SALINITY MANAGEMENT IN PROCESSING TOMATOES

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WHERE DO SALTS COME FROM?

- Irrigation water is the primary source of salts in agricultural systems
- Also from fertilizers, manures, composts
- Shallow saline water tables

Sodium (Na^{+})
Calcium (Ca^{2+}) Cations
Magnesium (Mg^{2+})

Chloride (Cl^{-})
Sulfate (SO_4^{2-}) Anions
Bicarbonate (HCO^{3-})

Boron (B), Carbonate (CO32-), Nitrate (NO3-), Potassium (K+)

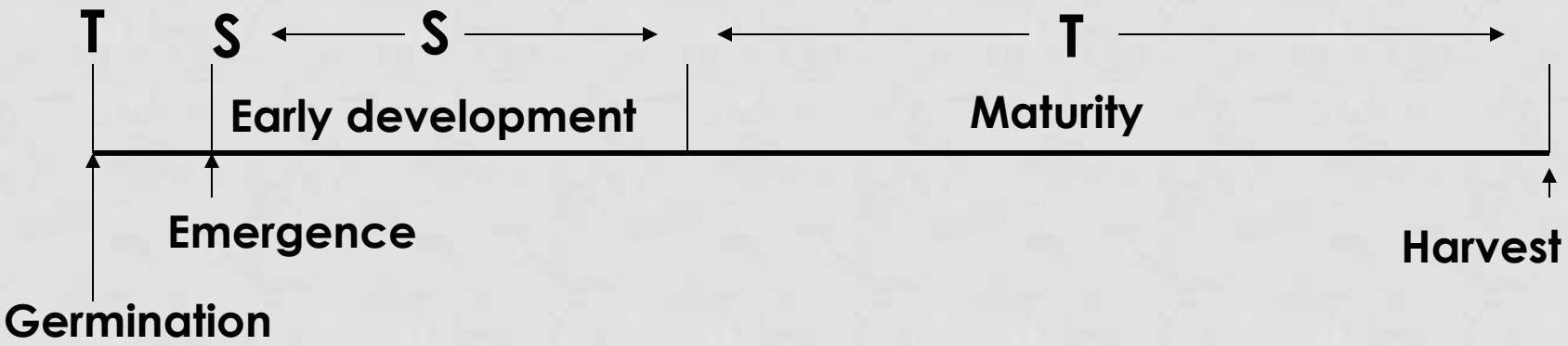
HOW DOES SALT EFFECT PLANTS?

