



# **Irrigating Processing Tomatoes under Limited Water Supply Conditions**

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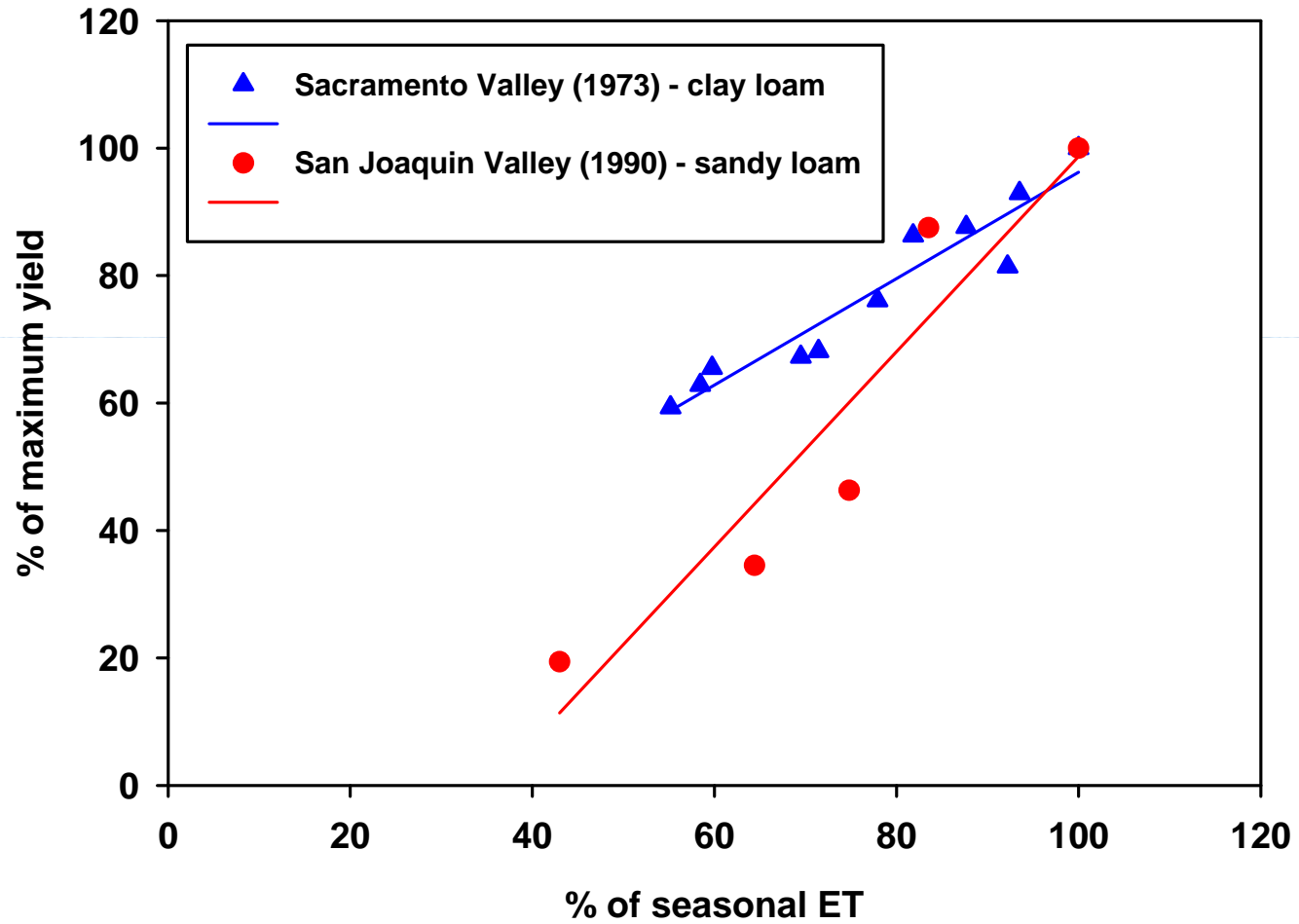
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# Definitions

