and Yamada, 1982) suggesting:
  - Growth stages least sensitive to water deficits are:
    - Early vegetative growth to about 7-9 nodes
    - After peak flowering into boll maturation
  - Most sensitive growth stages are:
    - Flower bud formation through early flowering
    - Later flowering intermediate in sensitivity

- well-researched tools useful in assessing plant water stress:
  - Leaf Water Potential (Grimes and Yamada, 1982; many others)
  - Crop Water Stress Index / infrared thermometry (Howell et al, 1984, Hutmacher, 1995, others)

Cotton Lint Yields (kg/ha) with targeted water stress periods under subsurface drip irrigation (applied water reductions (mm) shown in red, base of about 700 mm) – SJV Acala



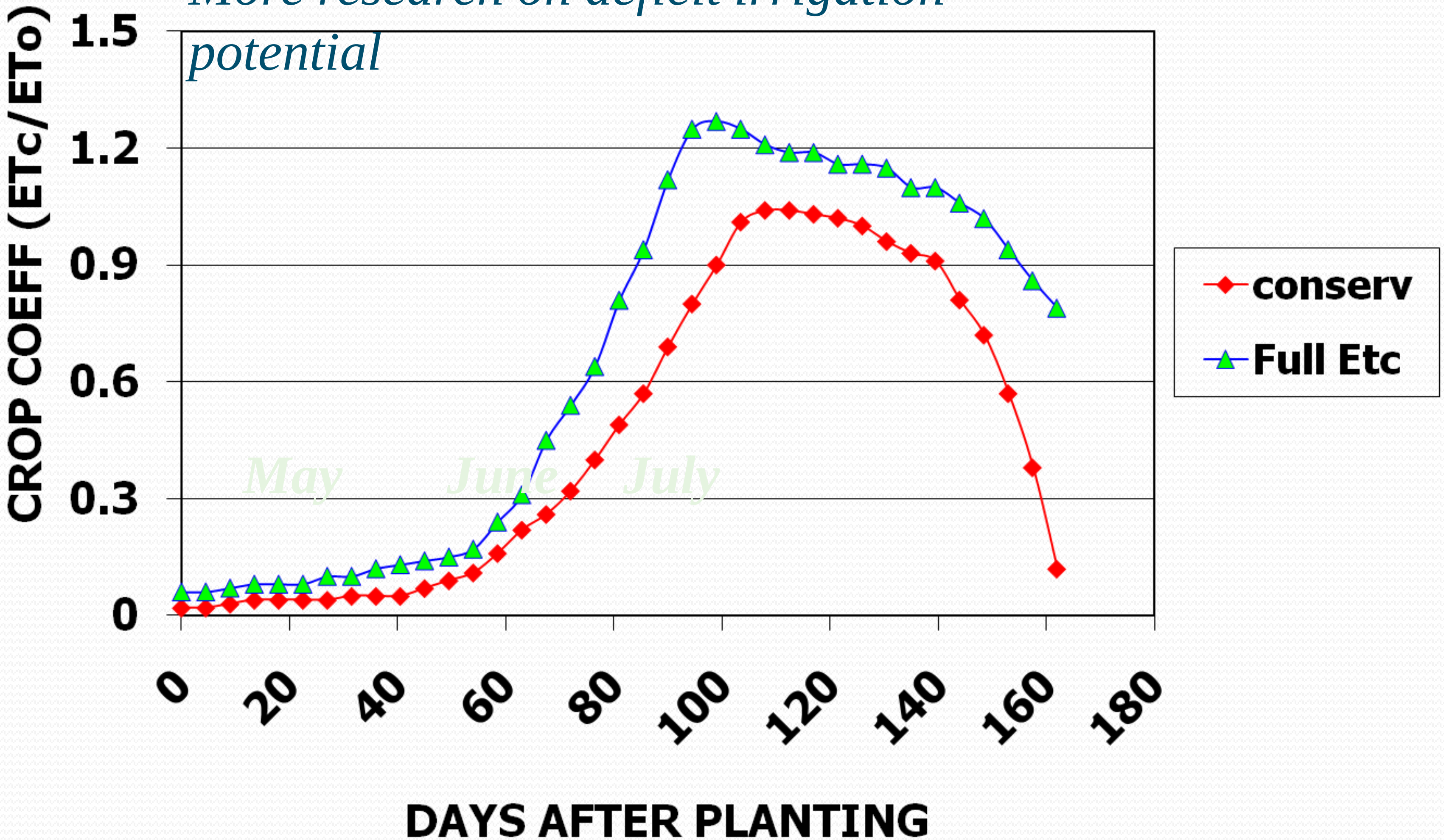
Applied Water cut by 70% in stress treatment - duration imposed as a 0.3 Mpa (3 bar) difference in Leaf Water Pot.

Etc treatments used in SDI Cotton Studies – WSREC
(UC Hutmacher et al) – clay loam soil, deep rooting

Irrigation Trt #	Irrigation Treatment Code	Irrigation Level (% Etc)		
		June Sq to early bl	July Early bl to pk bl +	August Boll fill to cutout
1	100	100	100	100
2	100/100/80	100	100	80
3	100/100/60	100	100	60
4	100/80/60	100	80	60
5	100/80/80	100	80	80
6	100/60/60	100	60	60

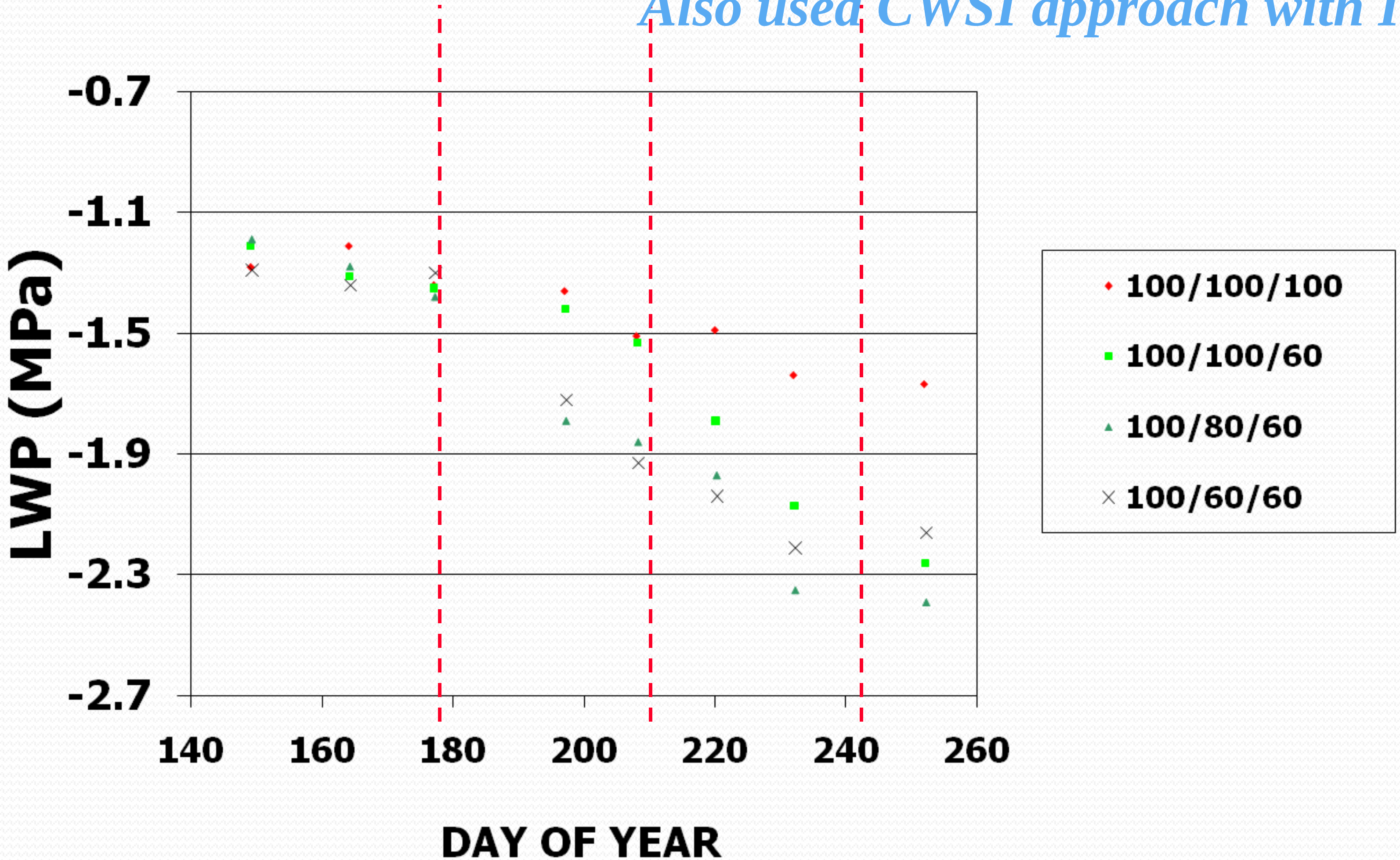
Comparison of Crop Coefficients for Cotton – under SDI Irrigation - WSREC