Overal salinity causes osmotic stress → Stunting, reduced yields

Specific ion toxicity (NA, Cl, B) → Marginal leaf burn

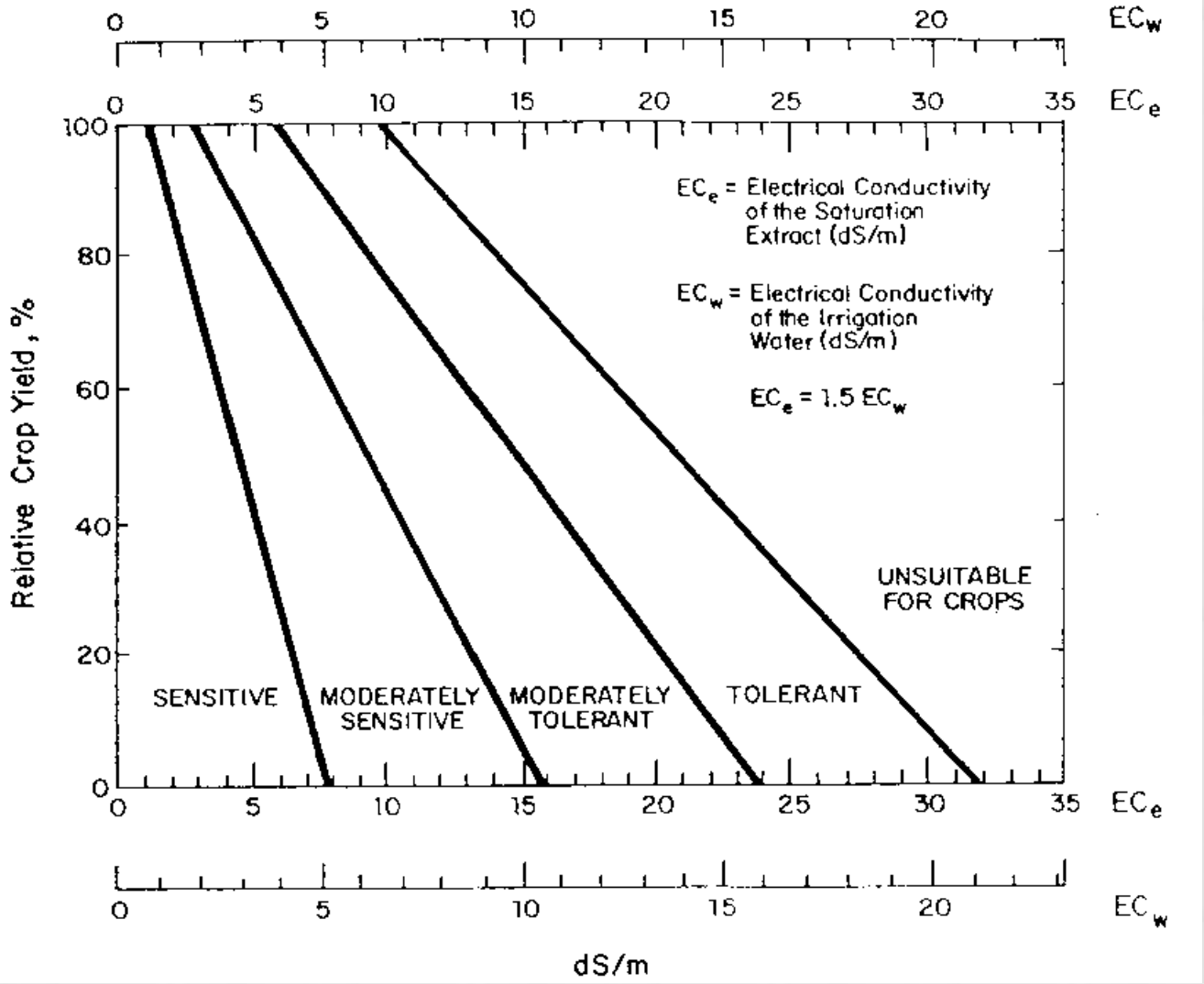
Physical changes to soil → Water infiltration problems