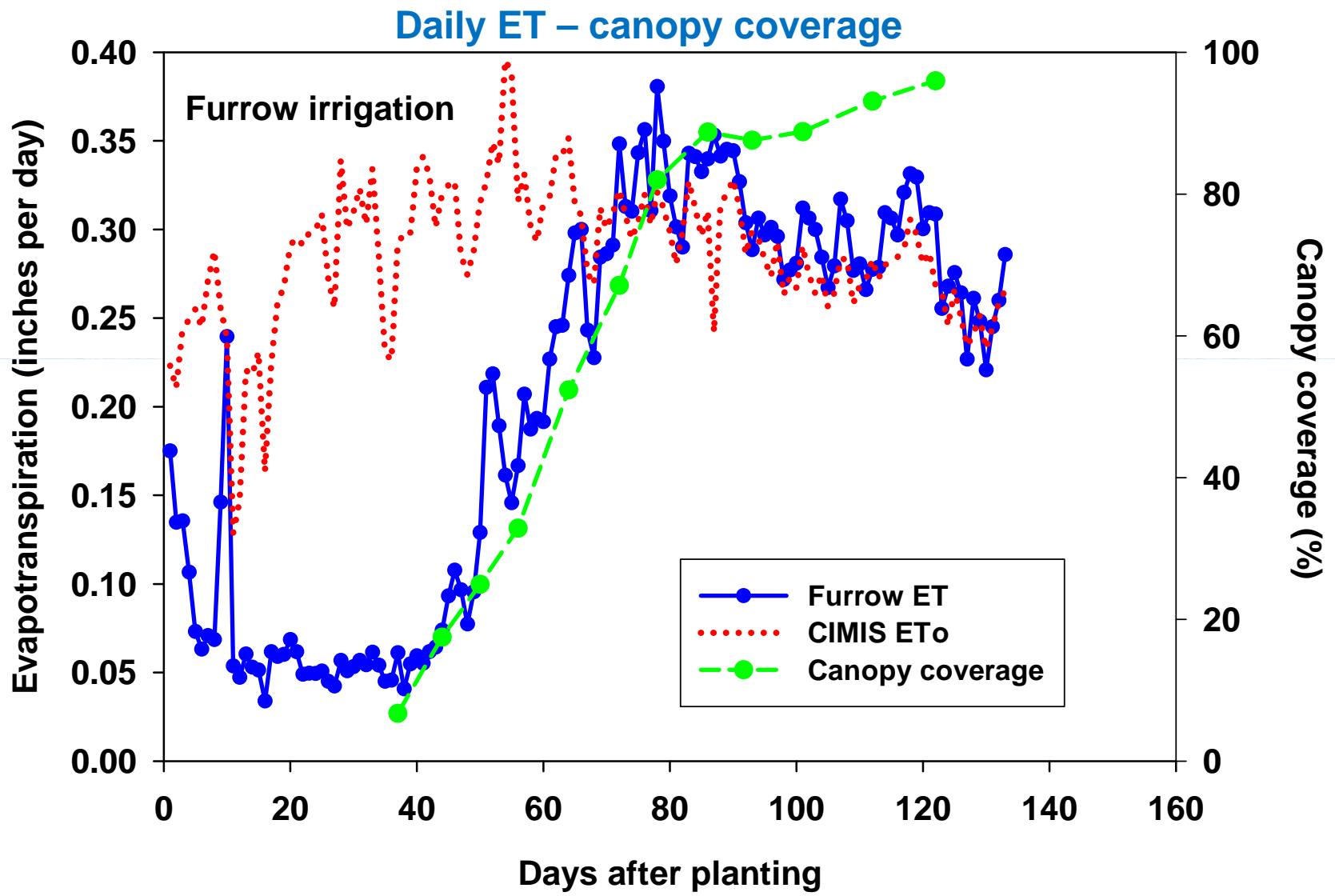
- **Evapotranspiration (ET) – crop water use**
  - Evaporation from plant leaves – transpiration
  - Evaporation from soil surface
  - ET varies with stage of growth and time of year
- **Reference crop ET (ET<sub>o</sub>) – evapotranspiration of well-watered grass**
  - California Irrigation Management Information System (State Department of Water Resources)
  - Calculated using site specific climate and soil data and complex equations
- **Units of ET: inches, centimeters, millimeters**
  - One inch of ET = one acre-inch of water (27,160 gallons) ÷ one acre
  - Standardizes ET – independent of field size
- **Applied water = ET ÷ irrigation efficiency**

### Yield – ET relationship for tomato



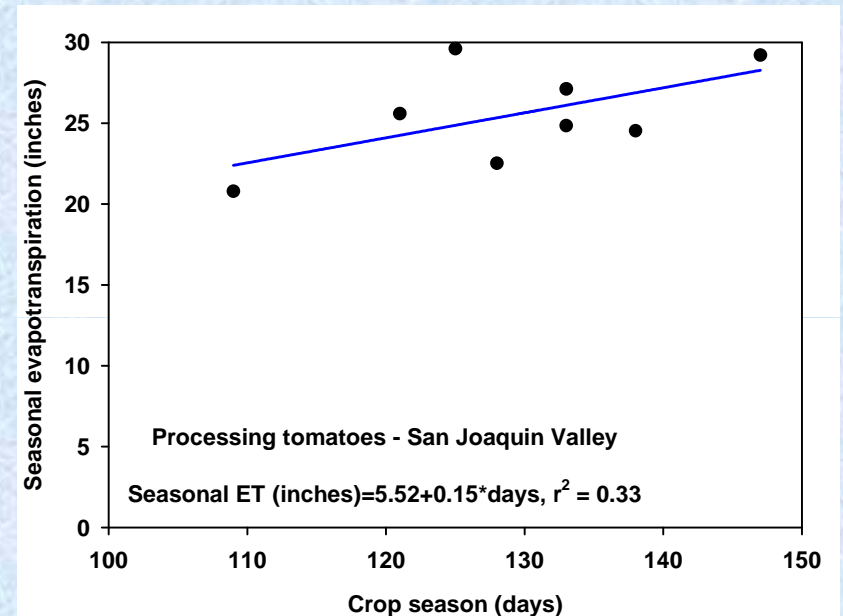
# Evapotranspiration of processing tomatoes (fully irrigated)

