Irrigation and Salinity Considerations: some research results on drip irrigation of processing tomatoes

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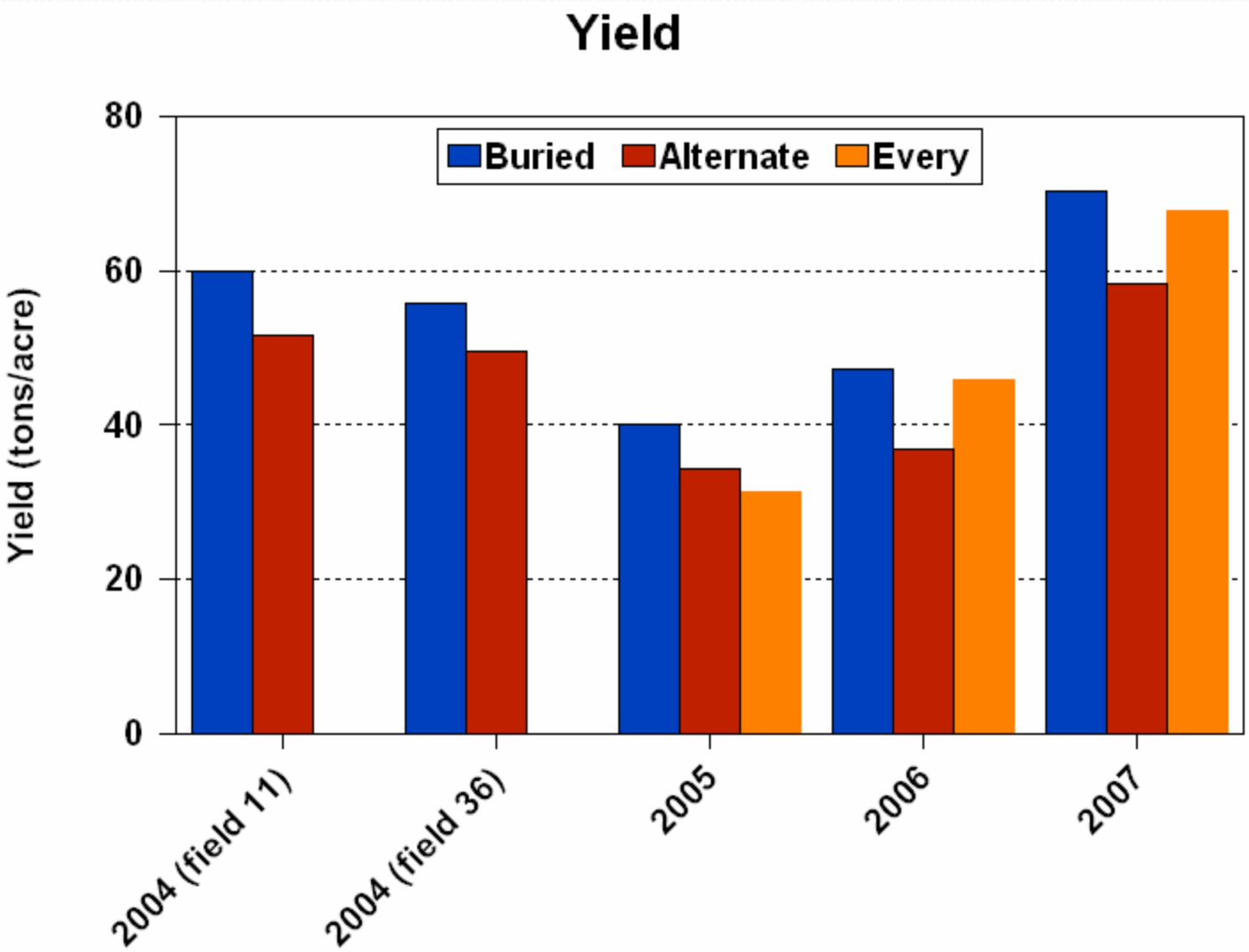
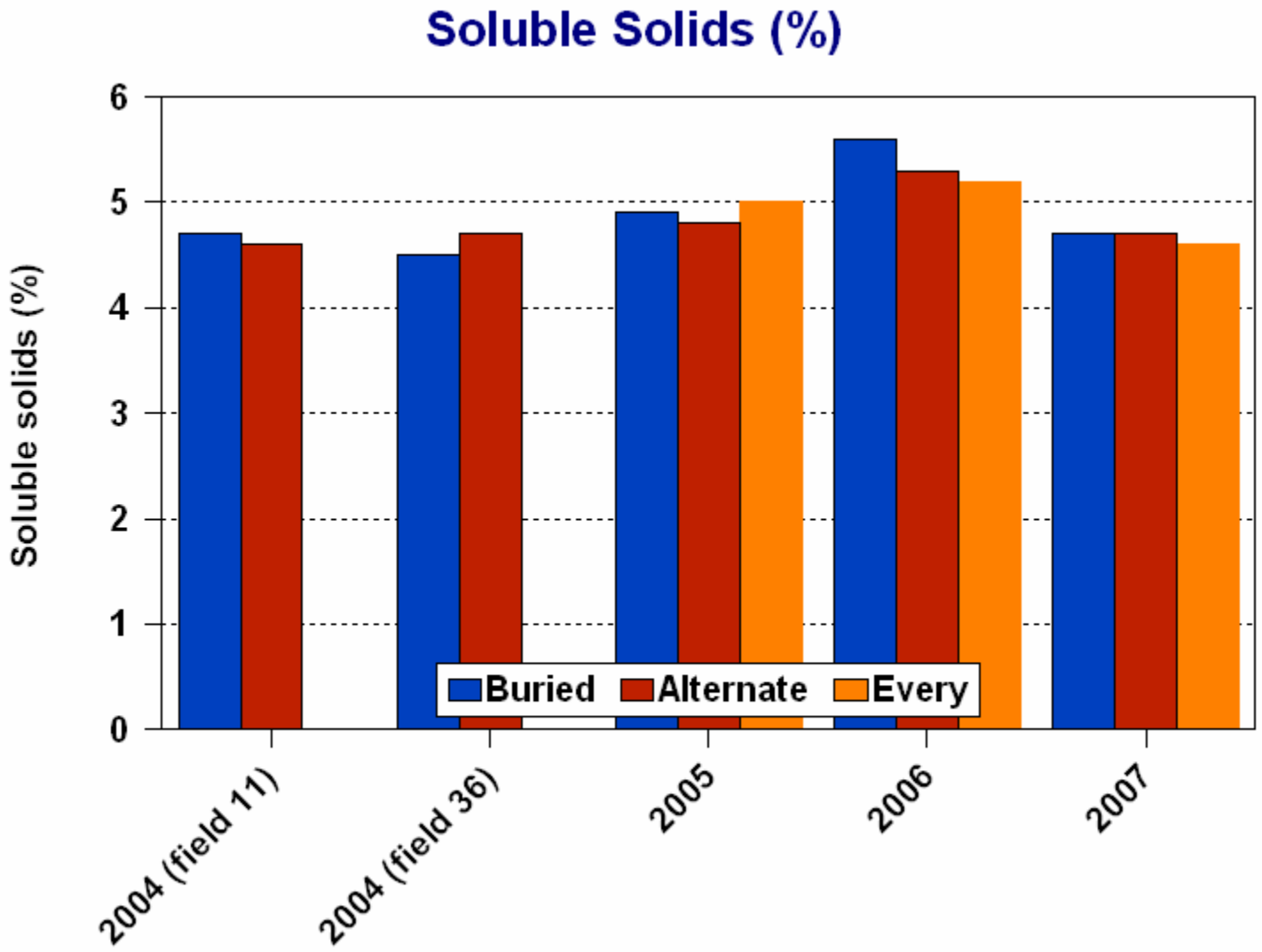
Research