Crop Sensitivity to Salinity in Relation to Stage of Growth

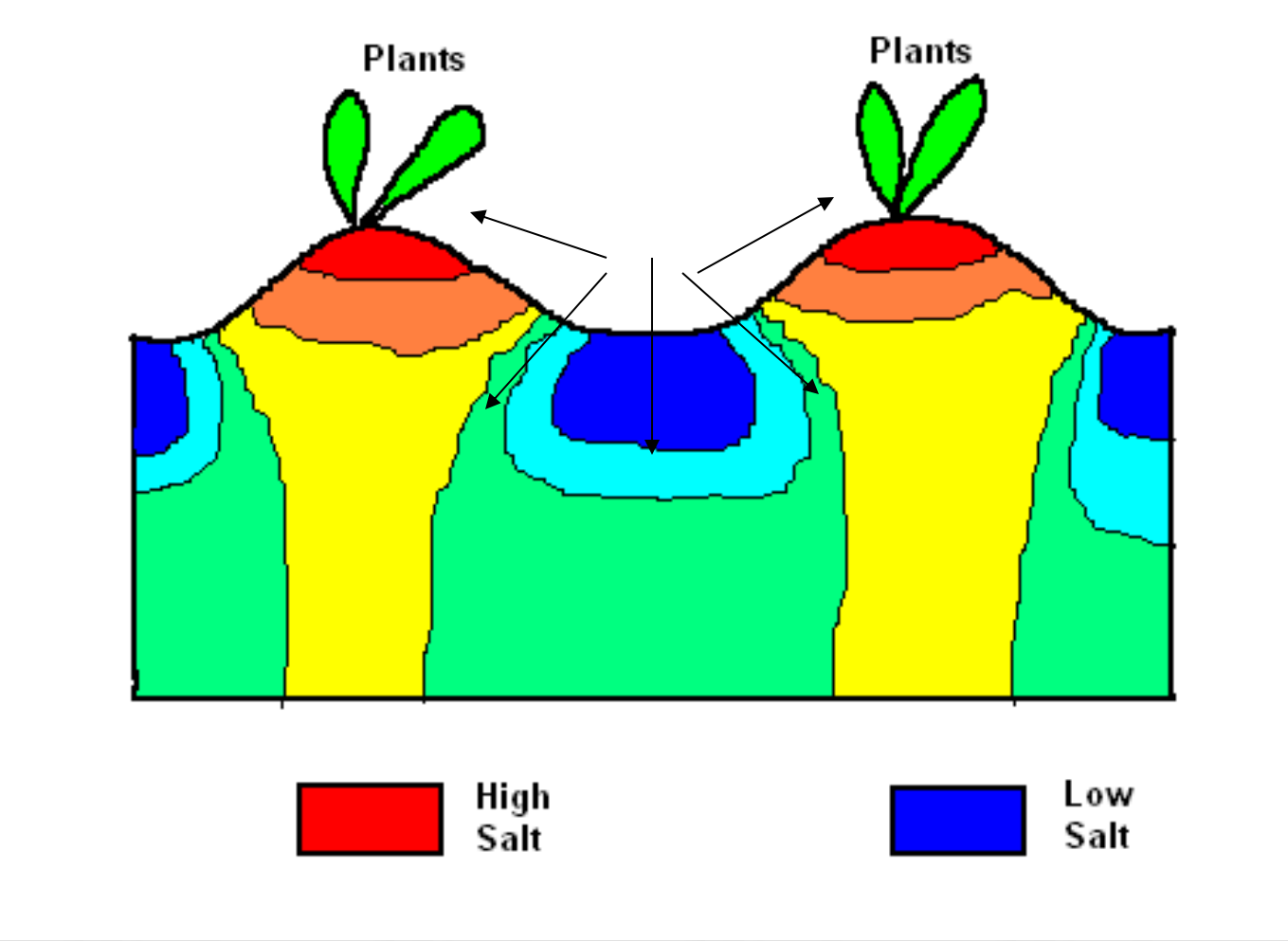


After Maas and Grattan, 1999

TOMATOES ARE MODERATELY SENSITIVE TO SALINITY

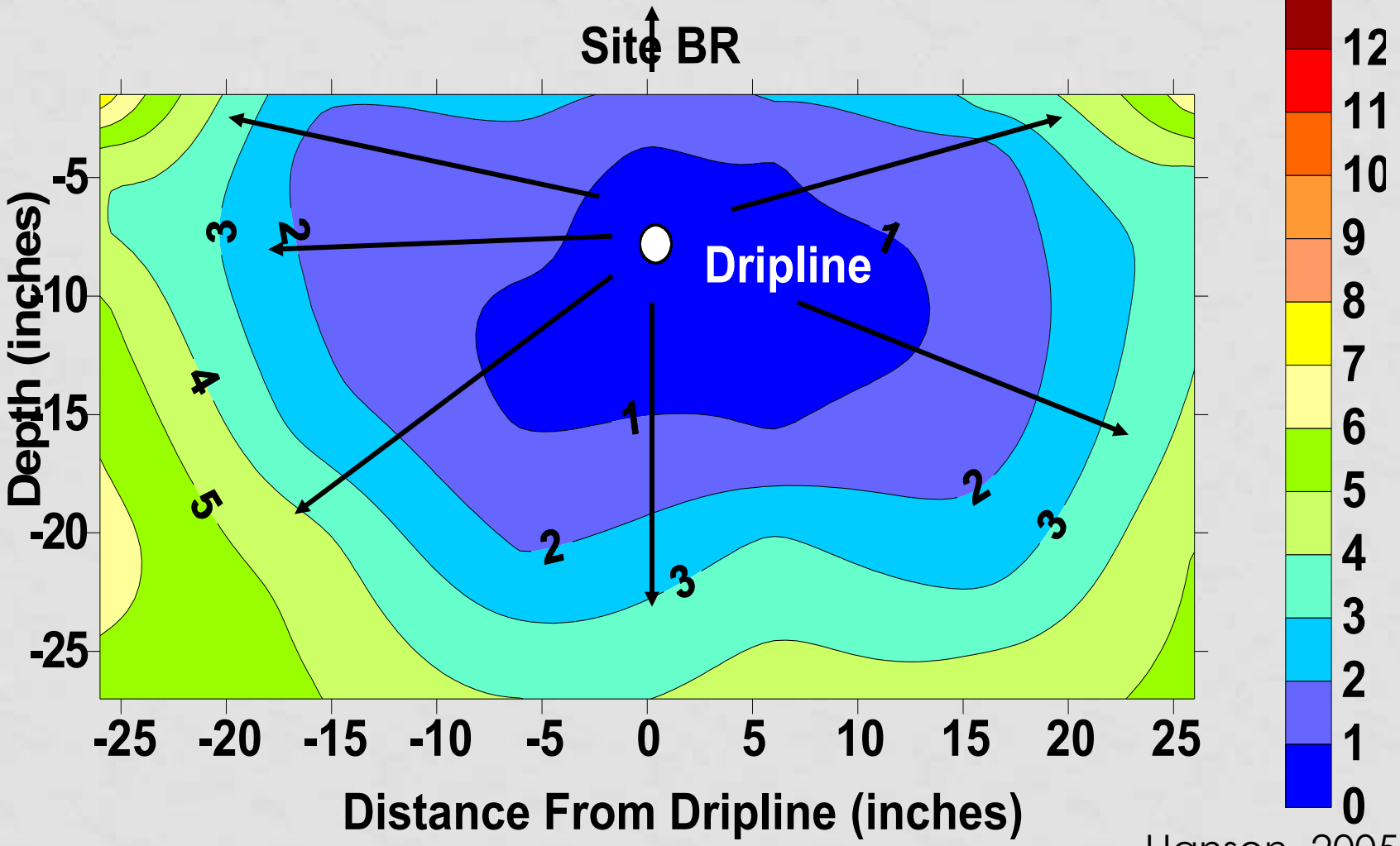


SALT PATTERN UNDER FURROW IRRIGATION



B. Hanson, 2005

SALT PATTERN UNDER DRIP IRRIGATION



Hanson, 2005

PROCEDURES

Two commercial field sites in the Delta region

- Furrow irrigated field