More research on deficit irrigation potential

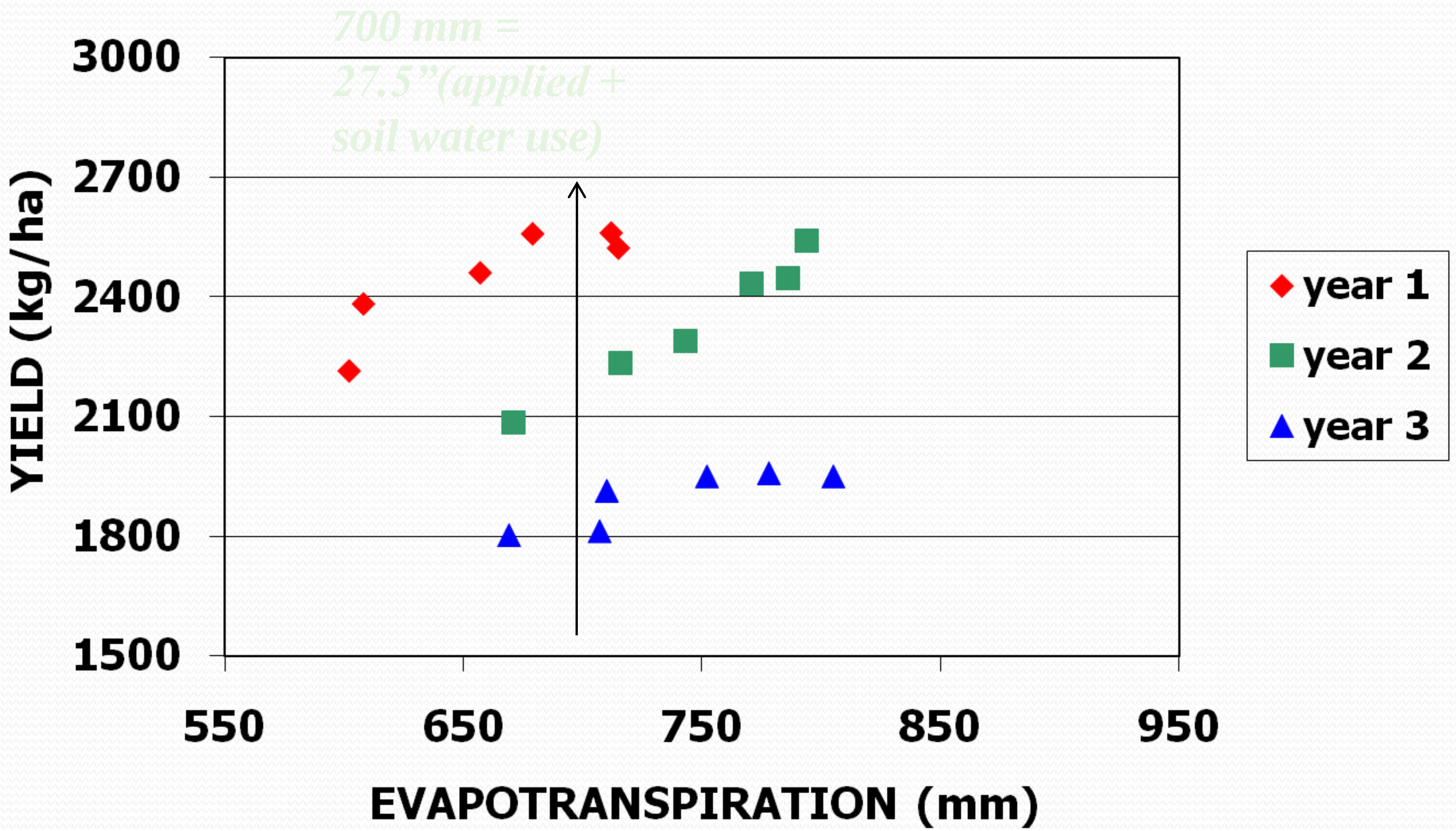


Leaf Water Potential (midday) by Irrig treatments used in SDI Pima Cotton Studies – WSREC

Also used CWSI approach with IR

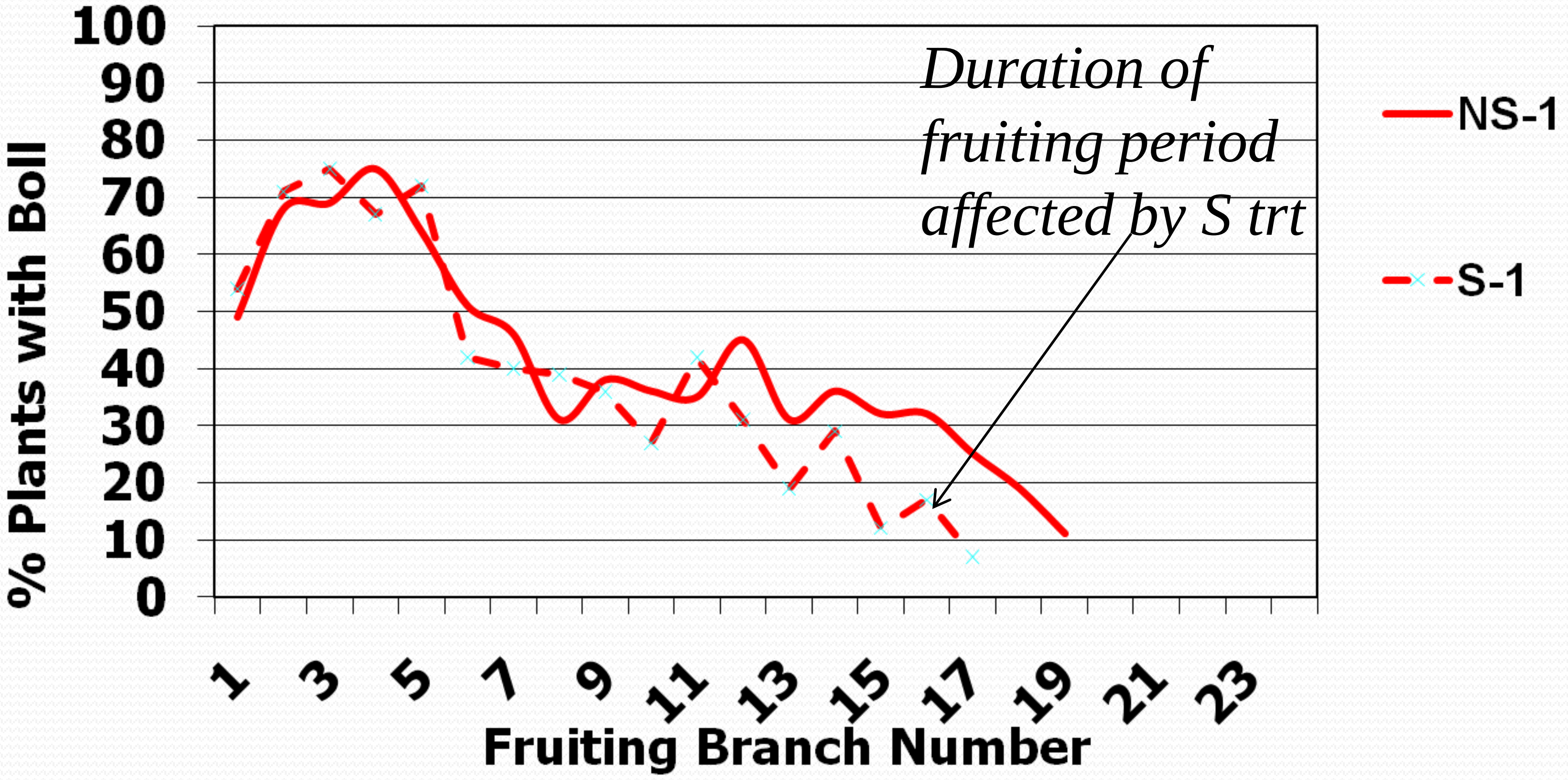


Crop Etc and lint yield responses in irrigation studies – WSREC - SDI



Fruit Retention **(FP-1 POSITION)** Pima as function of Irrigation Trt: NS (t1-100) versus T5(100/80/60)

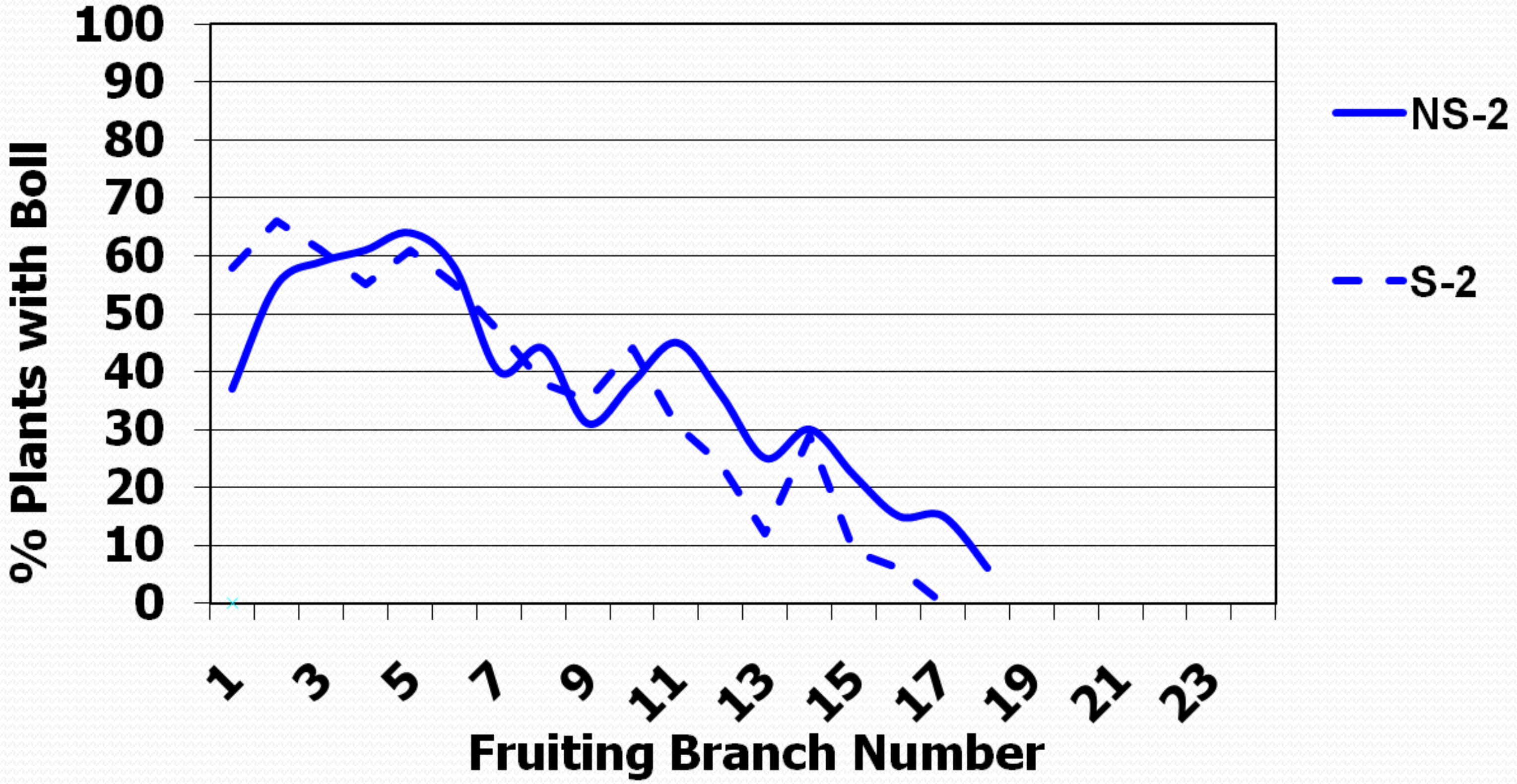
NS: 1.2 -1.3   -1.3-1.55   -1.5-1.75 LWP
S: -1.2-1.4   -1.55-1.95   -1.95-2.45



Fruit Retention **(FP-2 POSITION)** Pima as function of Irrigation Trt: NS (t1-100) versus T5(100/80/60)