- **Drip line placement**
- **Crop water use**
- **Drip irrigation under saline soil conditions**

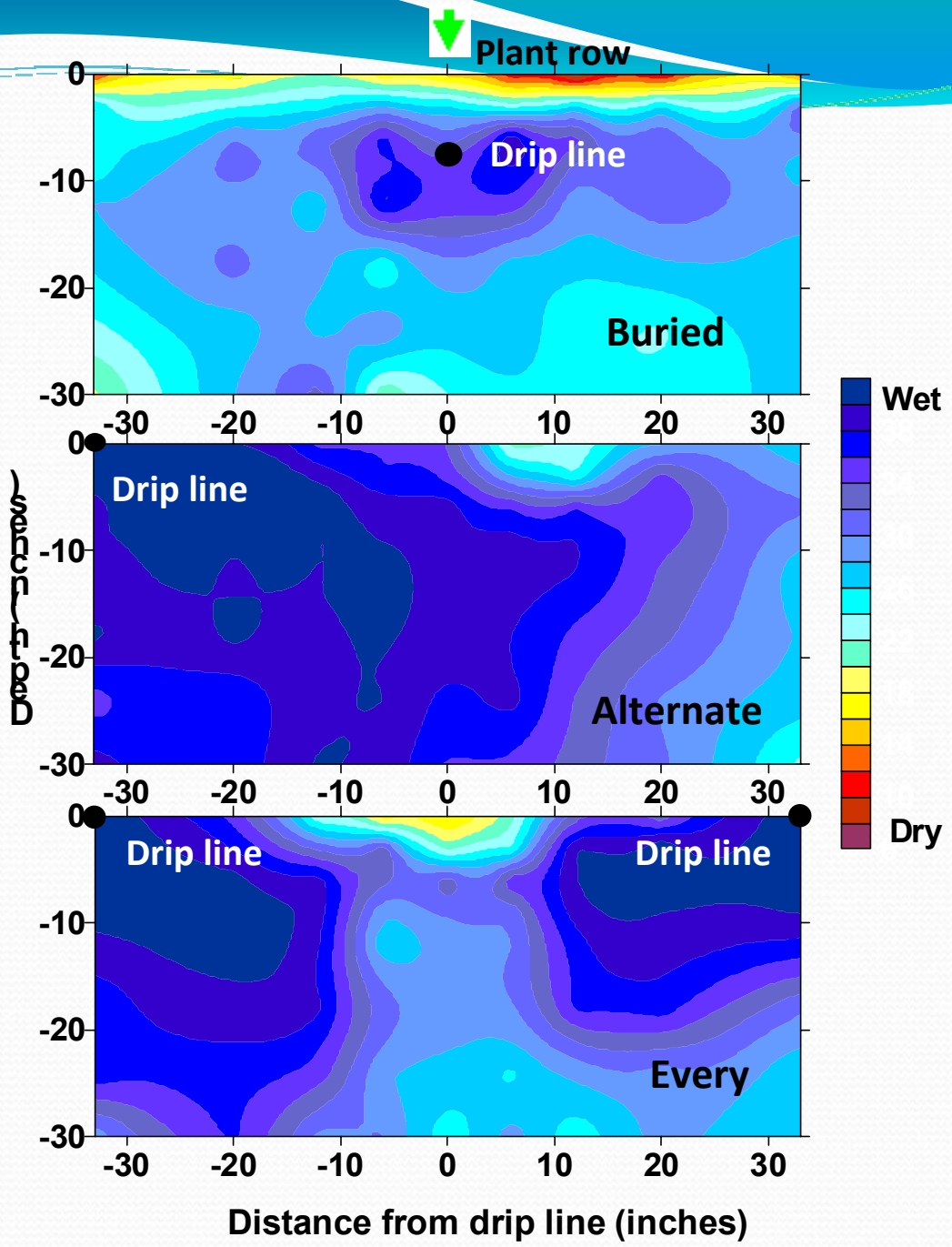
Drip line placement

- **Buried placement**
  - **Middle of bed; 8 to 14 inches deep**
  - **Drip line placement nearly coincides with plant row location**
  - **Modified tillage**
  - **Limited crop rotations**
- **Alternate furrow placement**
  - **Drip line as far as possible from plant row**
  - **Weeds**
  - **Drip lines removed before harvest and reused elsewhere**
  - **Long irrigation times**
- **Every furrow placement**
  - **Drip line as far as possible from plant row**
  - **Weeds**
  - **Vine training considerations**
  - **Drip lines remove before harvest and reused elsewhere**