- Drip irrigated field (2014 was second year)
  - Grower's schedule
  - Full irrigation in the early season followed by a deficit irrigation strategy

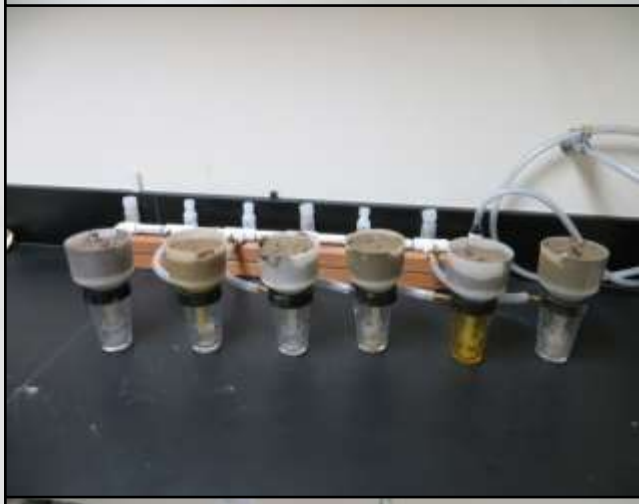
Both sites were transplanted with 60" bed configuration with single plant rows

- Both sites categorized as Egbert series
- Both irrigated with water sourced from the San Joaquin Middle River near Howard Road

PROCEDURES

Measurements:

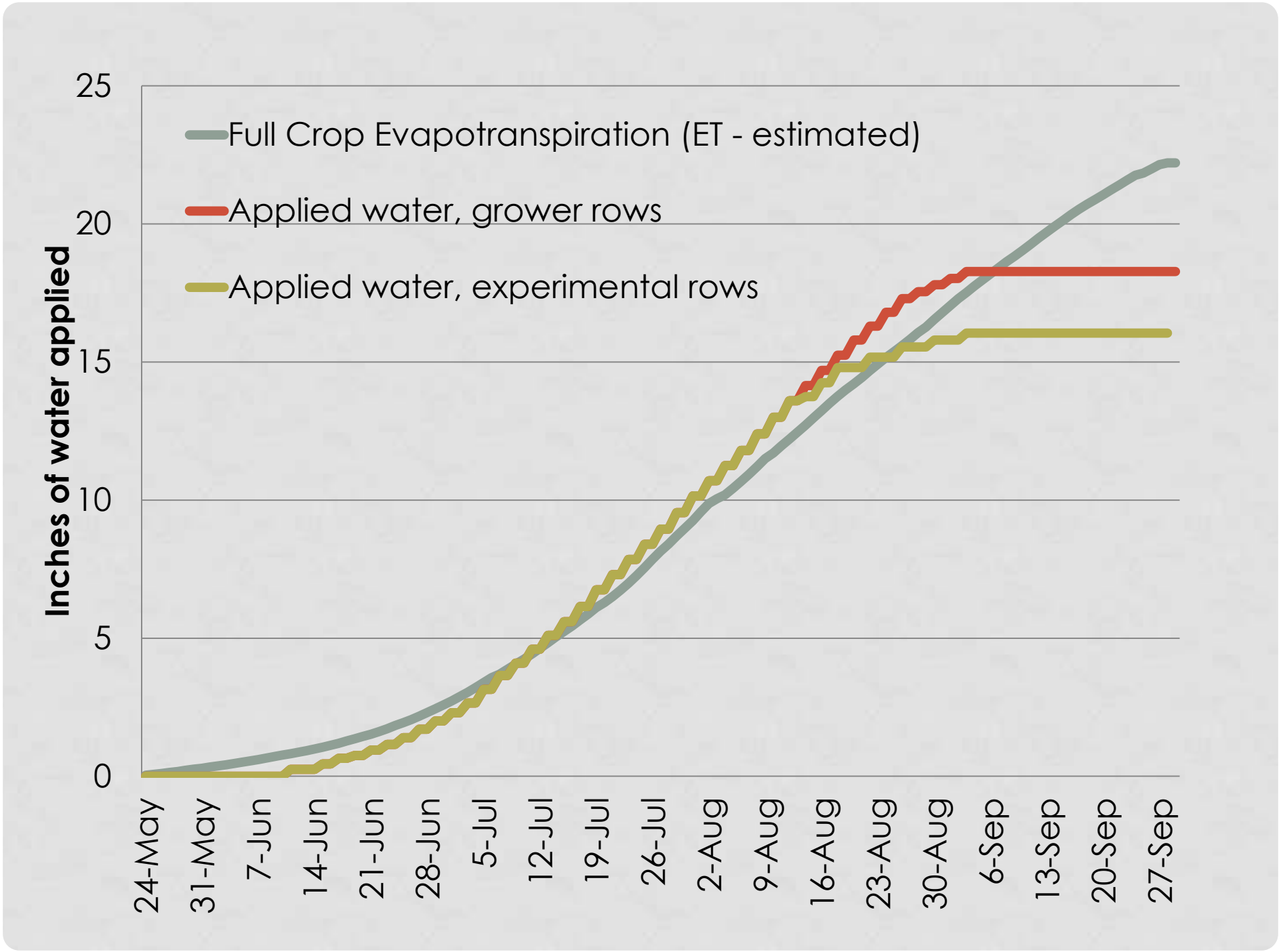
- Fruit yield and quality
- Applied water volumes (drip field)
- Groundwater salinity
- Depth to water table
- Irrigation water salinity
- Soil salinity