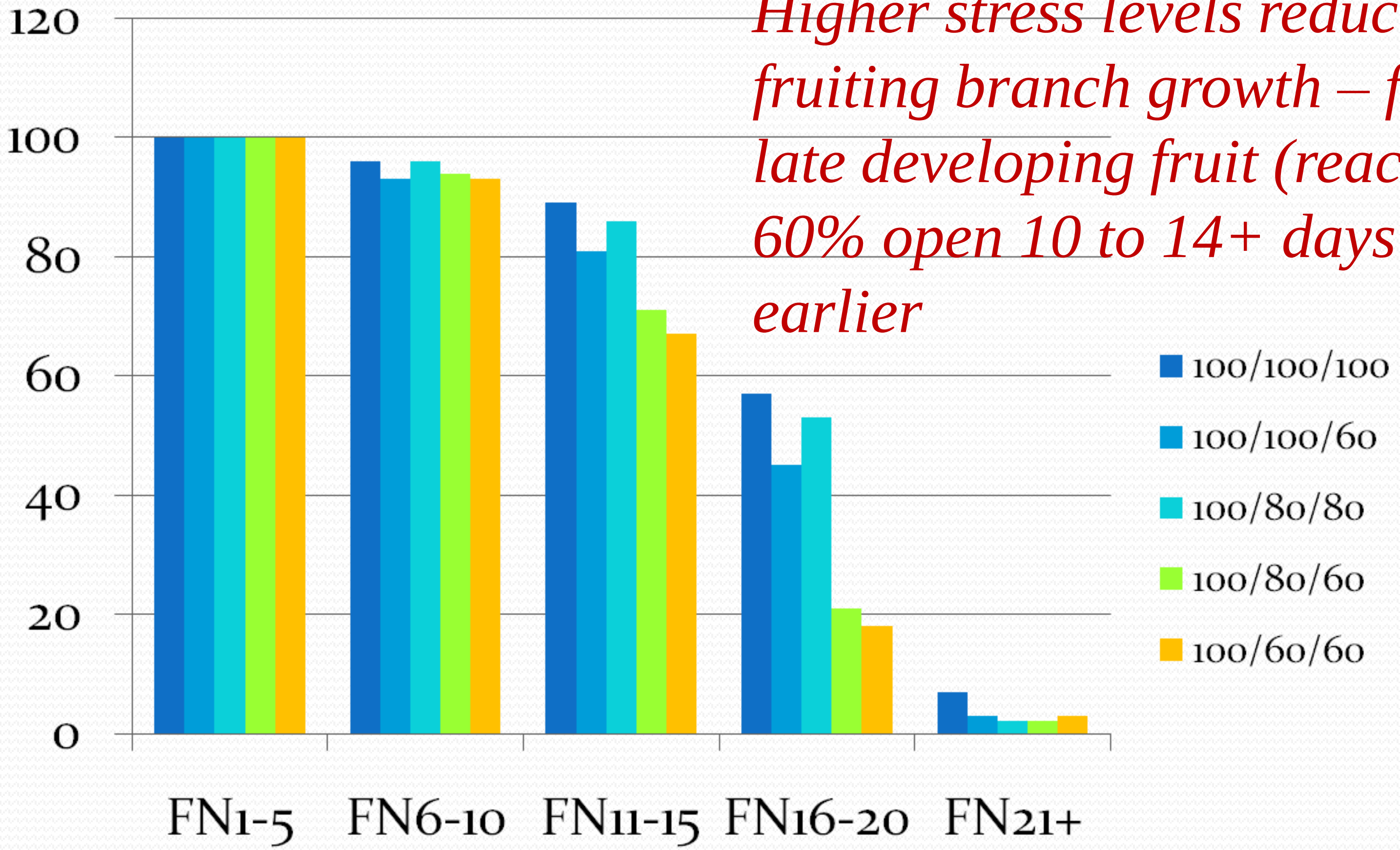
NS: 1.2 -1.3 -1.3-1.55 -1.5-1.75 LWP

S: -1.2-1.4 -1.55-1.95 -1.95-2.45



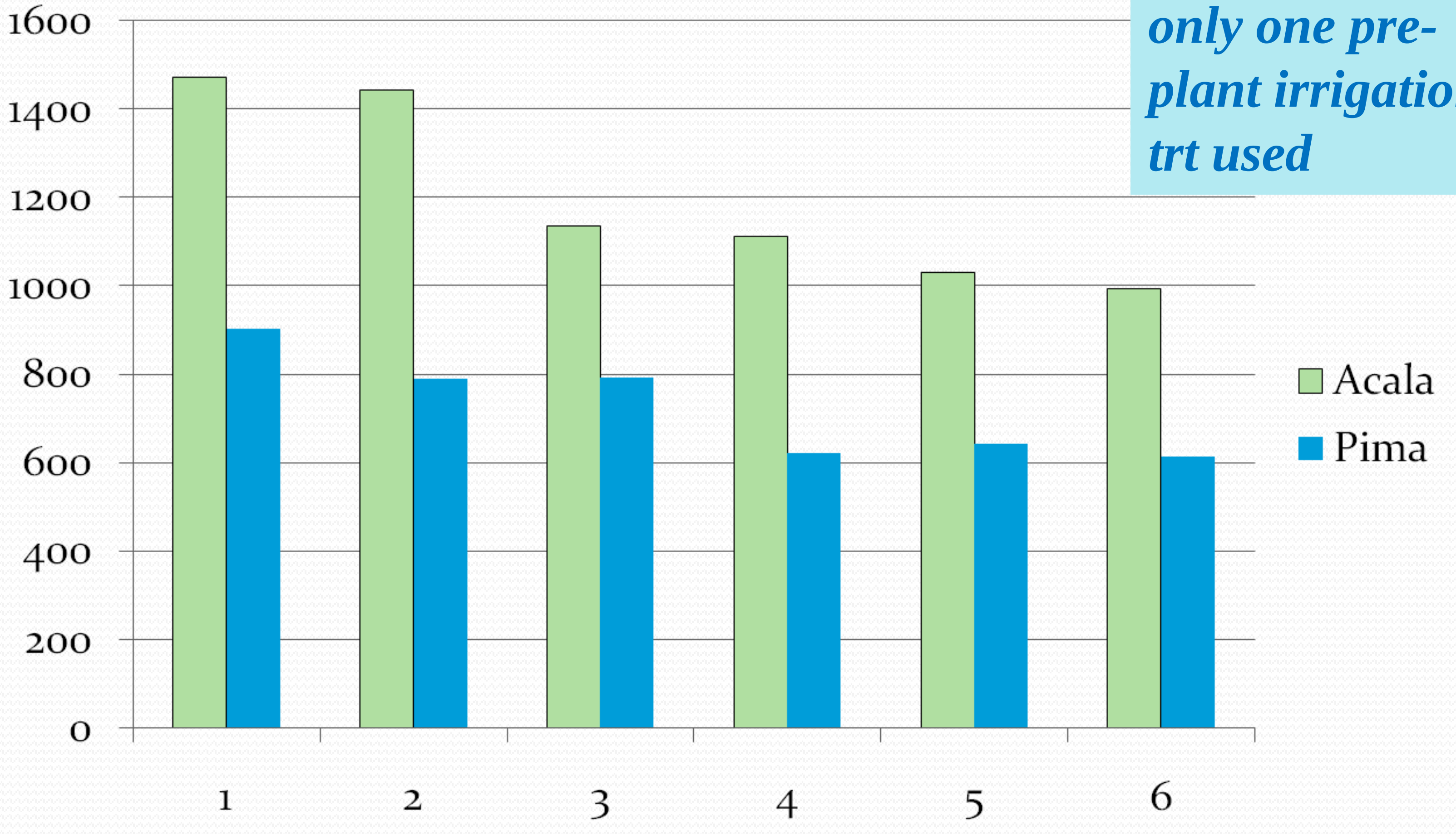
% of Potential Positions within Fruiting node (FN) range shown that have **FP-2 sites** – Pima SDI treatments

Higher stress levels reduce fruiting branch growth – fewer late developing fruit (reaches 60% open 10 to 14+ days earlier

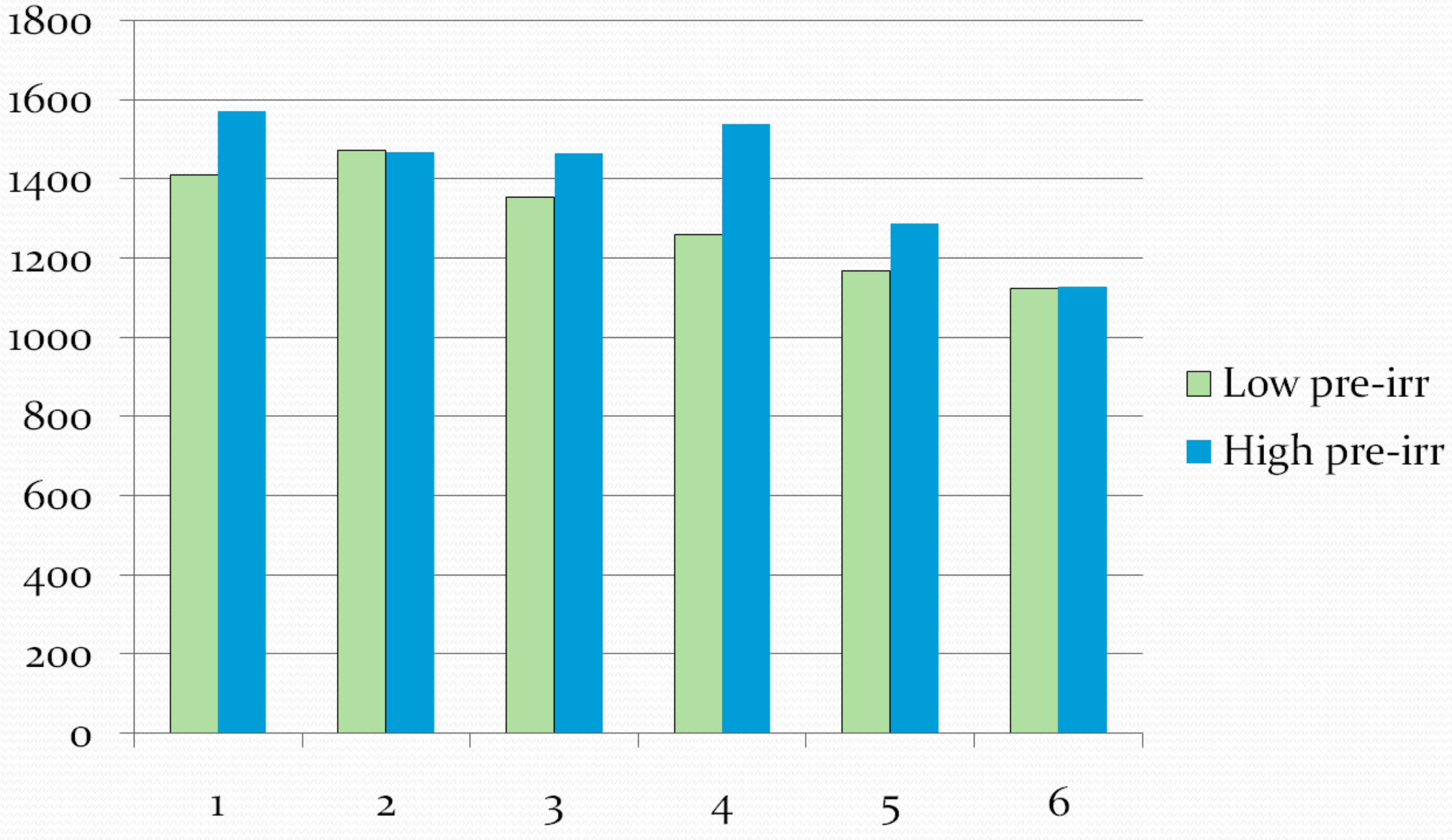


Drip irrigation treatment responses of
Acala (Phy-725RF) & Pima (Phy-805RF) cotton –
YIELD (lbs/acre) 2009 trial results – Shafter location