- **Westlands Water District – western Fresno County**
- **Eight commercial tomato fields – drip and furrow irrigation**
- **Different cultural practices**
  - plant rows per bed
  - stand establishment – drip, sprinkle
  - planting times – early to late plantings
  - varieties
- **Growers' normal irrigation practices**
- **Published in *California Agriculture***



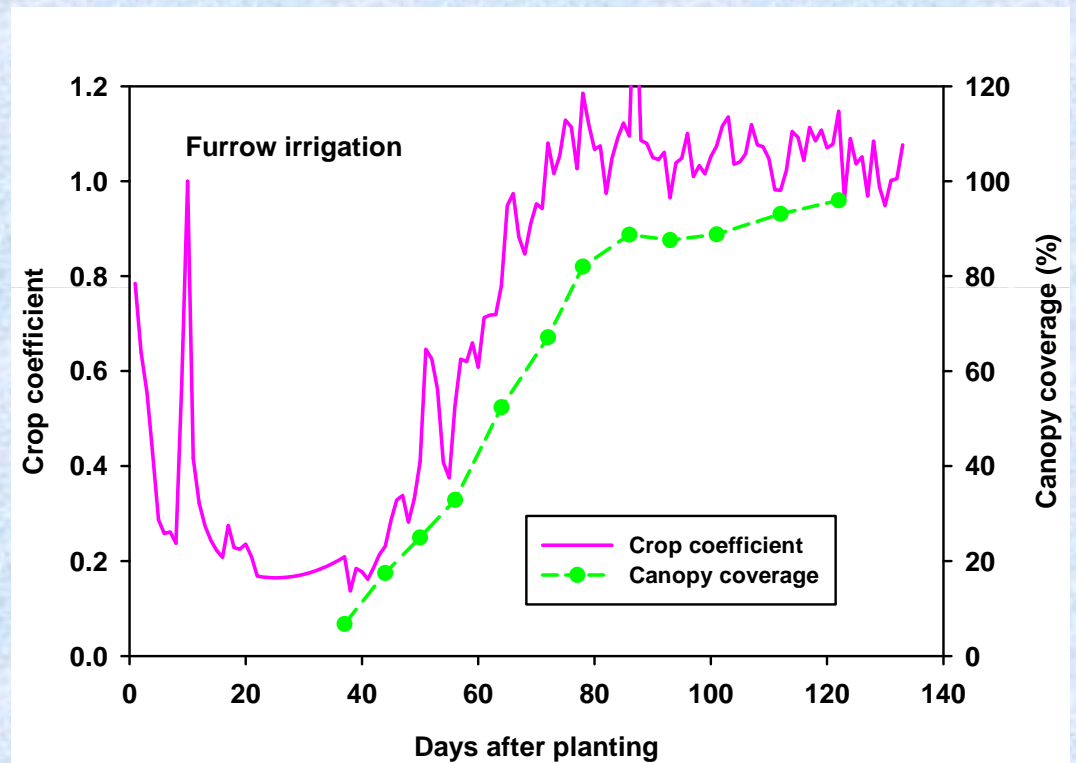
# Seasonal ET

- Average seasonal ET = 25.5 inches
- Range = 21 – 30 inches (depends on crop season)
- Little difference between furrow and drip irrigation
- Similar to historical values calculated in 1981
- Similar to Sacramento Valley values
  - 1972 – 26.8 inches
  - 1973 - 29.9 inches