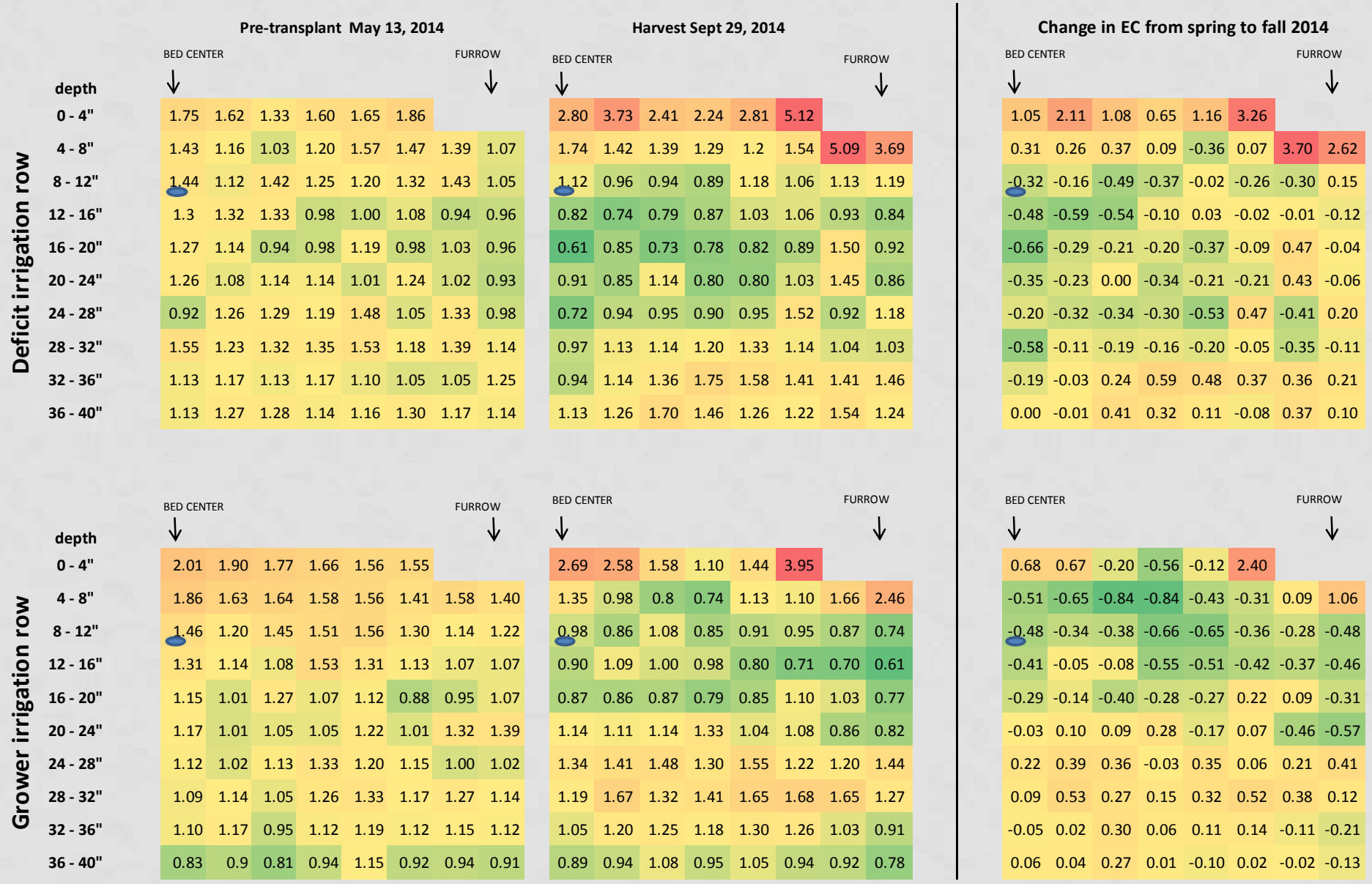
DRIP-IRRIGATED FIELD

- Soil sampled on May 13 after pre-irrigation
- Transplanted to UG 19406 on May 23
- Irrigation cutbacks initiated on Aug. 14, 7 weeks before harvest
- Soil sampled and harvested on Sept 29-30