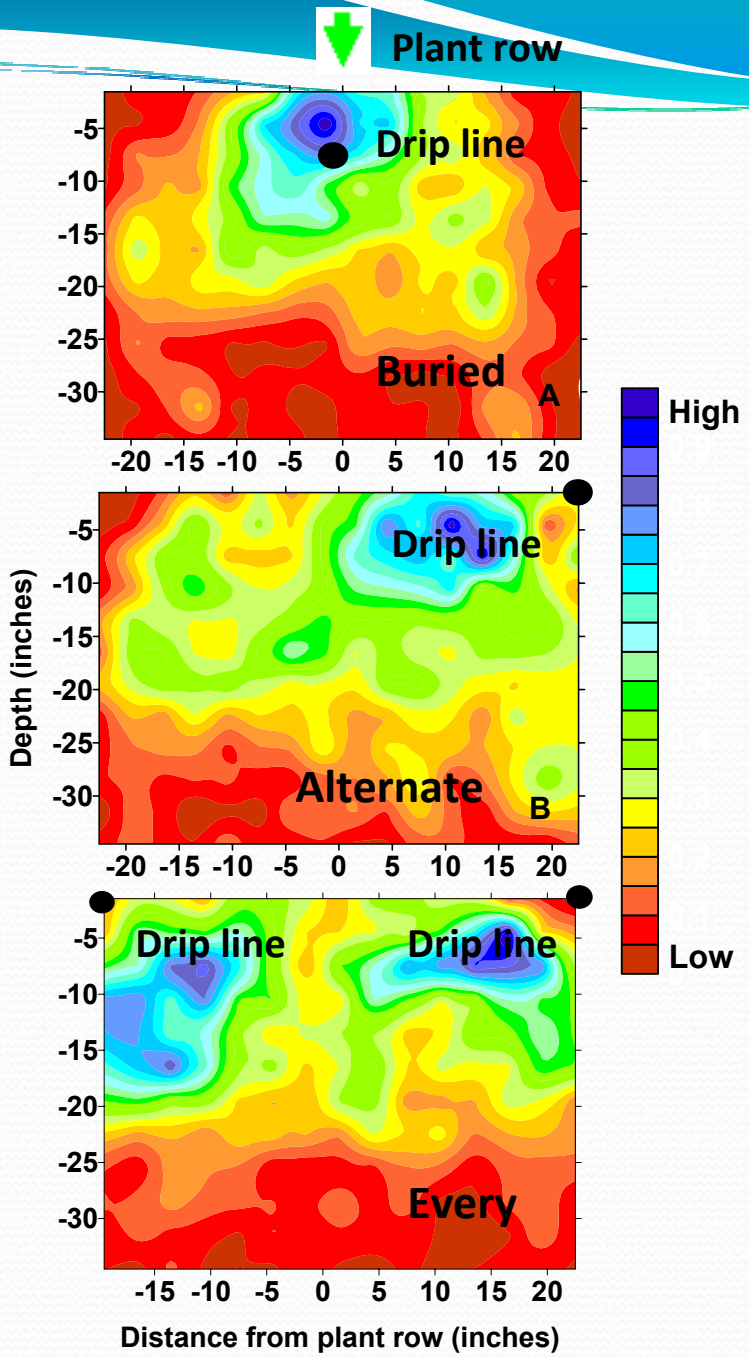

Yield
Buried
Alternate
Every
Yield (tons/acre)
80
60
40
20
0
2004 (field 11)
2004 (field 36)
2005
2006
2007


Soluble Solids (%)
Soluble solids (%)
6
5
4
3
2
1
0
Buried
Alternate
Every
2004 (field 11)
2004 (field 36)
2005
2006
2007