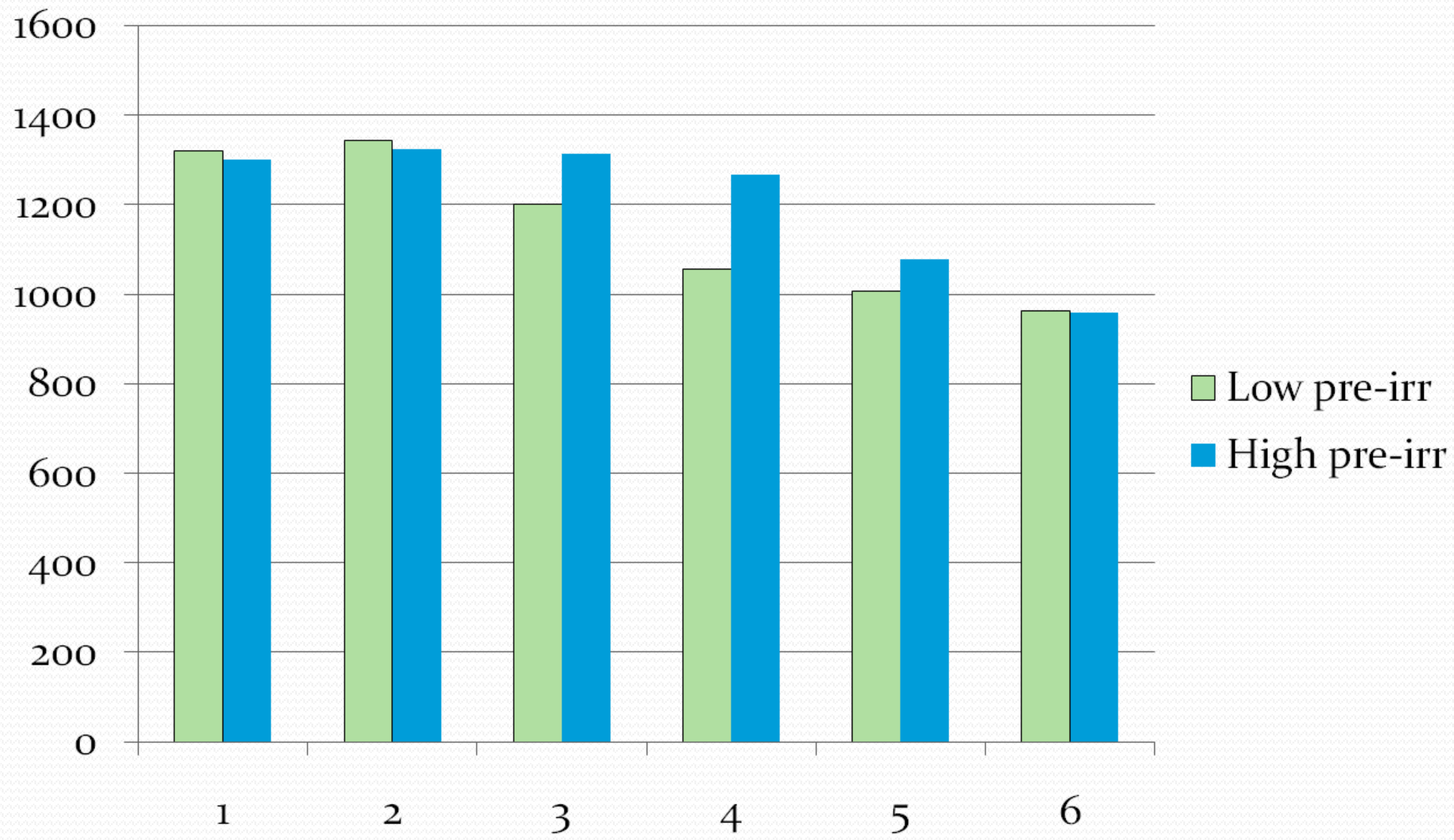
At Shafter site, only one pre-plant irrigation trt used



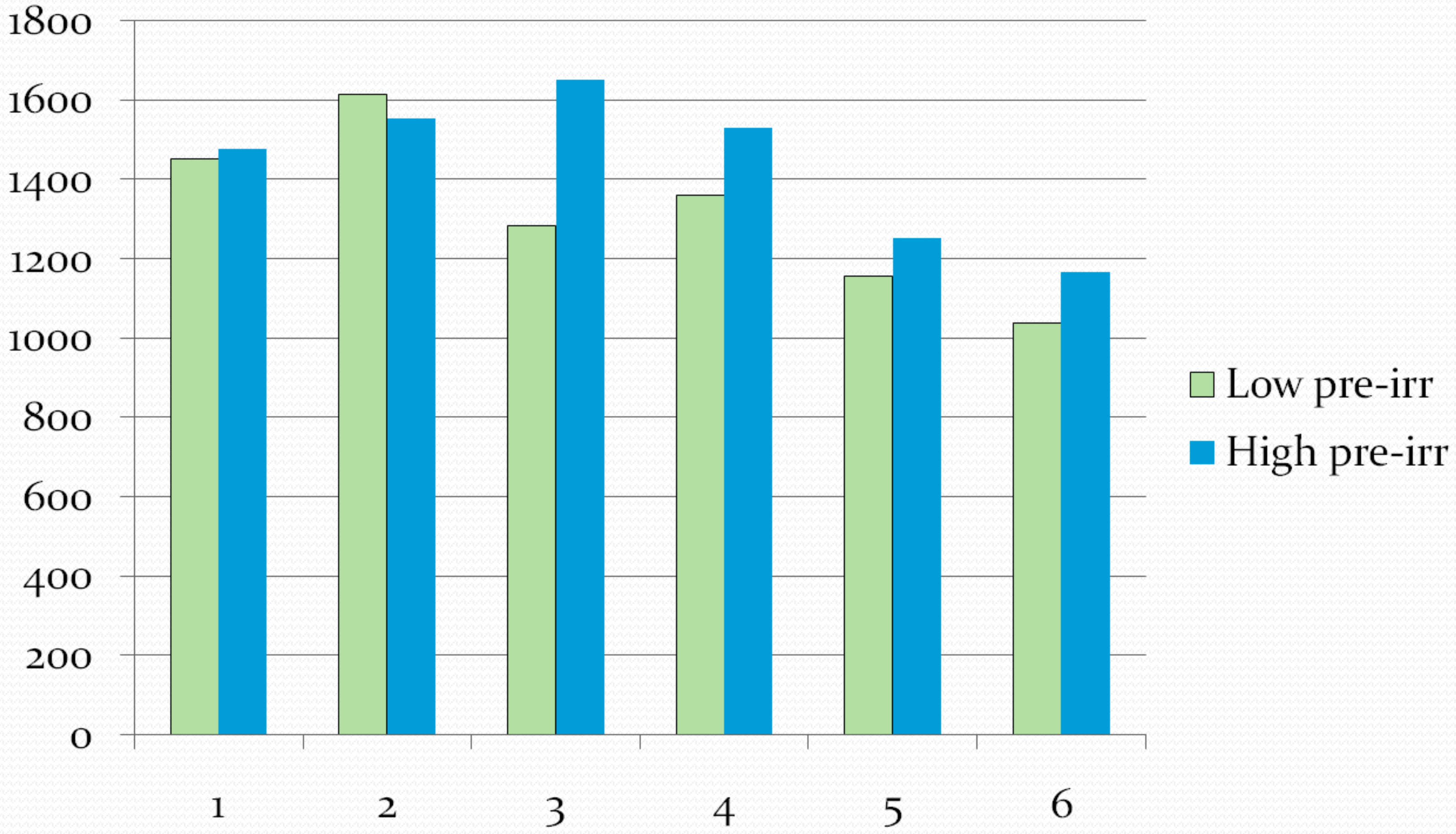
Drip irrigation treatment responses of **Pima (Phy-805RF)** cotton – **YIELD (lbs/acre)** 2009 trial results – West Side location