- EC of irrigation water averaged 0.6 dS/m


Full Crop Evapotranspiration (ET - estimated)
Applied water, grower rows
Applied water, experimental rows
Inches of water applied
25
20
15
10
5
0
24-May
31-May
7-Jun
14-Jun
21-Jun
28-Jun
5-Jul
12-Jul
19-Jul
26-Jul
2-Aug
9-Aug
16-Aug
23-Aug
30-Aug
6-Sep
13-Sep
20-Sep
27-Sep

Drip field - Electrical Conductivity (dS/m)



FURROW FIELD

- Transplanted with H5608 on Apr 29
- Soil sampled on May 20
- Irrigated weekly using alternate furrows
- EC_w averaged 0.62
- Last irrigation July 30
- Soil sampled Aug 29
- Harvested Sept 2

Furrow field - Electrical Conductivity (dS/m)

Field bottom

3 wks after transplanting

depth	BED CENTER							FURROW
0 - 4"	3.87	2.10	0.97	0.73	0.72	0.95	1.10	1.55
4 - 8"	1.74	1.31	1.06	0.99	0.89	0.94	0.84	1.11
8 - 12"	1.28	1.40	1.40	1.11	1.03	1.02	1.18	1.22
12 - 16"	1.15	1.31	1.35	1.43	1.23	1.22	1.58	1.28
16 - 20"	1.52	1.49	1.48	1.50	1.34	1.48	1.46	1.43
20 - 24"	1.62	1.74	1.53	1.54	1.38	1.43	1.54	1.54
24 - 28"	1.75	1.67	1.48	1.52	1.43	1.43	1.68	1.72
28 - 32"	2.04	1.78	1.77	1.61	1.77	1.68	1.72	1.91
32 - 36"	1.93	1.96	1.98	1.72	1.80	1.81	1.80	2.25
36 - 40"	2.26	2.36	2.28	1.90	1.95	1.87	2.11	2.40

At harvest

BED CENTER							FURROW
3.95	3.50	1.63	1.54	1.53	1.16		
1.88	1.27	0.85	0.86	0.92	0.70	0.74	1.68
1.26	1.13	0.91	0.99	0.99	0.84	0.80	0.80
1.74	2.14	1.53	1.24	1.15	0.90	1.32	1.39
2.30	2.48	1.50	1.59	1.85	1.98	2.17	2.44
1.96	2.63	2.23	2.24	2.29	2.53	2.56	2.85
2.48	2.52	2.47	2.45	2.67	2.66	2.60	2.61
2.60	2.81	2.76	2.54	2.53	2.82	2.65	2.54
2.65	2.79	2.88	2.96	3.11	2.84	2.76	2.14
1.99	2.2	2.41	2.58	2.82	2.84	2.46	2.57

Changes in EC from spring to fall 2014

BED CENTER							FURROW
0.09	1.41	0.66	0.82	0.81	0.21		
0.14	-0.04	-0.21	-0.13	0.03	-0.24	-0.10	0.57
-0.02	-0.27	-0.49	-0.12	-0.04	-0.19	-0.38	-0.42
0.59	0.83	0.18	-0.20	-0.07	-0.32	-0.26	0.12
0.78	0.99	0.02	0.09	0.51	0.49	0.70	1.01
0.33	0.89	0.70	0.70	0.91	1.10	1.02	1.31
0.72	0.85	0.99	0.94	1.24	1.23	0.92	0.88
0.56	1.03	0.99	0.93	0.76	1.14	0.94	0.63
0.73	0.83	0.90	1.24	1.31	1.03	0.96	-0.11
-0.27	-0.18	0.13	0.69	0.87	0.97	0.35	0.17