Soil moisture



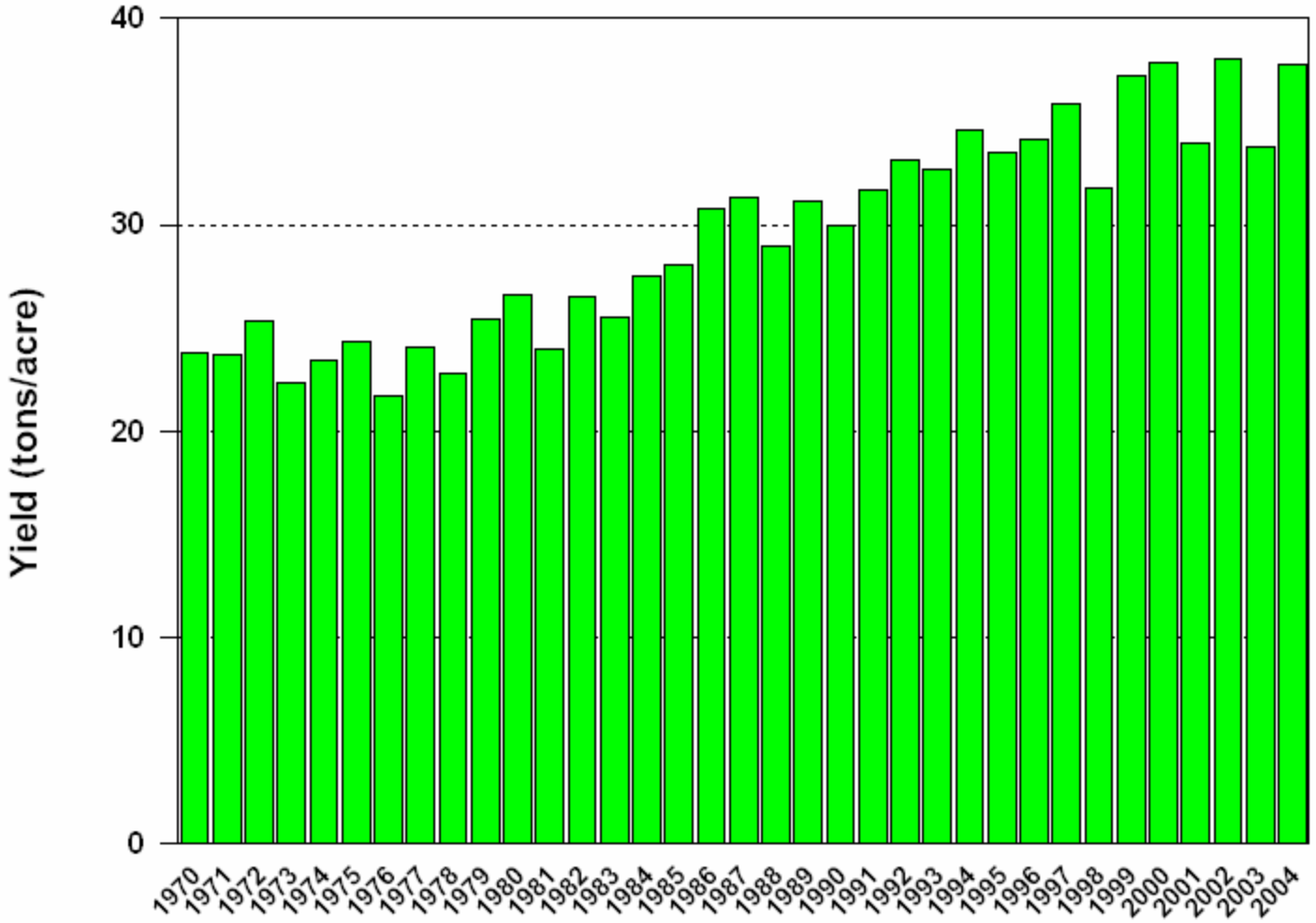
Root distribution

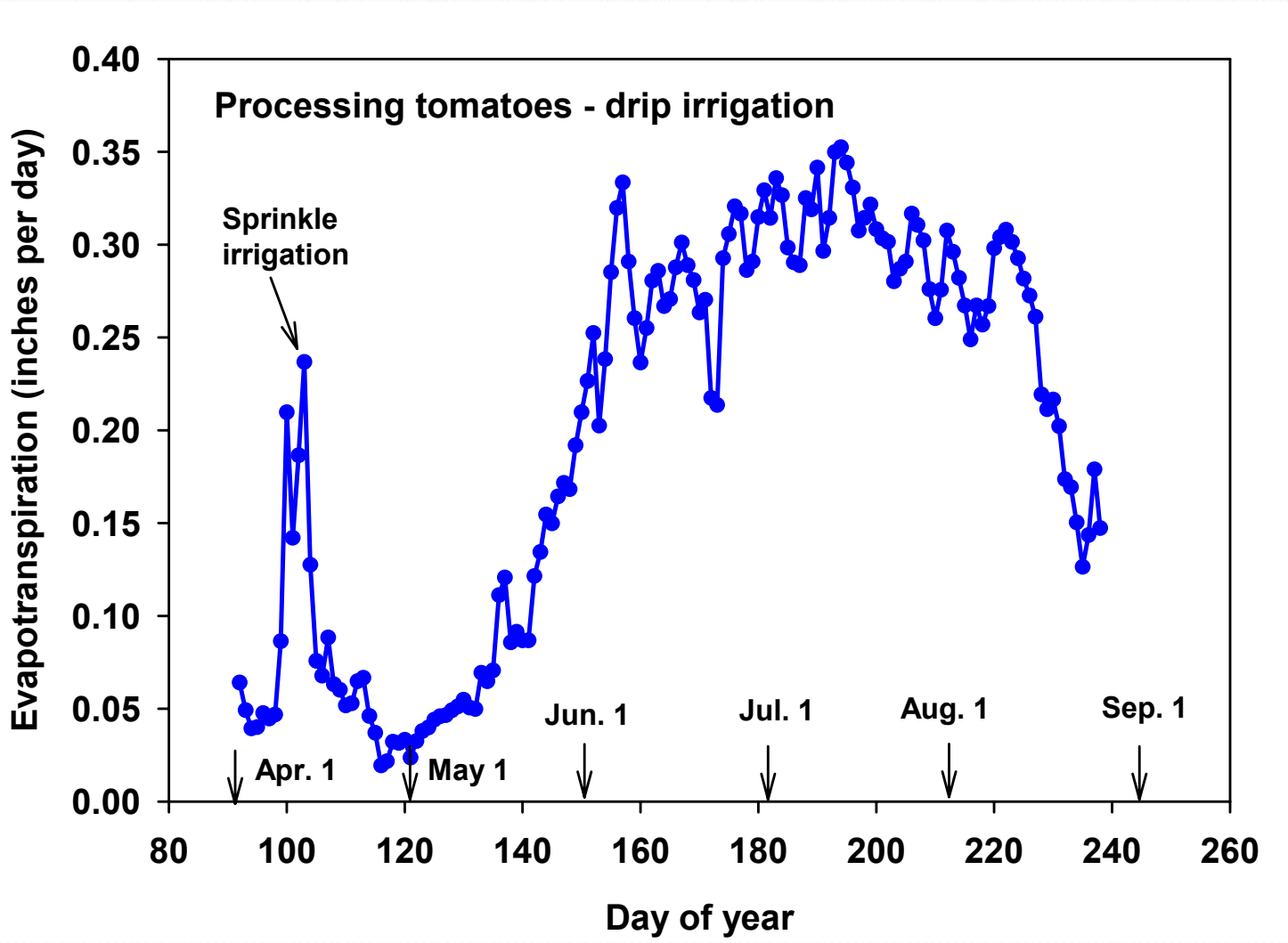


Crop water use or evapotranspiration

- Measured in commercial fields
- Drip irrigation and furrow irrigation
- Four-year period – variety of cultural practices (crop season, planting dates, plant rows per bed, irrigation, stand establishment)

