Soil Salinity as a Major Challenge for Sustainable Agriculture in the Low Desert of California

Ali Montazar
Irrigation and Water Management Advisor
University of California ANR

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California Low Desert Region

- Colorado River as main source of ag. Water
- 3-inch annual rain
- Dominated by heavy soils / low organic matter
- Diverse cropping systems/irrigation practices

Imperial - Palo Verde - Coachella Valleys

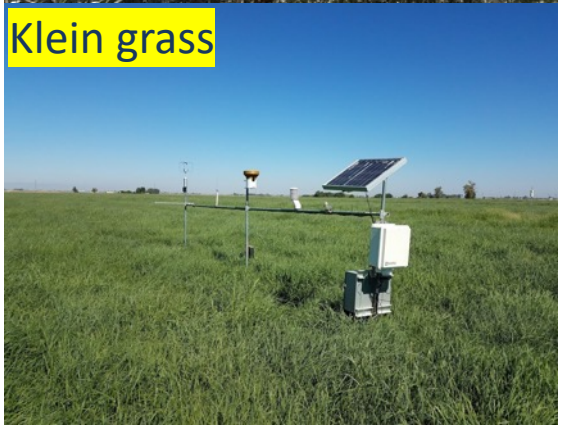
- ≈ 680,000 acres
- ≈ $ 4.1 billion Ag.

Where does this data come from?

Water conservation/irrigation studies over the last 5-year

- 78 commercial fields in the low desert of CA
- 12 various commodities including alfalfa, onions, carrots, lettuce, spinach, date palm, olives, lemon, sugarbeets, wheat, kleingrass, and sunflowers
- Various soil types and conditions
- Various irrigation practices (flood, furrow, solid-set sprinkler, drip, subsurface drip, linear-move sprinkler)

Monitoring stations in experimental fields



Plant, soil, and water use/crop water consumptive data



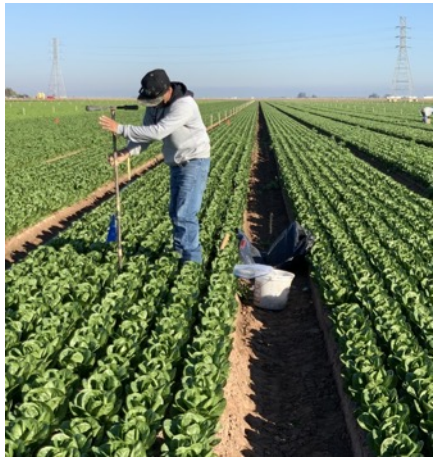






Research staff


Geonics EM-38




Salinity survey

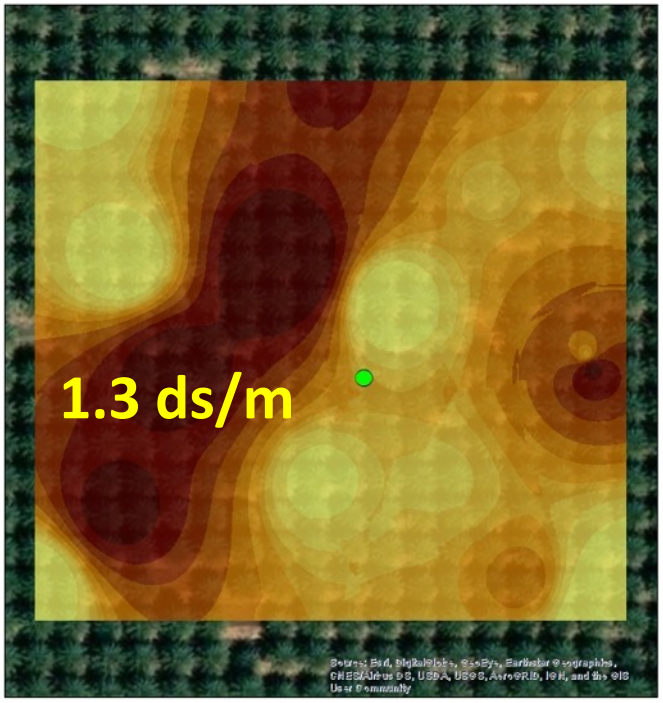
Salinity survey – Summer 2021





Soil salinity map in date palms

Coachella



ECe dS/m

0.64 - 1.09	1.26 - 1.3
1.1 - 1.15	1.31 - 1.38
1.16 - 1.18	1.39 - 1.45
1.19 - 1.2	1.46 - 1.56
1.21 - 1.25	1.57 - 2.04