Field top

3 wks after transplanting

depth	BED CENTER							FURROW
0 - 4"	2.94	1.43	0.91	0.90	1.20	1.19		
4 - 8"	1.12	0.91	0.9	0.83	0.85	0.73	0.72	0.58
8 - 12"	0.98	1.09	1.12	0.96	1.05	1.00	0.81	0.88
12 - 16"	1.11	1.13	0.98	0.90	1.12	1.18	0.93	0.85
16 - 20"	1.35	1.17	0.99	1.01	1.04	1.12	1.04	1.02
20 - 24"	1.15	1.14	1.06	1.09	1.15	1.11	1.20	1.10
24 - 28"	1.29	1.15	1.17	1.16	1.22	1.16	1.14	1.47
28 - 32"	1.24	1.24	1.21	1.20	1.22	1.27	1.17	1.19
32 - 36"	1.27	1.38	1.38	1.33	1.35	1.42	1.39	1.30
36 - 40"	1.40	1.33	1.32	1.33	1.34	1.23	1.41	1.50

At harvest

BED CENTER							FURROW
3.41	1.60	1.27	1.59	1.77	1.80		
0.94	0.91	0.71	0.88	0.50	0.52	1.24	
0.94	0.76	0.71	0.48	0.85	0.65	0.71	0.81
0.86	0.82	0.97	0.76	0.68	0.83	0.79	0.97
0.86	1.02	0.81	0.74	0.84	0.85	0.84	0.80
1.01	1.01	1.05	0.82	0.88	0.92	0.98	0.86
1.19	1.43	1.54	1.31	1.21	1.06	1.08	1.10
1.24	1.49	1.73	1.80	1.40	1.56	1.35	1.22
1.40	1.59	1.77	1.73	1.28	1.25	1.53	1.36
1.28	1.25	1.30	1.44	1.29	1.17	1.38	1.15

Changes in EC from spring to fall 2014

BED CENTER							FURROW
0.46	0.16	0.37	0.69	0.57	0.61		
-0.18	0.00	-0.19	0.05	-0.36	-0.21	0.51	
-0.04	-0.33	-0.41	-0.48	-0.20	-0.36	-0.10	-0.07
-0.26	-0.30	-0.01	-0.14	-0.44	-0.36	-0.14	0.13
-0.50	-0.15	-0.18	-0.27	-0.20	-0.28	-0.20	-0.21
-0.14	-0.13	-0.01	-0.27	-0.27	-0.19	-0.22	-0.24
-0.10	0.28	0.37	0.15	-0.01	-0.10	-0.06	-0.37
-0.01	0.25	0.52	0.60	0.18	0.29	0.17	0.03
0.13	0.20	0.39	0.40	-0.07	-0.17	0.15	0.07
-0.13	-0.08	-0.02	0.11	-0.05	-0.06	-0.03	-0.35

RESULTS

- Furrow field: Adequate leaching towards top of field, much poorer leaching towards field bottom
- Drip field: Even with drip irrigation application volumes lower than estimated crop ET, localized leaching occurred around the drip tape (top 20 to 32 inches depending on soil texture)
- Slightly greater irrigation cutbacks with drip system did affect salinity increases somewhat
- High variability of Delta soils apparent even over short distances within the study area; soil texture and organic matter greatly affect leaching ability

SALINITY MANAGEMENT

- Leach salts out of root zone
  - Align drip tape with plant row
  - If needed, apply in-season irrigation in excess of ET
  - Winter rainfall or irrigation
- More frequent in-season irrigations
  - Easier for plant to extract water
- Apply fertilizer modestly
- Amendments (gypsum, acids)

Salinity distribution in relation to various leaching fractions

ET

Same irrigation water ECw

Soil Depth

Low LF

High LF

40%

30%

20%

10%

ECe

Steve Grattan, UCD

RESOURCES

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Drip Irrigation Salinity Management for Row Crops

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In the past, California farmers have commonly used furrow and sprinkle irrigation to irrigate row crop plantings. More recently drip irrigation has come into increasing use in many other areas, including California's coastal valleys and the west side of the San Joaquin Valley. Growers in some of these areas encounter high soil salinity caused either by irrigation with saline water (in the coastal valleys) or upward flow of saline ground water (in many

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