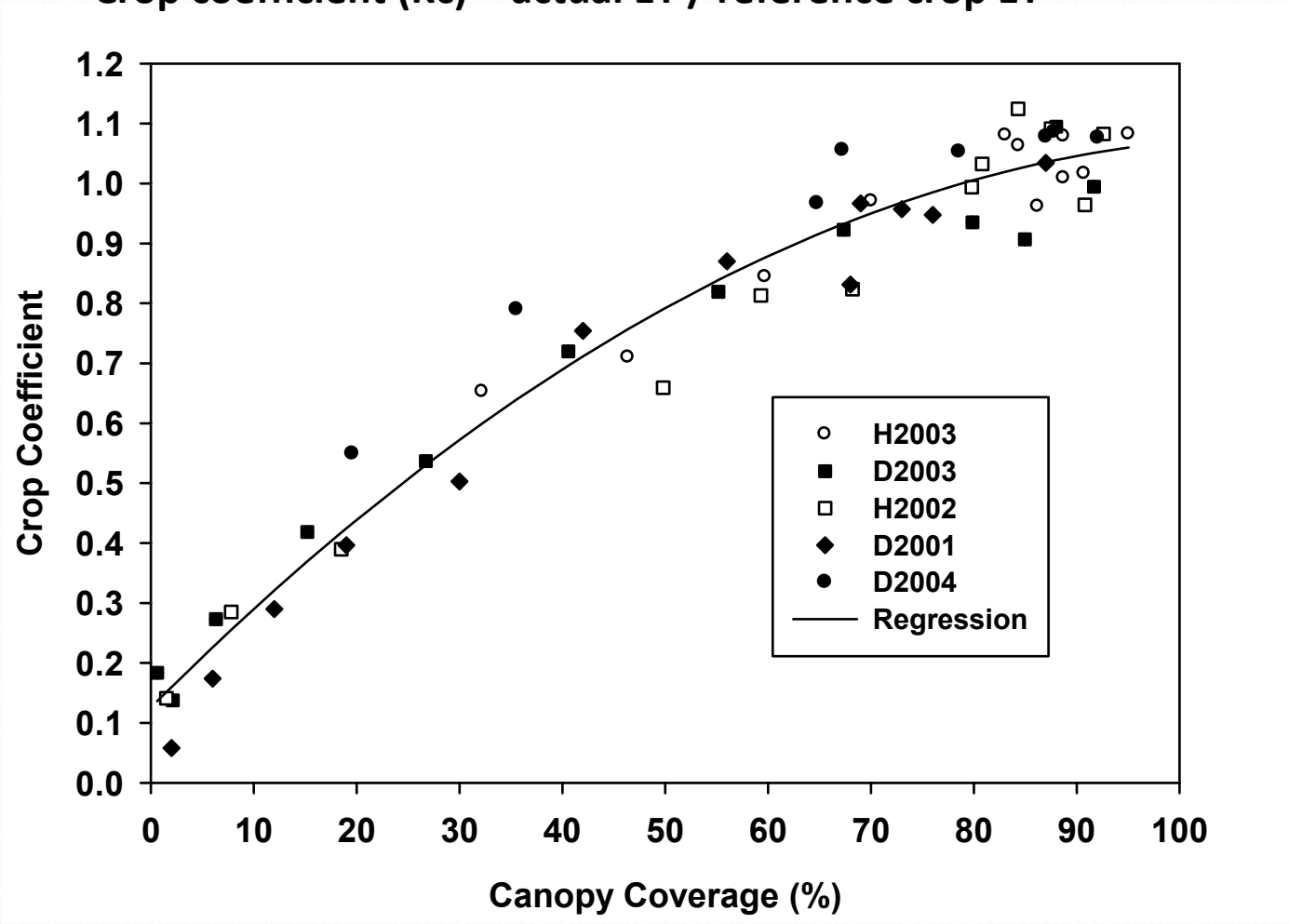
Processing tomato yield

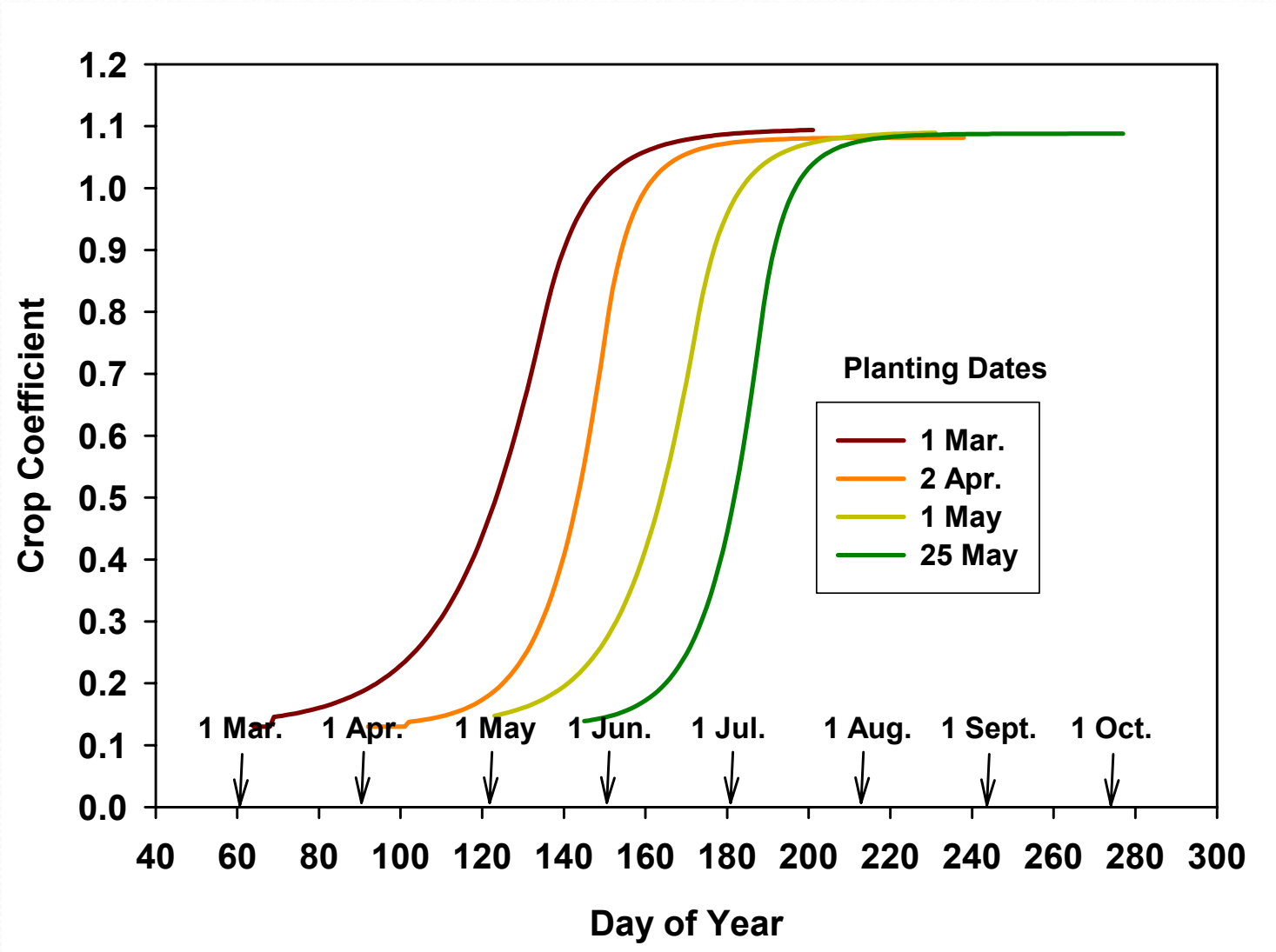



Processing tomatoes - drip irrigation
Sprinkle irrigation
Evapotranspiration (inches per day)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Apr. 1
May 1
Jun. 1
Jul. 1
Aug. 1
Sep. 1
80
100
120
140
160
180
200
220
240
260
Day of year

ET = Kc x reference crop ET

Crop coefficient (Kc) = actual ET / reference crop ET




Crop Coefficient
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Planting Dates
1 Mar.
2 Apr.
1 May
25 May
1 Mar.
1 Apr.
1 May
1 Jun.
1 Jul.
1 Aug.
1 Sept.
1 Oct.
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Day of Year

Results

- ET ranged from 20.8 to 29.6 inches (significant factors: planting date and crop season)
- No difference between drip and furrow irrigation
- Average ET of study fields = 25.5 inches
- No difference between this average and the historical average (1981)
- Different crop coefficients were found compared to historical coefficients
- Substantial change in water use efficiency of tomatoes (ET/yield) over time