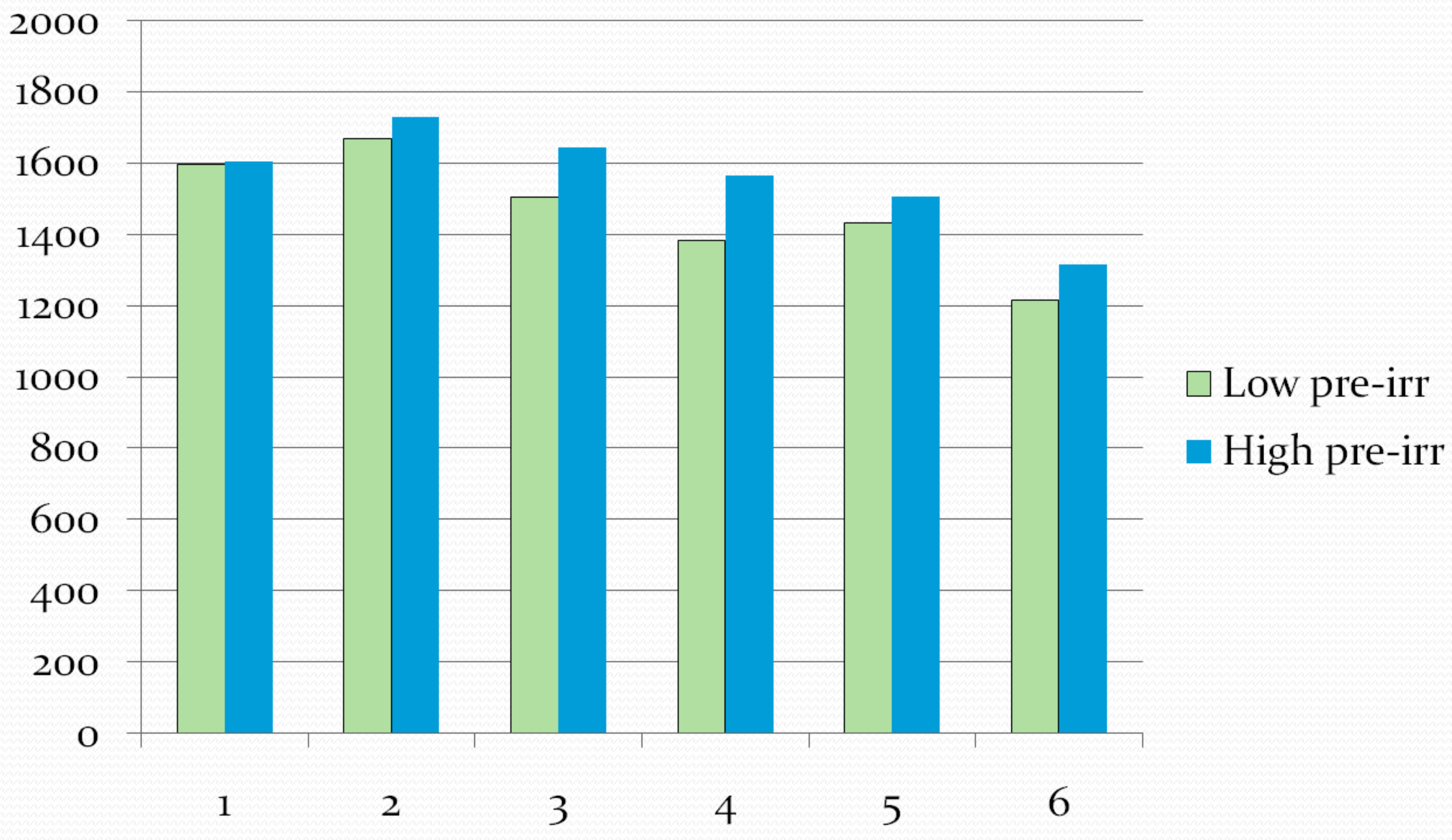
Drip irrigation treatment responses of **Pima (Phy-805RF)** cotton – **YIELD (lbs/acre)** 2010 trial results – West Side location



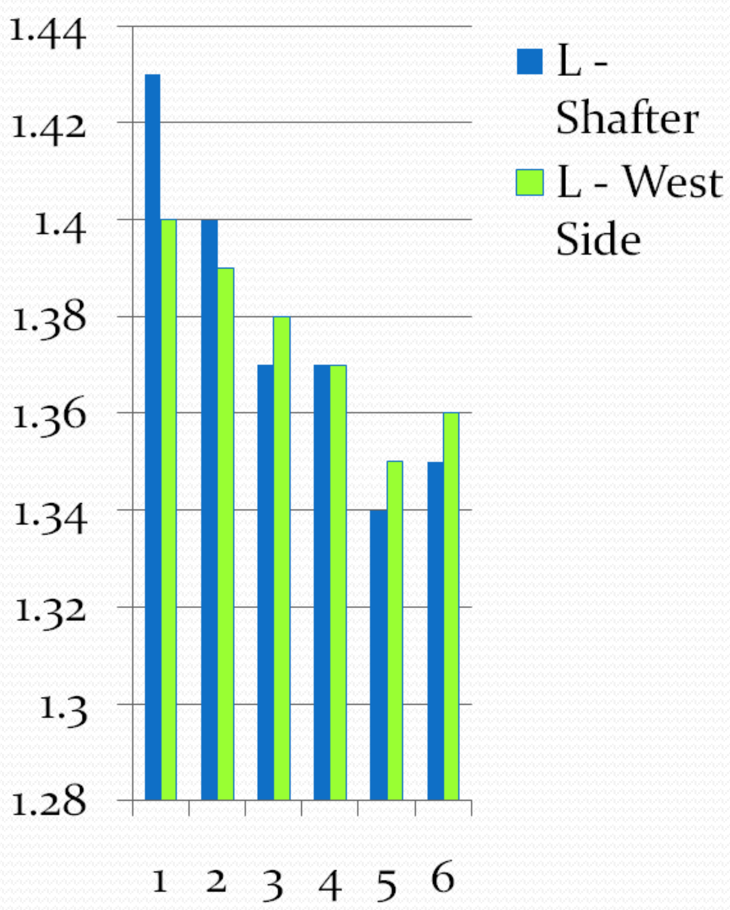
Drip irrigation treatment responses of **Acala (Phy-725RF)** cotton – **YIELD (lbs/acre)** 2009 trial results – West Side REC location



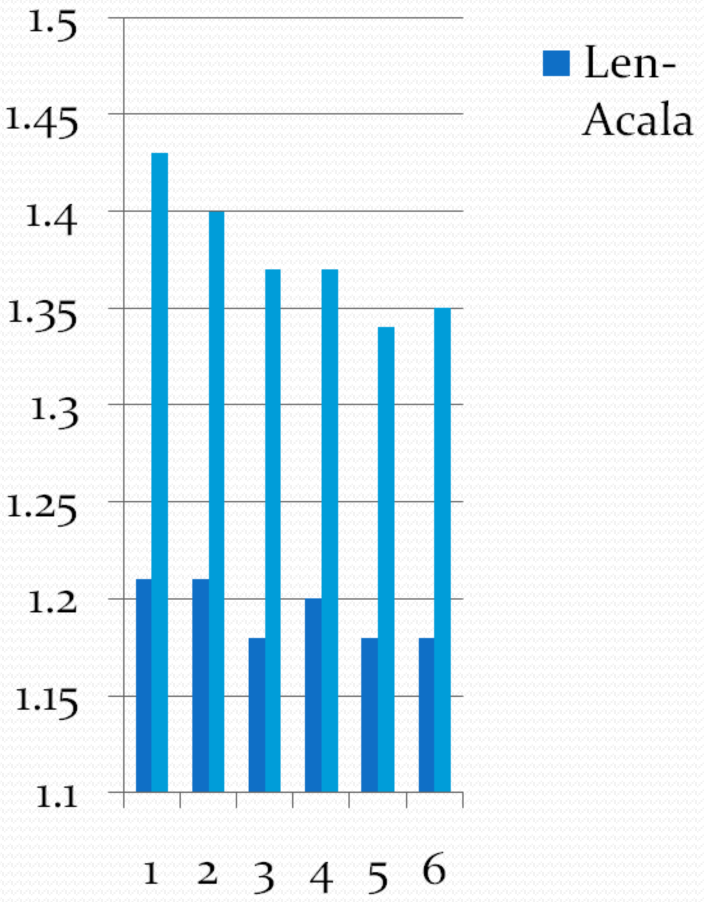
Drip irrigation treatment responses of **Acala (Phy-725RF)** cotton – **YIELD (lbs/acre)** 2010 trial results – West Side REC location

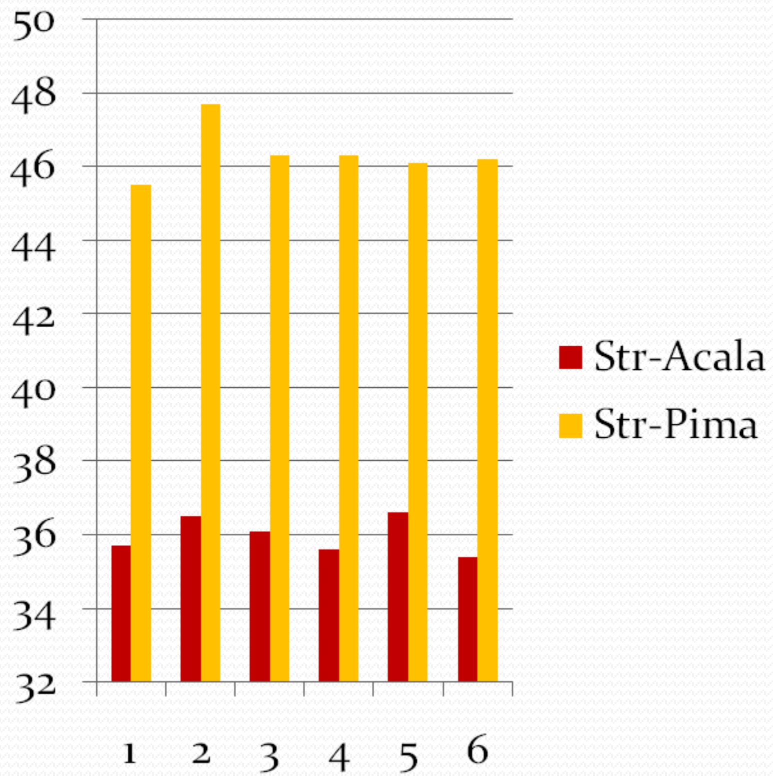


SDI treatment impacts on **Pima** fiber length and strength – 2009 – Shafter versus WSREC



SDI treatment impacts on **Acala & Pima** fiber length and strength - 2010





Water stress impacts on fruit retention & yield *Deficit SDI Studies Summary*

- Impacts on retention patterns and yield influenced by timing and duration of water stress
- high temperatures or interrupted water supplies can increase stress impacts some stages
- Deficit SDI irrigation practiced as frequent water applications at reduced amounts in our conditions produced:
  - moderate reductions in fruit retention and boll size
  - At higher stress levels, fruiting site # reduced more through impacts on stem and fruiting branch growth
- Some mild to moderate deficit irrigation combinations produce some water savings with limited impacts on yields or quality