Monitoring Station

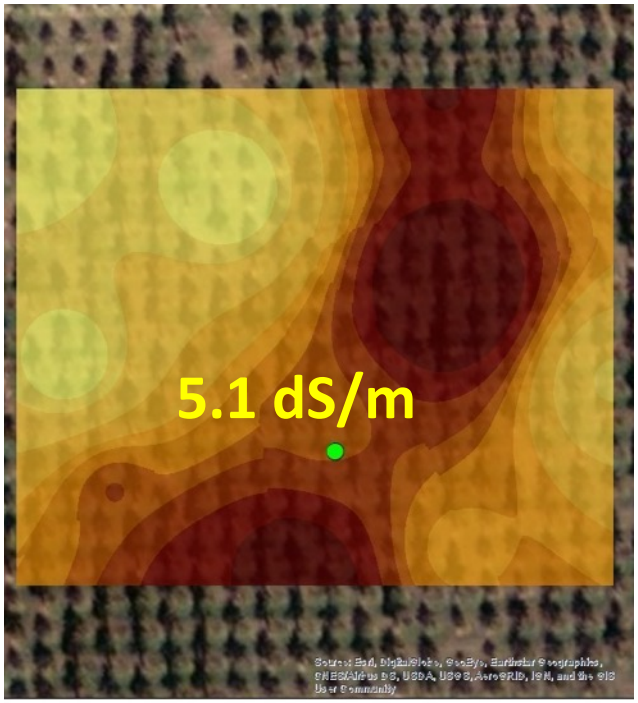
1-2 ft. depth

N

0 10 20 40 60 80 Meters

EC_e= 0.64 – 2.04 dS/m

Winterhaven



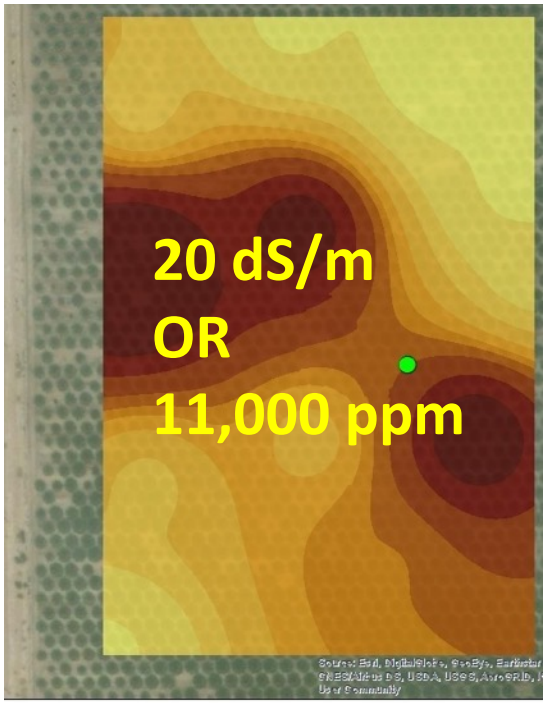
ECe dS/m

0.77 - 1.87	4.33 - 4.61
1.88 - 2.36	4.62 - 4.8
2.37 - 3.38	4.81 - 5.15
3.39 - 4.05	5.16 - 5.63
4.06 - 4.32	5.64 - 7.62