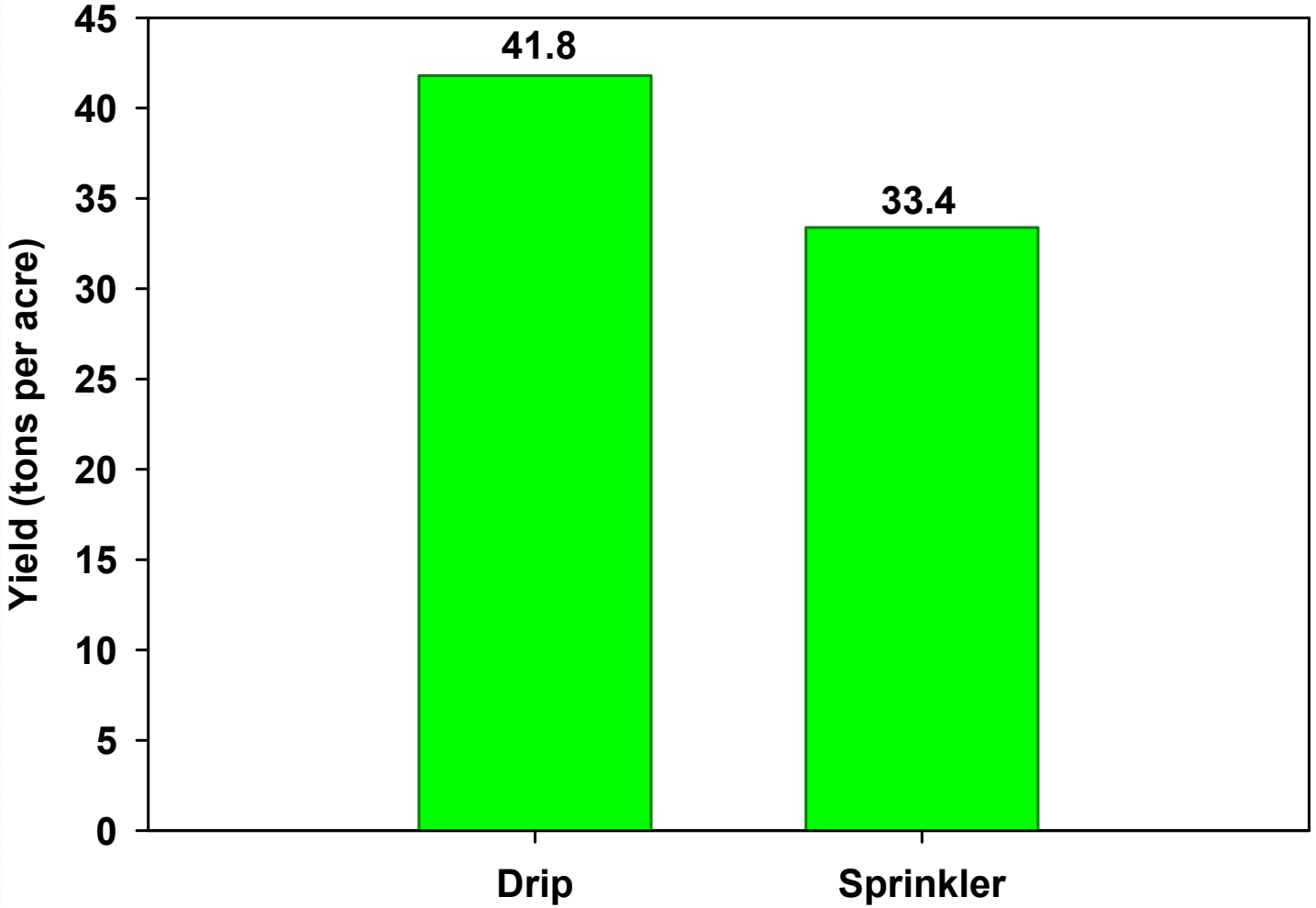
Drip irrigation under saline soil conditions in the San Joaquin Valley

- Saline soils (west side of San Joaquin Valley) – result of upward flow of shallow saline ground water
- 30 years of research – no technically, economically, and environmentally friendly subsurface drainage water disposal method
- Options for growers
  - Land retirement
  - Convert to different irrigation method
  - Reuse drainage water
  - Increase direct crop water use of shallow ground water

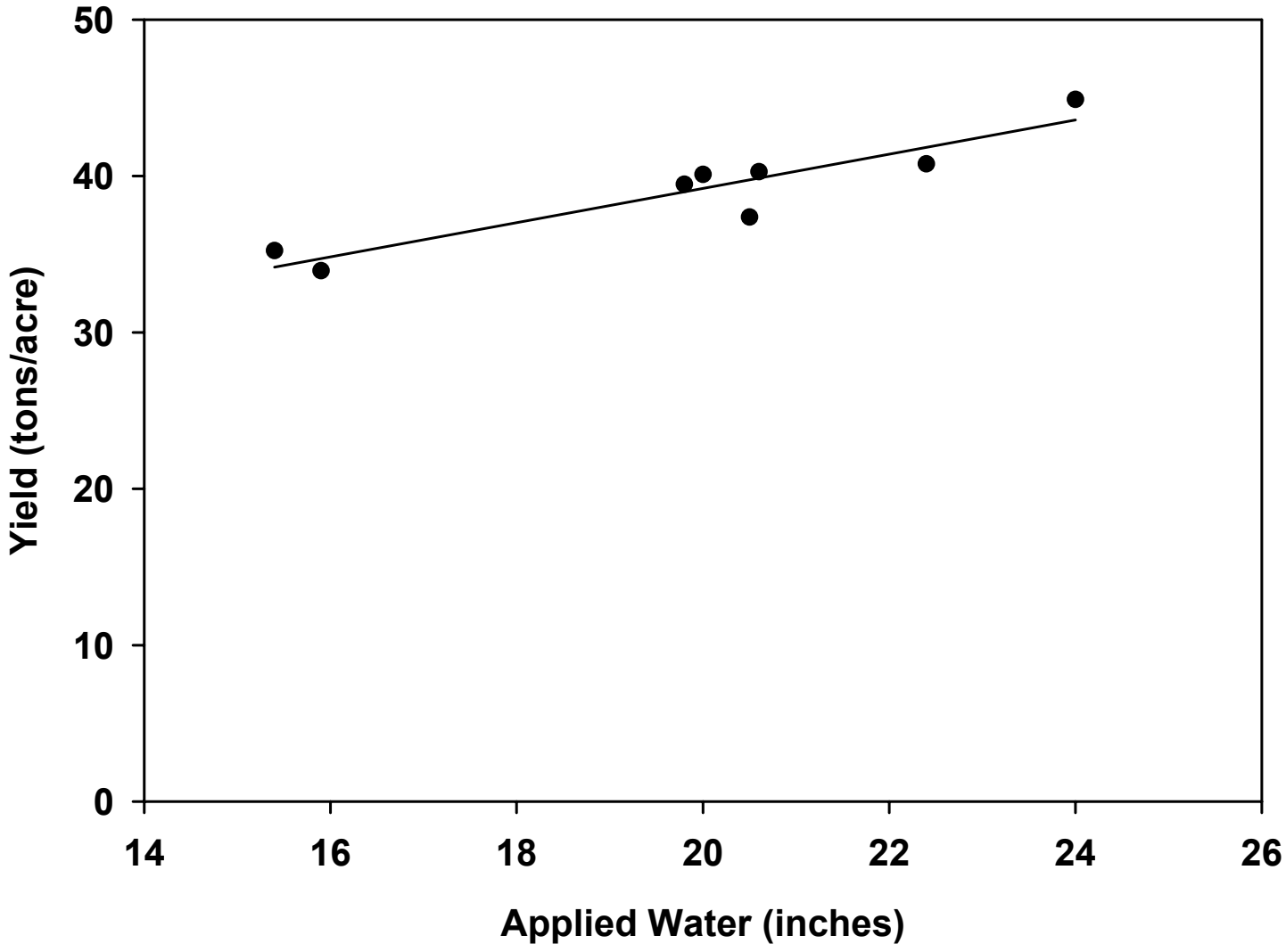
Drip Irrigation of Processing Tomatoes Under Saline, Shallow Ground Water Conditions

- **Three commercial fields**
  - **Subsurface drip irrigation vs. sprinkle irrigation**
  - **Drip line depths – 8 to 12 inches**
  - **One drip line per bed**
  - **2 to 3 irrigations per week**
  - **EC of irrigation water – 0.3 to 1.1 dS/m**
  - **Water table depth – 2 to 6 feet deep**
- **Fourth site**
  - **Very shallow water table (18 to 24 inches deep)**
  - **Daily irrigation**
  - **EC of irrigation water – 0.5 dS/m**