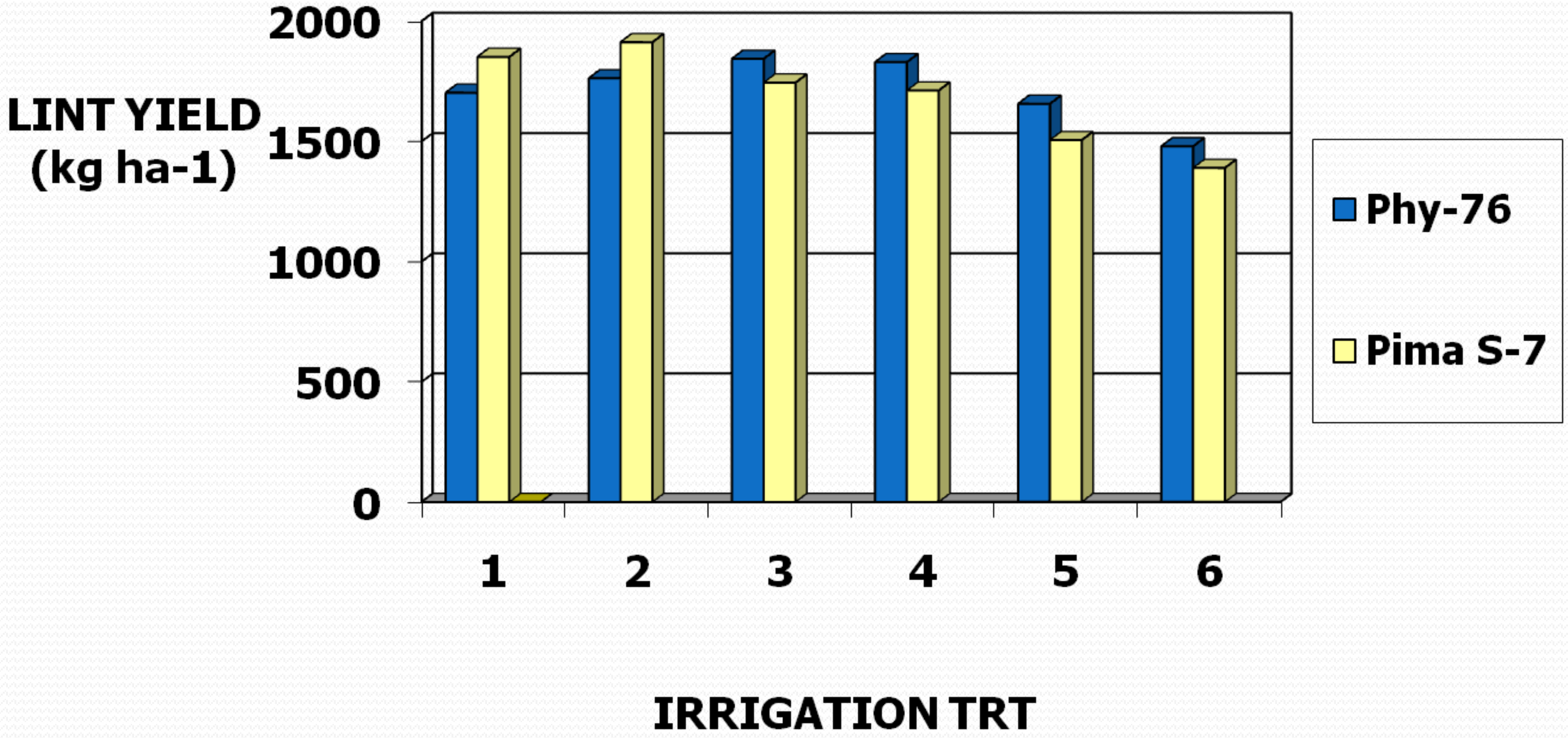
Genetics & Reduced Irrigation Options instead of Targeted Deficit Irrigation

Available cultivars with shorter fruiting & growing seasons

- Example: Cotton cultivars in CA selected previously to make use of long growing season & available heat units. Reasonable when water was available and inexpensive. Need to re-evaluate shorter-season cultivar potential under new water situation?
- If TRUE shorter season cultivars are available, more severe deficit irrigations may not be the best approach to maximize water use efficiency

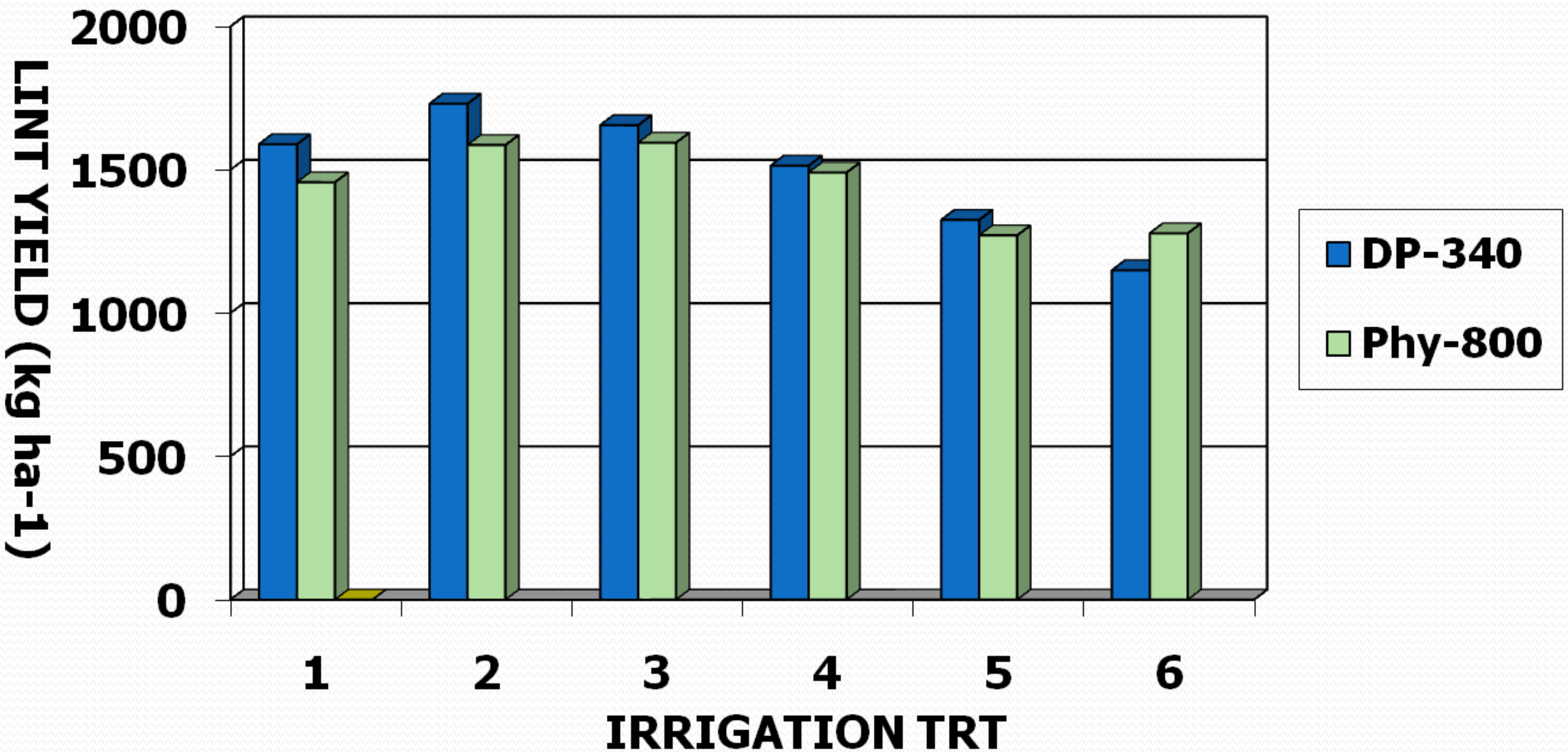
Subsurface Drip Pima – West Side REC - clay loam soil – older varieties (Phy-76 more indeterminate than S-7)