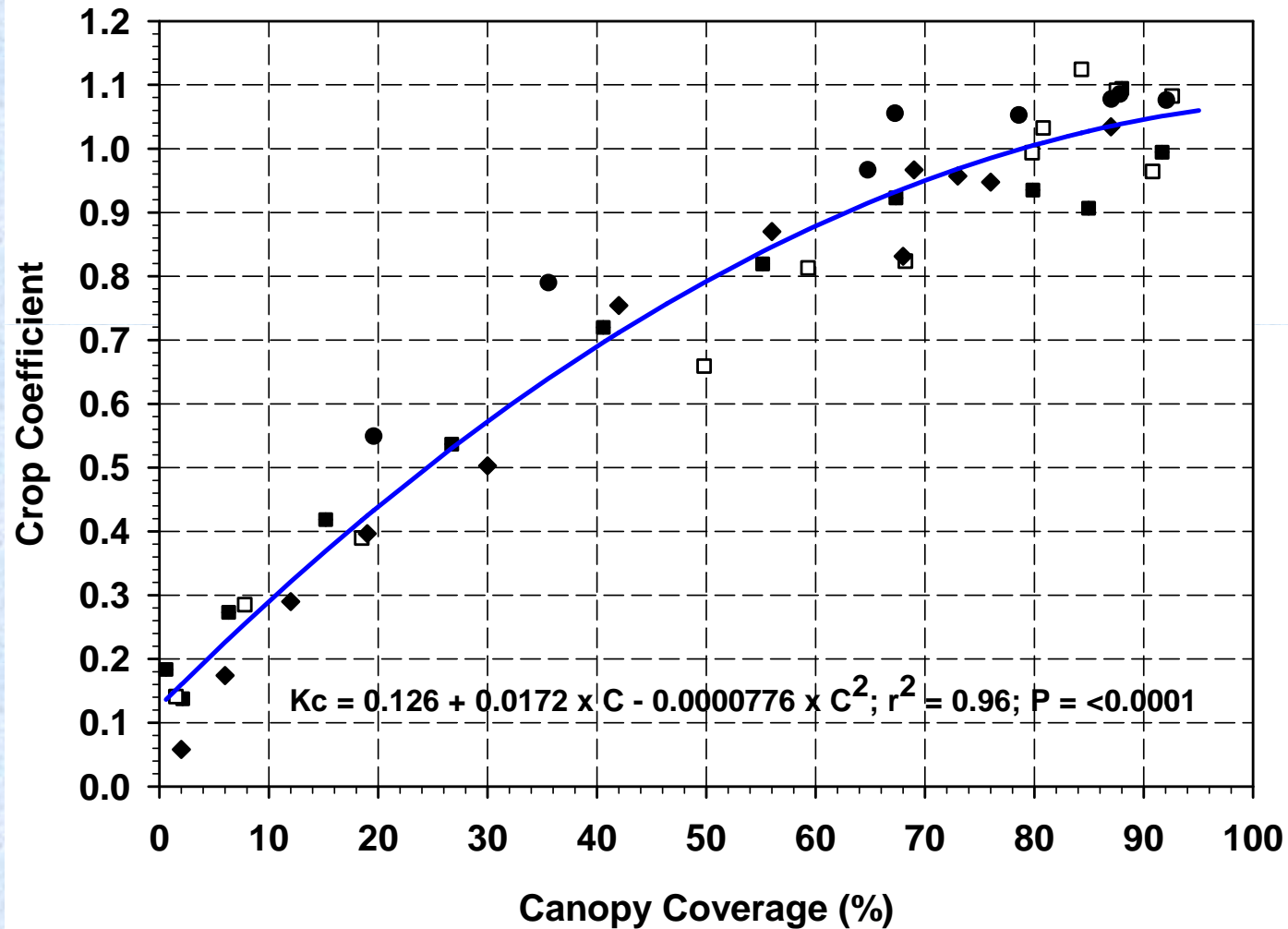


# Calculating evapotranspiration between irrigations

- **ET = Kc x ETo x DAY**
  - ET = crop ET
  - Kc = crop coefficient
  - ETo = CIMIS reference crop ET
  - DAY = days between irrigation
- **Crop coefficient**
  - Relates crop ET to reference crop ET
  - Varies with stage of growth
- **Appropriate after stand establishment**



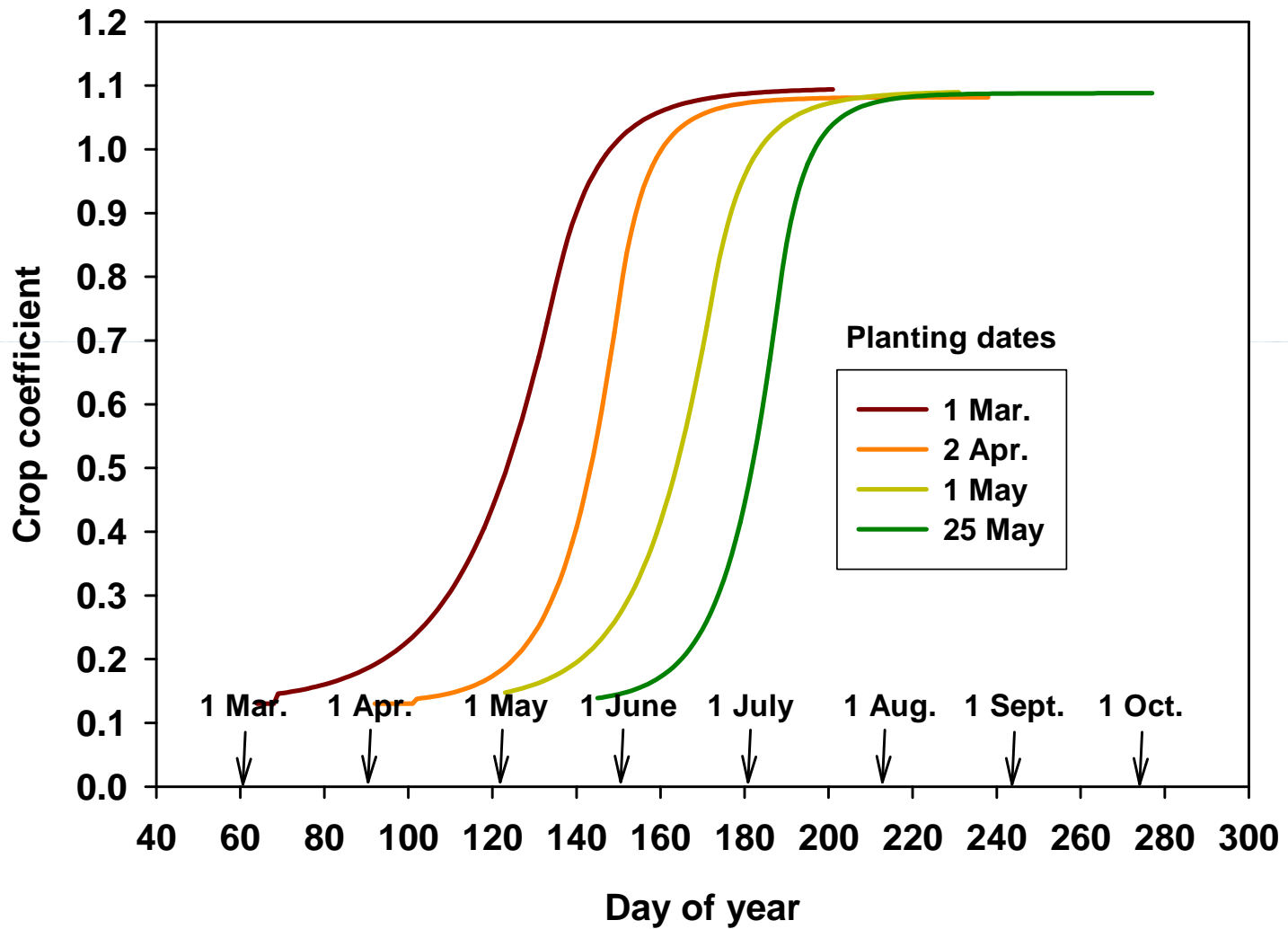
## Crop coefficient – canopy coverage relationship