Monitoring Station

0.77 – 7.62 dS/m

Westmorland



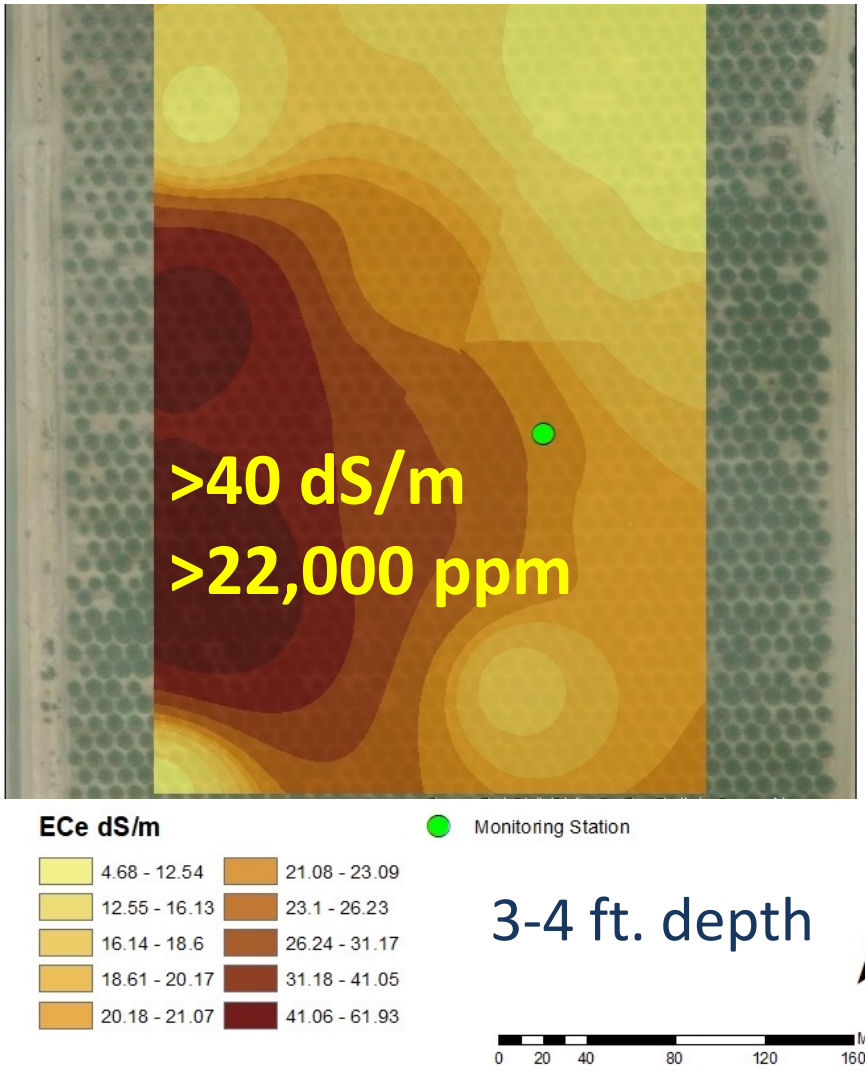
ECe dS/m

6.51 - 11.92	19.09 - 19.79
11.93 - 15.3	19.8 - 20.82
15.31 - 16.63	20.83 - 22.66
16.64 - 18.06	22.67 - 24.8
18.07 - 19.08	24.81 - 32.57

Monitoring Station

6.51 - 32.57 dS/m

[Surveyed in May 2019]