High early fruit retention year – harder to keep Stress trts fruiting

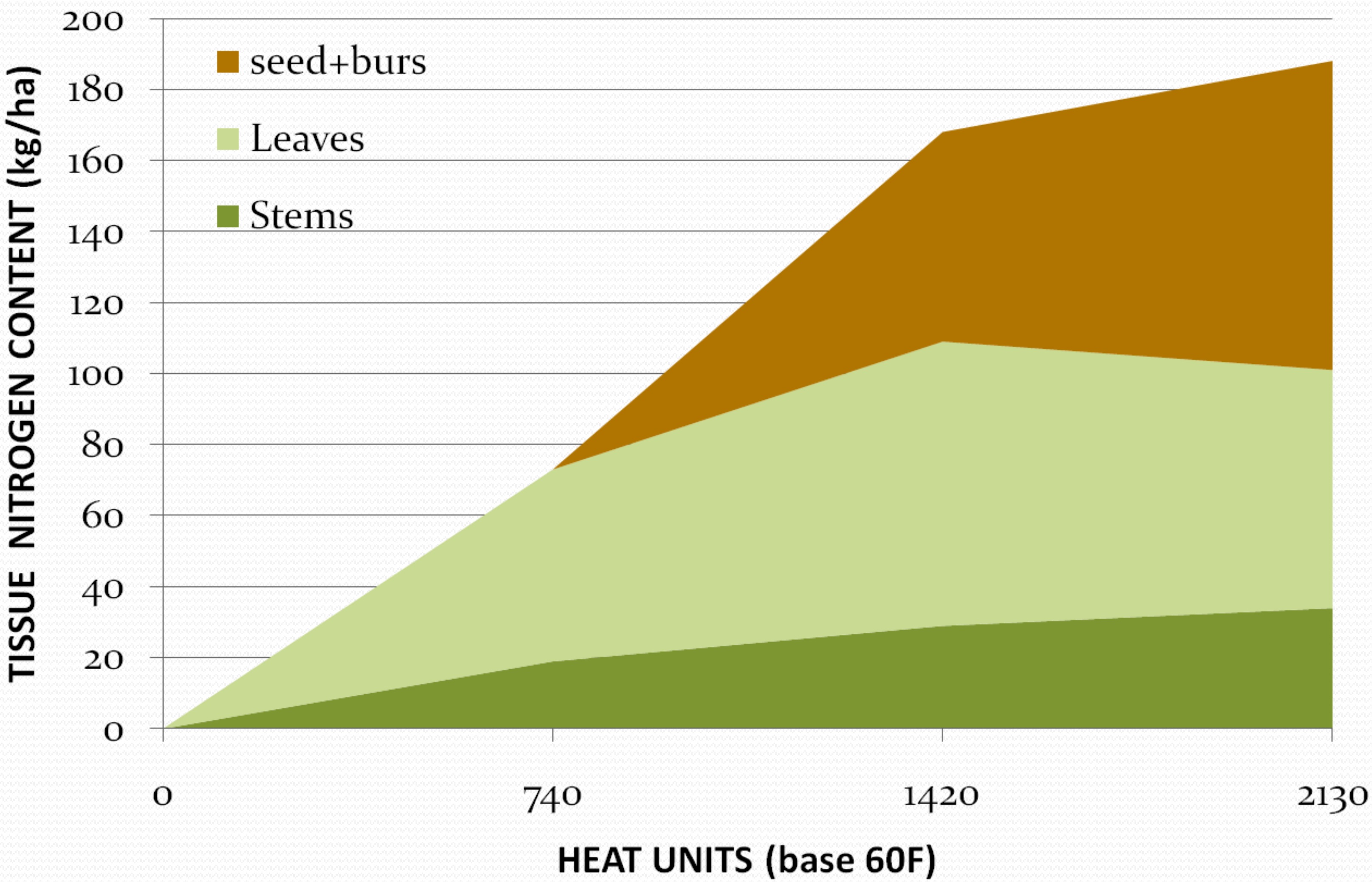


Etc treatments used in SDI Cotton Studies – WSREC (UC Hutmacher et al) – Pima 07

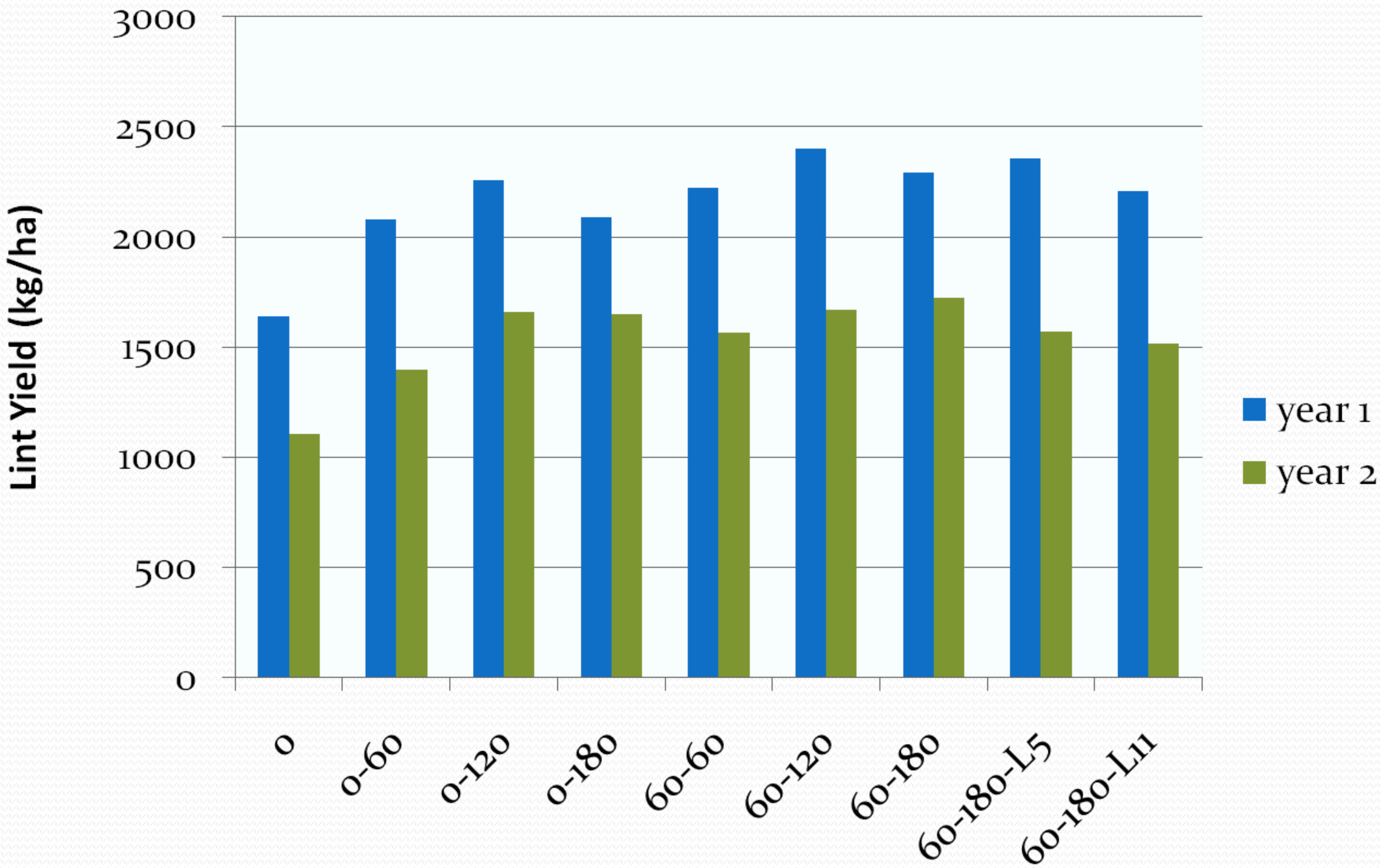
Moderate to Good early fruit retention year – Stress late season less impact



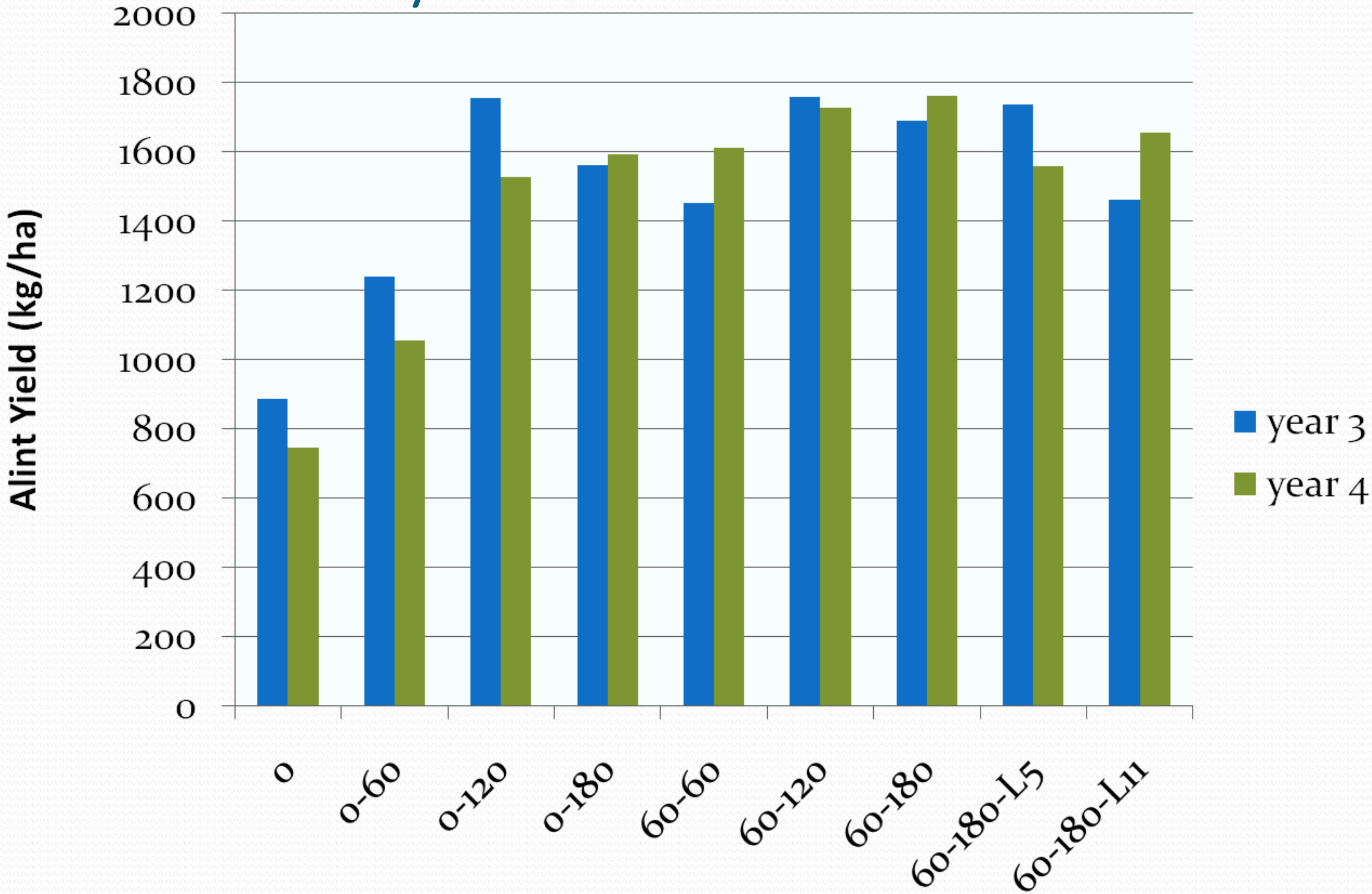
Nitrogen Uptake – drip irrig.
Acala cotton (yld=1430 kg/ha)