Canopy coverage =  $100 \times \text{width of canopy} \div \text{furrow spacing}$



### Crop coefficient/time of year for various planting dates



# Using ET data for irrigation water management

- **Furrow irrigation**

- Estimate the amount of soil moisture depletion that can occur without reducing yield (allowable depletion)
- Calculate the daily ET ( $ET = K_c \times E_{To}$ ) and keep track of the total values since the last irrigation
- Irrigate when the total ET since the last irrigation is about equal to the allowable depletion

- **Drip irrigation**

- Determine the desired interval between irrigations (grower preference)
- Calculate the total ET between irrigations
- Apply an amount of water equal to the total ET  $\div 0.80$

## Late season water management

- **Objective: increase soluble solids of processing tomatoes**
- **Options: cutoff time of irrigation; cutback – timing and amount**
- **Furrow irrigation**
  - **Cutoff - terminate irrigation at predetermined time before harvest**
  - **Cutback**
    - Reduce number of irrigations
    - Difficult to apply small amounts of water per irrigation: amount of water required to get the water to the end of the field; cracked soil
- **Drip irrigation**
  - **Cutback – apply small amounts of water per irrigation up to harvest time**
  - **Recommendation (T. K. Hartz) – applications of 30 to 70% of ETo starting about 6 weeks before harvest**

## **Irrigation water management options under limited water supply conditions**

- **Reduce irrigated acres – normal irrigations**
- **Full irrigation as much as possible, particularly during early growth stages; deficit or no irrigation thereafter**
- **Deficit irrigate during crop season regardless of growth stage**
- **Concern: allocation of the irrigation water by the irrigation/water district throughout the crop season**

## Reduce irrigated acres

- Fully irrigate the reduced acres using normal irrigation practices
- Amount of acreage reduction depends on the amount of irrigation water
- Late season irrigation water management
- No irrigation on remaining acres
- Yield loss
- Stretch the limited water supply by efficient irrigation
  - Determine ET between irrigation
  - Apply water efficiently

# **Full irrigation period followed by no irrigation or deficit irrigation**

- **Growth stage considerations (T. C. Hsiao, UC Davis)**
  - **Water stress during any growth stage will reduce yield**
  - **Earlier growth stages – more sensitive to water stress**
  - **Later growth stages – less sensitive to water stress**
- **Full irrigation to develop an adequate canopy cover (about 70 to 80 % coverage), followed by cutoff (no irrigation) or cutback (deficit irrigation) for the remainder of the crop season**
  - **Irrigate normal acres**
  - **Irrigate efficiently to stretch the limited water supply**
  - **Days after planting needed for full canopy coverage generally about 60 to 80 days**
  - **Amount of ET needed to develop an adequate canopy coverage generally about 6 to 10 inches of water (about 24 to 40 percent of the average normal seasonal ET)**
  - **Remainder of crop season generally between 50 to 70 days**
  - **Data from 18 commercial fields**

## **Full irrigation period followed by no irrigation or deficit irrigation (continued)**

- **Strategy best suited for clay loam soil with no root depth restrictions**
  - Large amount of stored soil moisture, deep roots
  - Potential for a minimal yield loss
- **Restricted root depth; sandy loam or loam soil**
  - Potential for a considerable yield loss
  - Consider using the reduced acres option