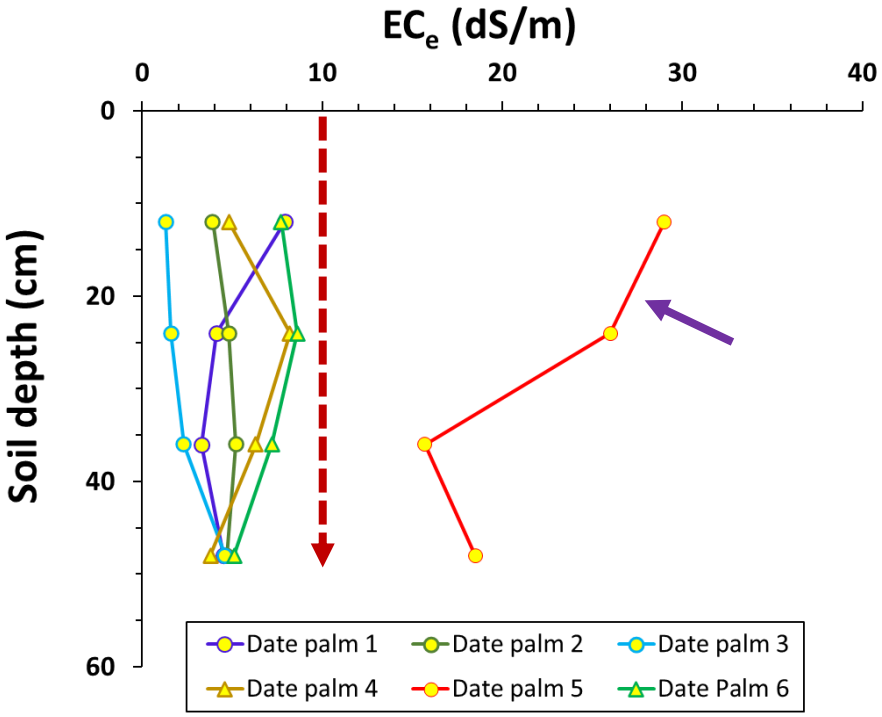


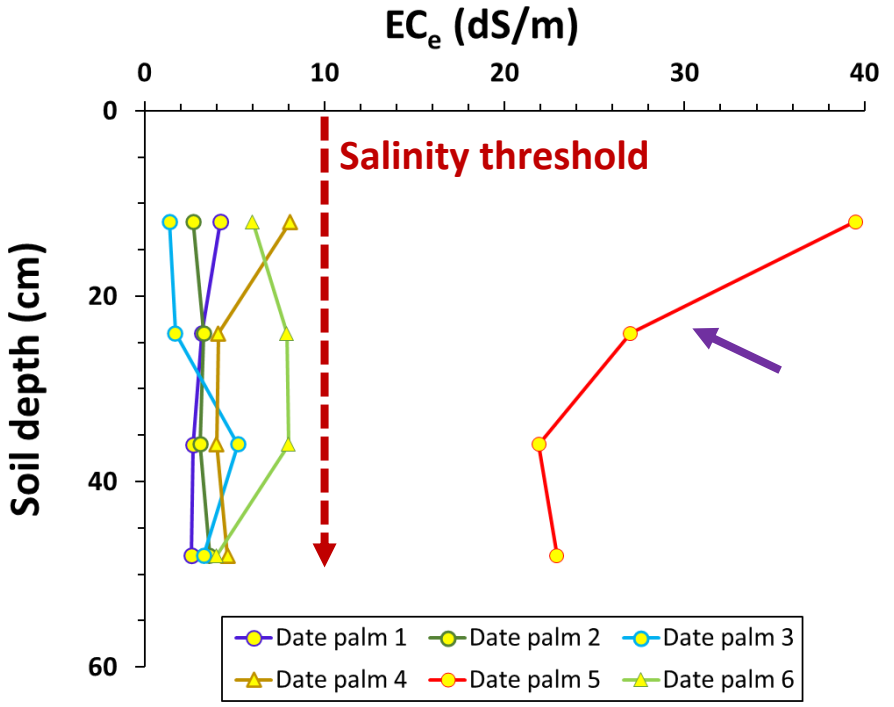
Soil salinity map (date palm located in Westmorland)

ECe varies from 4.6 to 61.9 dS/m

Drainage issue?

Soil salinity within the soil profile (six date palms)