Field-scale Comparisons - Yield



Fourth commercial field - water table depth =18 to 24 inches

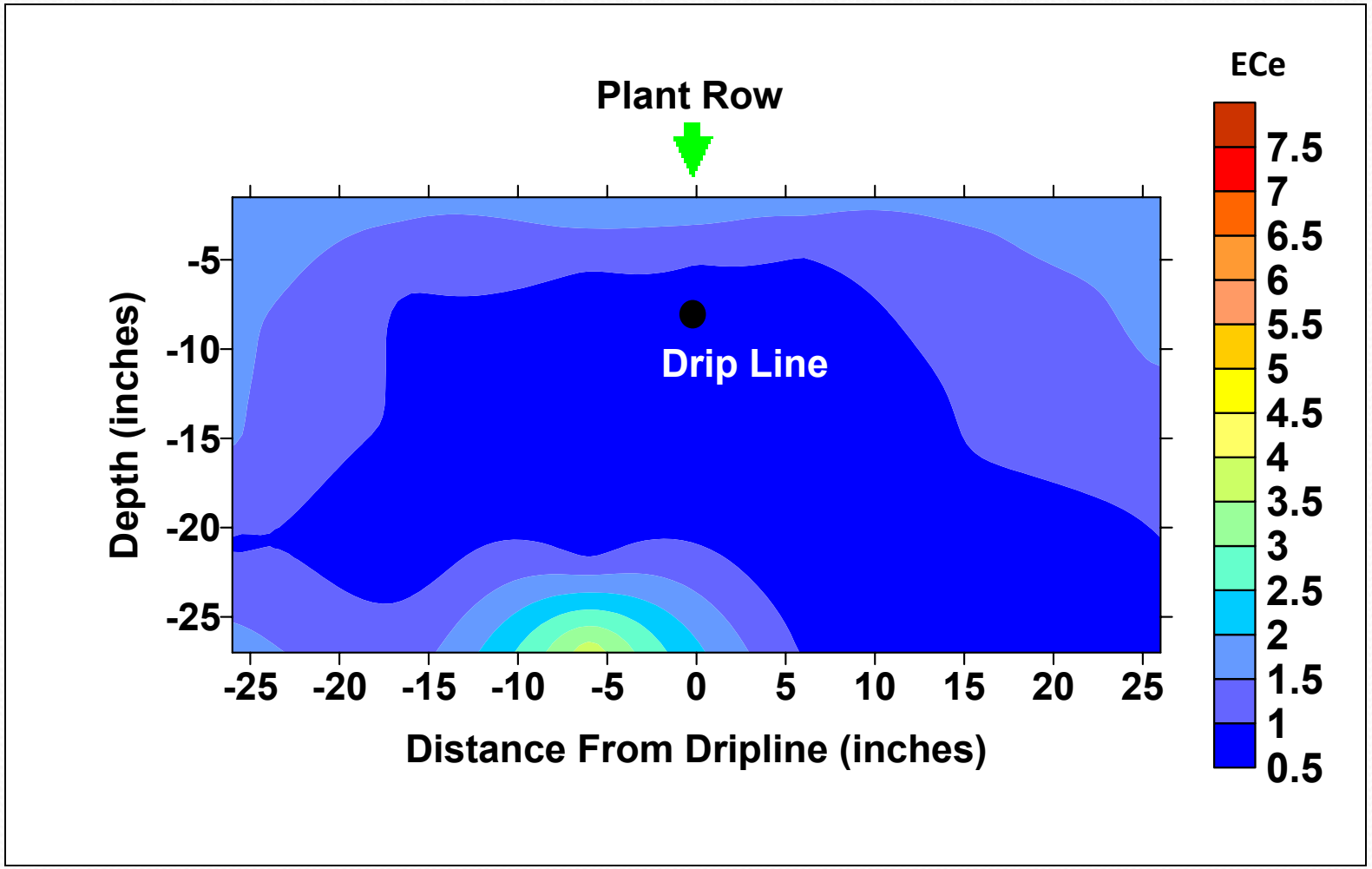


Factors Affecting Salt Distribution Around Drip Lines Under Saline, Shallow Ground Water Conditions

- Salinity of irrigation water
- Amount of applied irrigation water
- Salinity of ground water
- Depth to water table
- Soil texture