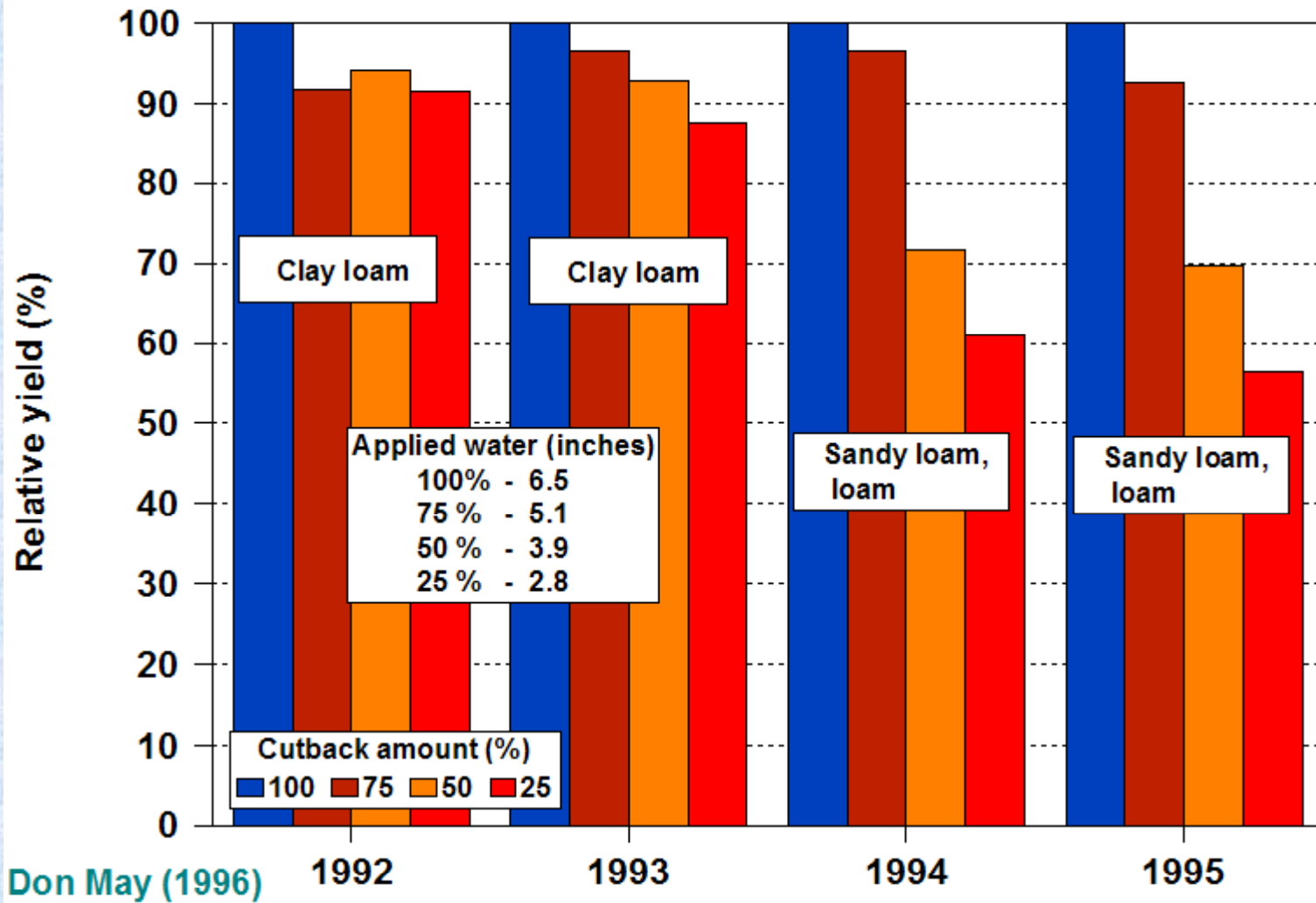
# Full irrigation period followed by no irrigation or deficit irrigation (continued)