Lint Yield Responses to N Treatments – SDI WSREC – Acala – years #1 & 2

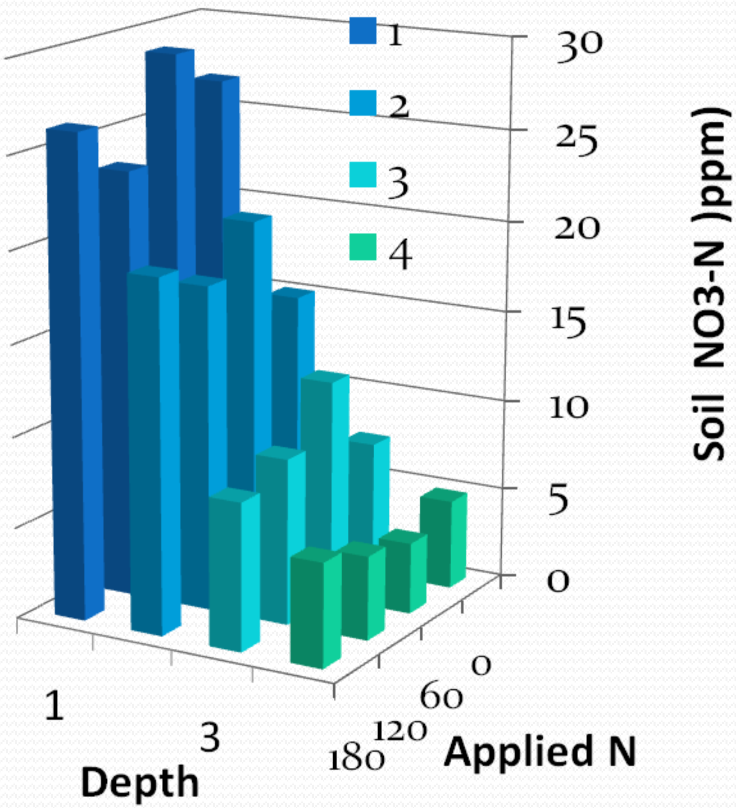


Lint Yield Responses to N Treatments – SDI WSREC – Acala – years #3 & 4

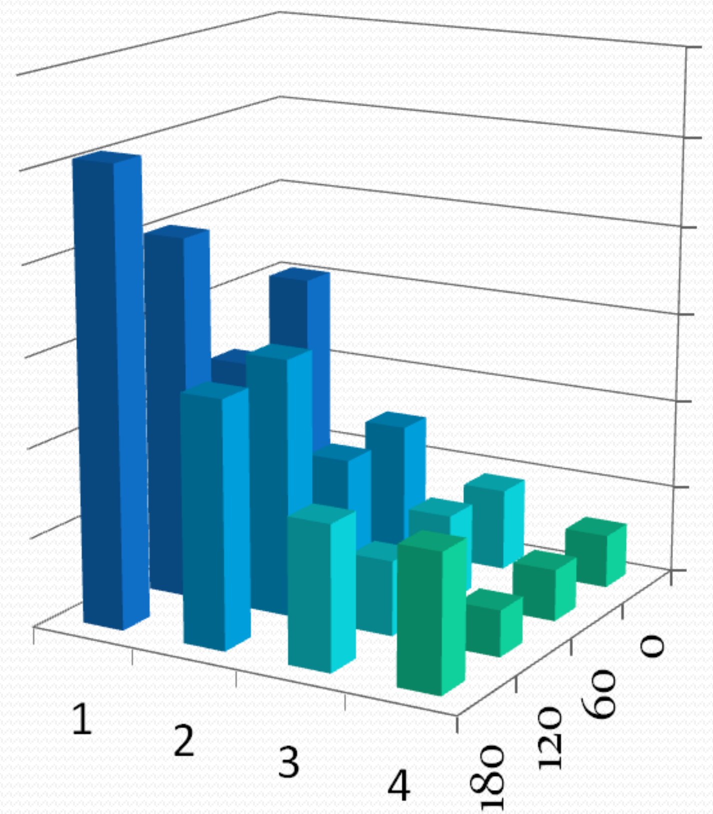


Soil NO3-N sat. extracts by N trt – SDI Acala

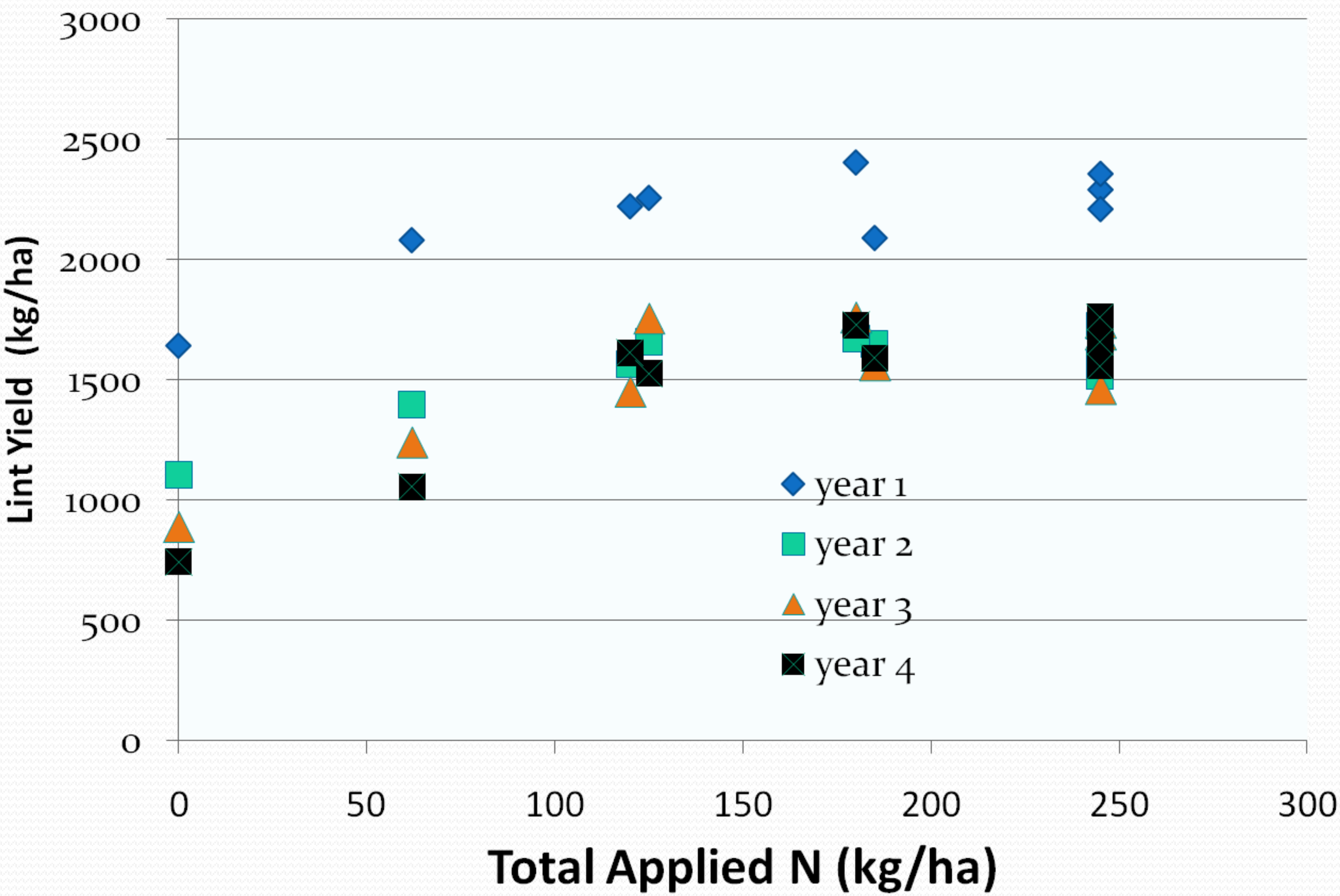
YEAR 1 – pre-EMERGENCE



YEAR 3 – PRE-EMERGENCE



Lint Yield Responses to Total Applied N
WSREC – SDI Acala – years 1 to 4

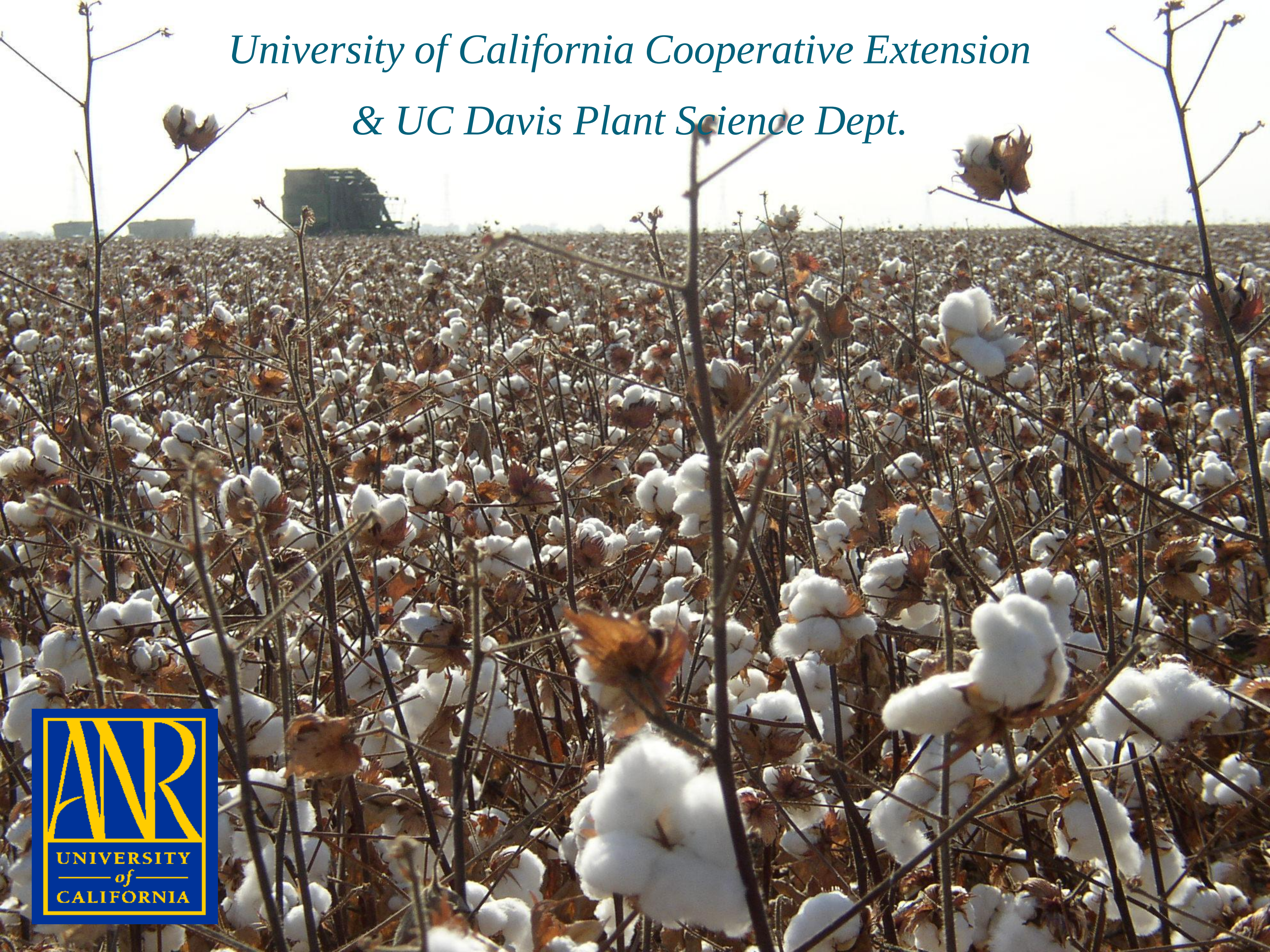


Concluding Comments

- Drip systems offer capabilities to deliver water and nutrients in a flexible, on-demand way
- Not all crops (in research trials or grower fields) respond economically to minimizing short-term water or nutrient stress (a particular capability of well-managed drip systems)
  - The above statement is less true when you push crops more to the limits and try to get higher and higher yields out of moderate size, “manageable” plants

Concluding Comments

- Water and nutrient mgmt approach with drip has ability to strongly impact availability and access to these inputs as long as user keeps in mind effective rooting volume
- Understanding some basis for crop responses can help explain how to get around limits imposed by roots and shoots as you try for higher yields within bounds of growing season length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