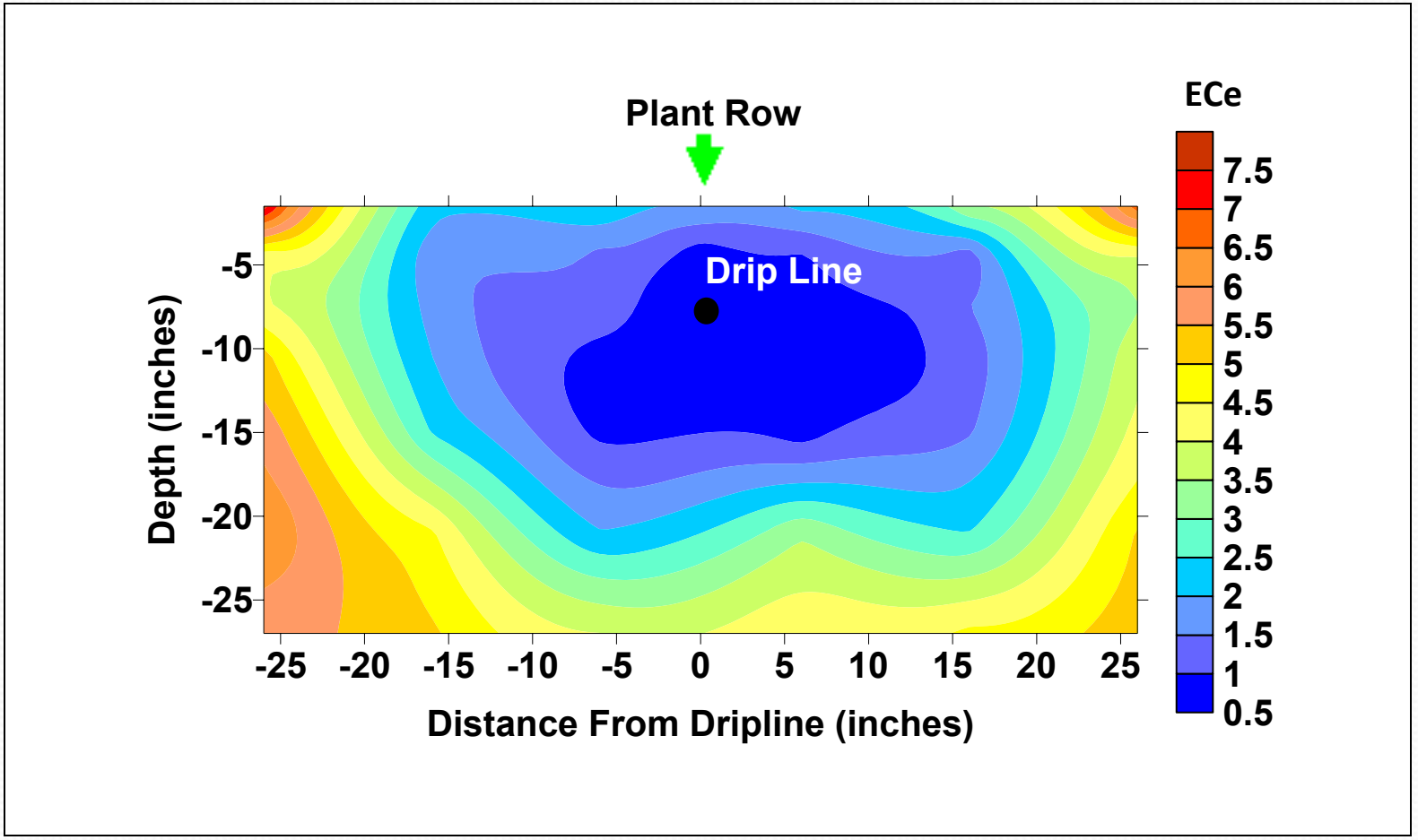
Soil Salinity

ECi = 0.3 dS/m
ECgw = 8 dSm to 11 dS/m
Average water table depth – 6 feet



Soil Salinity

ECi = 0.3 dS/m
ECgw = 5 dS/m to 7 dS/m
Water Table Depth – 2 to 3 feet



Is Subsurface Drip Irrigation of Processing Tomatoes Sustainable in these Salt Affected Soils?

- Key – salinity control in root zone
- Little or no field wide leaching based on water balance data (leaching = applied water - ET)
- Soil salinity data – considerable localized leaching around drip lines (responsible for yield increases)
- What is the actual leaching fraction under subsurface drip irrigation?

Year	Leaching Fraction (%)
	DI
1999	0
2000	22
2001	0
	BR1
1999	0
2000	0
2001	1
	DE
2000	17
2001	9
	BR2
2002	0

Computer simulations (HYDRUS-2D): water balance leaching fraction and actual leaching fraction for drip irrigation

Applied water (% of potential ET)	Water balance leaching fraction (%)	Actual Leaching fraction (%)
60	0	7.7
80	0	17.3
100	0	24.5
115	15	30.9

Notes:

- **Myth: applying an amount of water equal to the ET results in an irrigation efficiency = 100% for drip irrigation**
- **High irrigation efficiency under drip irrigation occurs only for severe deficit irrigation conditions**
- **This behavior is due to the wetting pattern around drip lines and can not be avoided**

Are subsurface drainage systems and drainage water disposal methods needed under subsurface drip irrigation?

- No drainage systems installed in commercial fields
- Little response of water table to drip irrigation except when overirrigation occurred at one site
- Growers continue to use subsurface drip irrigation with no long-term salinity effects
- Conclusions:
  - Subsurface drip irrigation is sustainable
  - Proper management is required
  - Drainage water disposal method is not needed for the conditions found in the commercial fields

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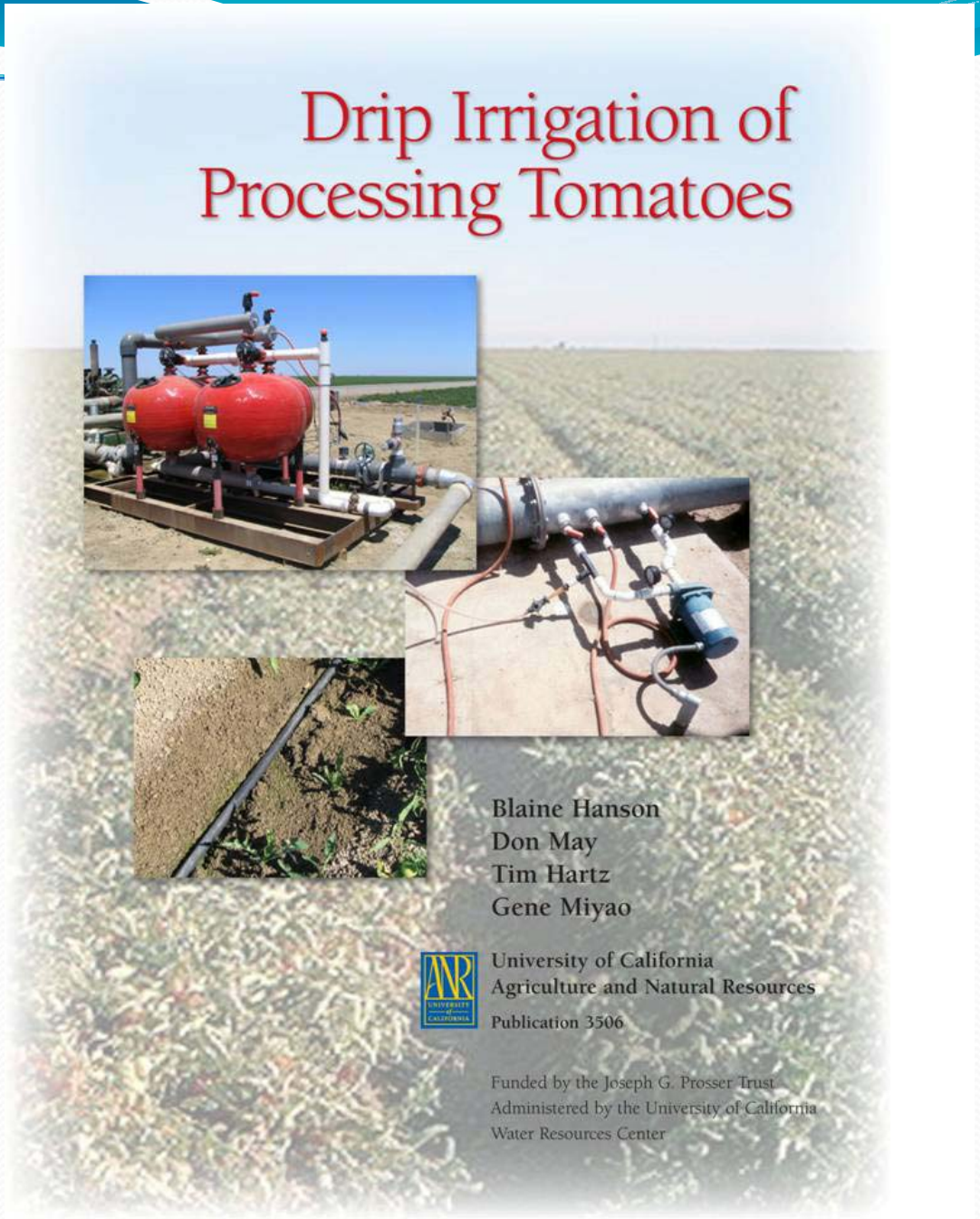

The End