- **General guidelines**

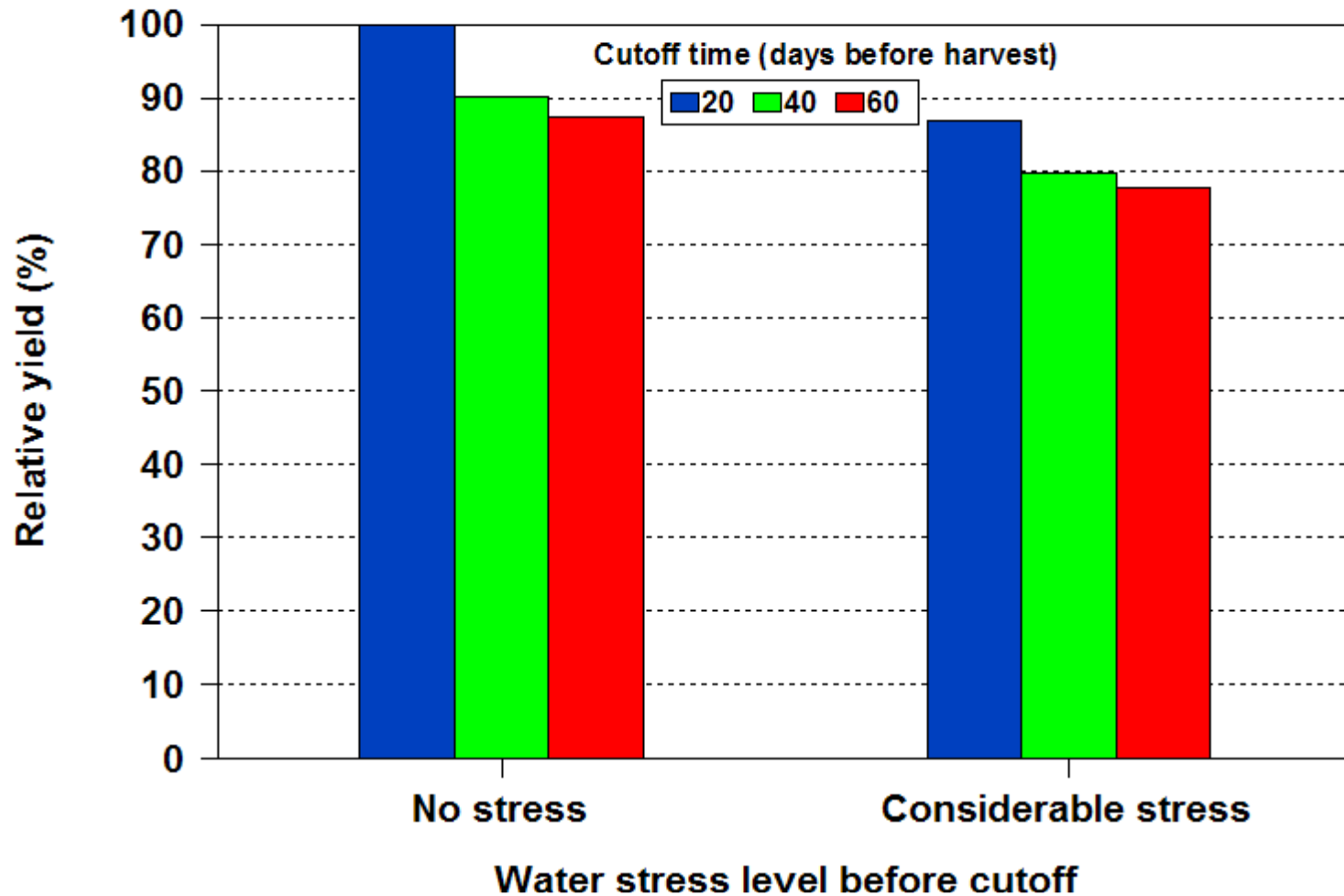
- **Start the crop season with a soil profile fully replenished with soil moisture**
- **Full irrigations if possible for the first 60 to 80 days after planting to develop the canopy size**
- **Drip irrigation**
  - **Full irrigations as long as possible followed by cutback of irrigation water**
  - **Cutback: continue to supply small amounts of water**
  - **Requires allocating the limited water supply between the period of full irrigation and the cutback period.**
- **Furrow irrigation**
  - **Full irrigations as long as possible**
  - **Last irrigation should fully replenish soil moisture in root zone**
  - **Cutoff**
  - **Cutback approach is difficult to implement with furrow irrigation**
  - **May need to reduce acres, particularly in sandy soil**



### Drip irrigation: cutback 60 days before harvest



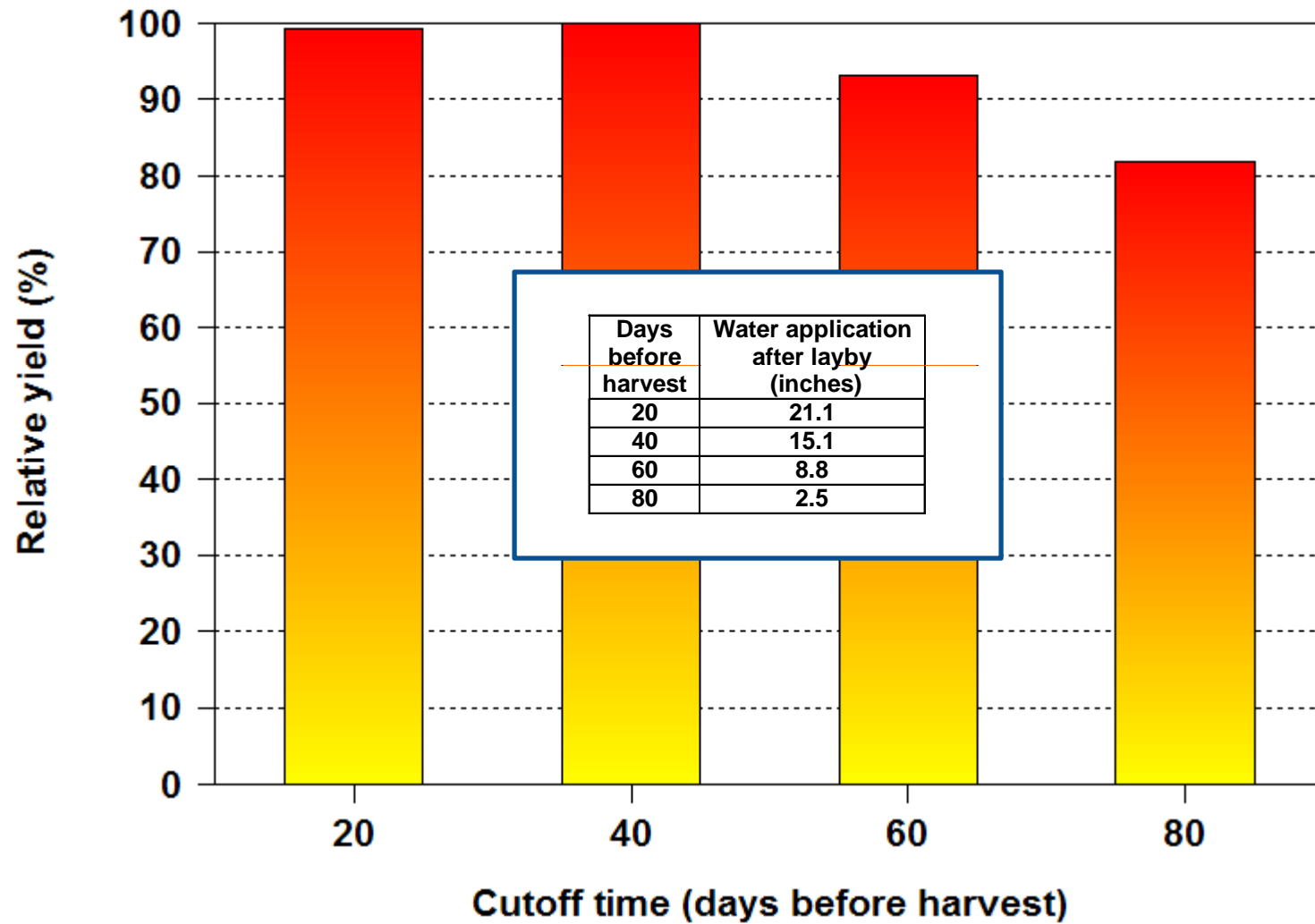
## Furrow irrigation: effect of stress during the first part of the crop season and cutoff time on yield (clay loam)



Don May, 1996

Note: stress was induced by decreasing the number of furrow irrigations

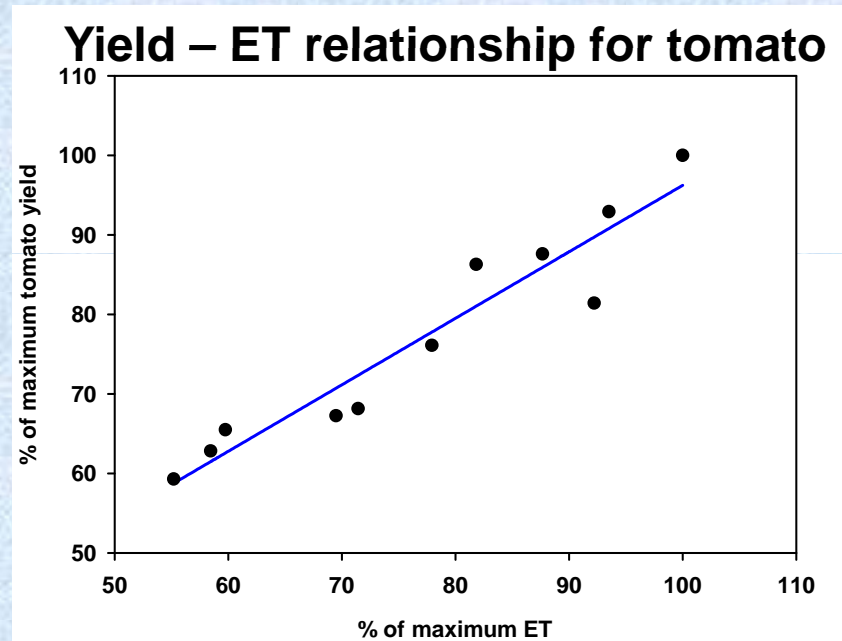
### Furrow irrigation: effect of cutoff time on yield (clay loam)



Don May, 1998

# Deficit irrigate throughout the crop season regardless of growth stage

- Spread the limited amount of water over the crop season
  - Reduce number of irrigations – all irrigation methods
  - Reduce amount applied per irrigation – sprinkle and drip irrigation
- Irrigate entire field or part of the field
- Yield loss
- Not feasible for small amounts of available irrigation water – economical yields?



## Which option is the best?

- **Normal irrigated acres = 160; drip irrigation; clay loam soil; crop season = 130 days; normal yield = 40 tons per acre**
- **Sufficient irrigation water to supply 50% of the normal ET = 13 inches of ET**
- **Reduce acres option**
  - **80 fully-irrigated acres**
  - **Total tons = 80 acres x 40 tons per acre = 3,200 tons**
  - **Smaller risk compared to full/deficit option**
- **Full/deficit option**
  - **160 irrigated acres**
  - **ET needed to develop the canopy = 10 inches of ET**
  - **Water application during cutback period (60 days before harvest) = 3 inches (25% cutback application)**
  - **Potential yield = 90% (based on research results) = 36 tons per acre**
  - **Total tons = 160 acres x 36 tons per acre = 5,760 tons**
  - **Larger risk compared to reduced acres option**

# Stretching a limited water supply during periods of full irrigation

- Amount of applied water will exceed the ET due to irrigation system inefficiencies
- Drip irrigation
  - Precise application of water throughout the field
  - Use CIMIS ETo and crop coefficients
  - Potential for applying an amount of water about equal to the total ET between irrigations
- Furrow irrigation
  - Losses – surface runoff, deep percolation
  - Reduce surface runoff from field
    - Decrease the irrigation set time
    - Recover and reuse surface runoff
      - Field recirculation system
      - Farm tail water reuse system
- Monitor soil moisture
  - Watermark electrical resistance blocks
  - Other types of sensors



**The End**