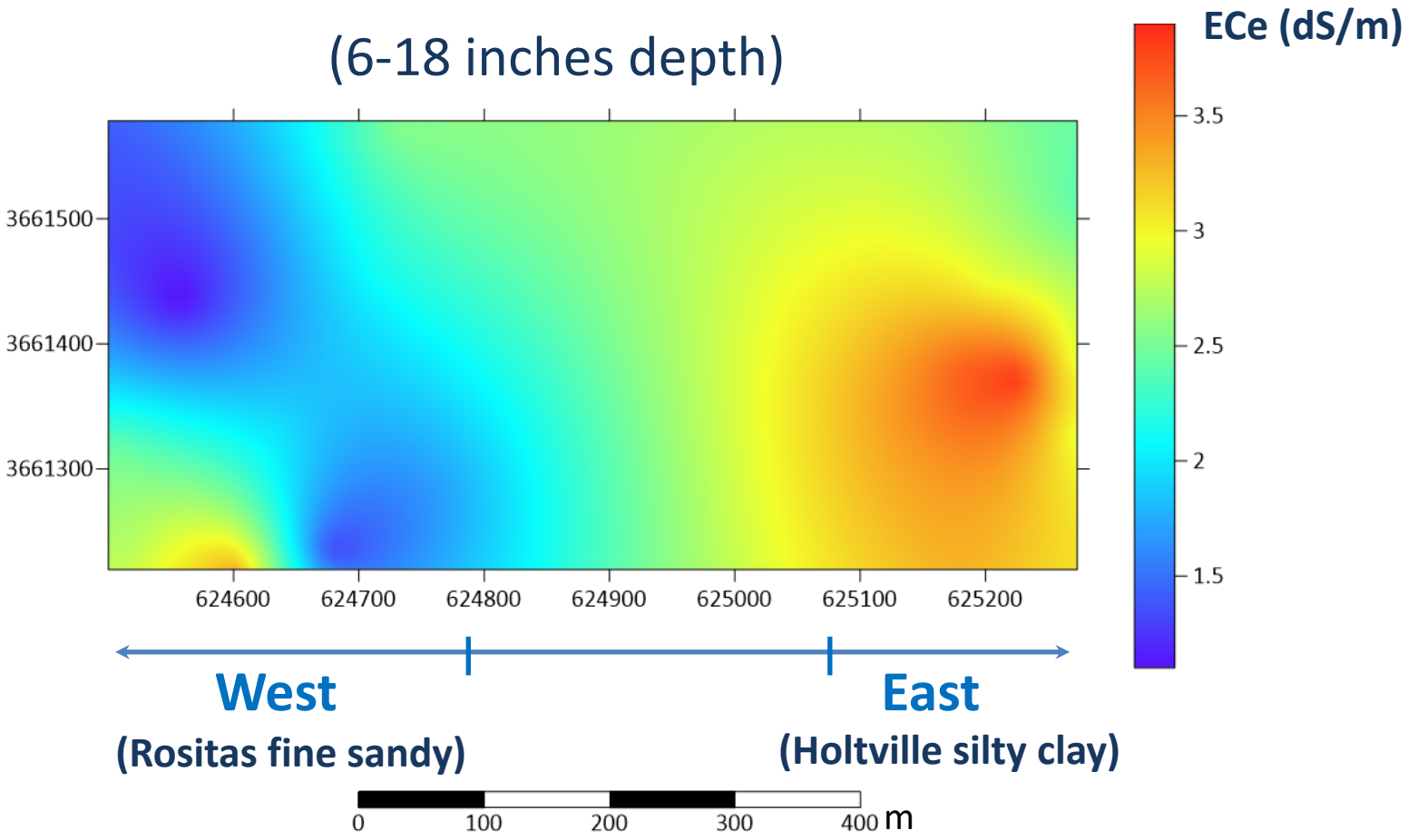
October, 2019

October, 2020

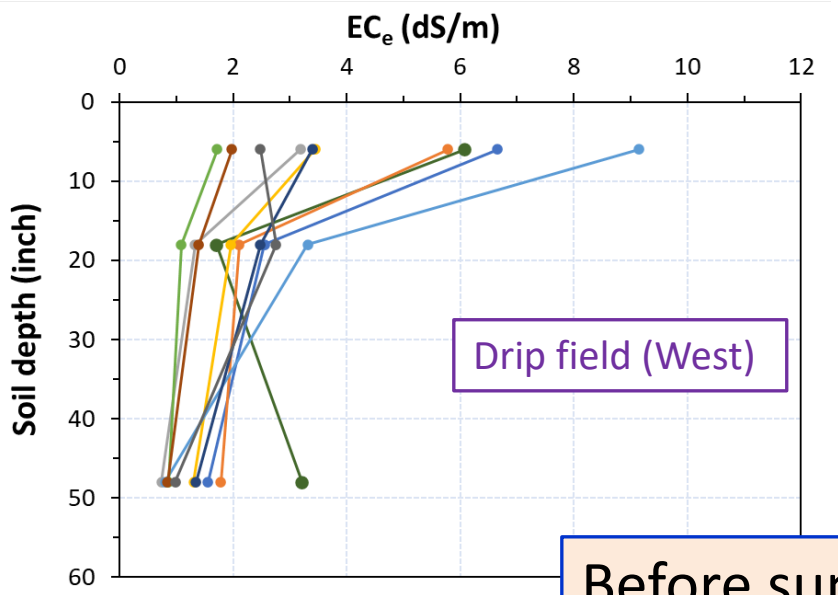
Date palm 5 located in Westmorland. This date palm has sodium hazard as well (SAR: 20-80)

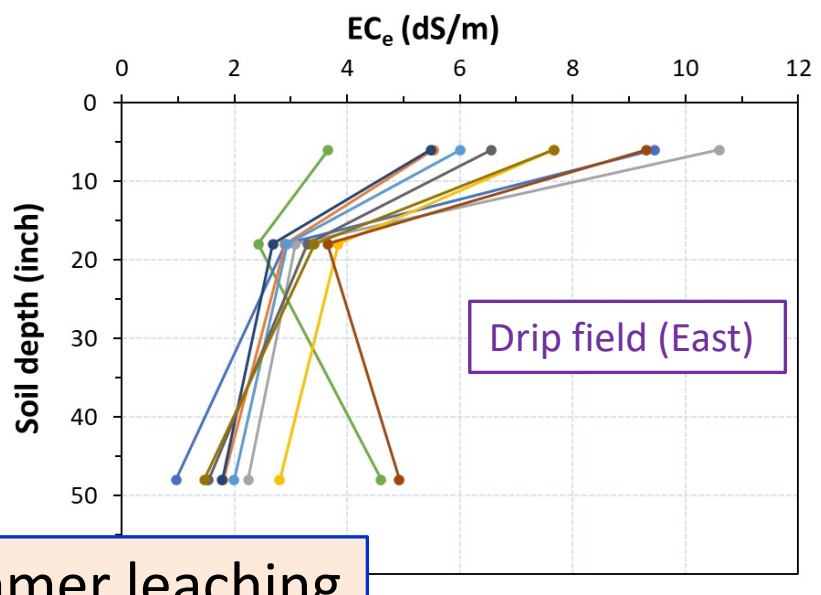
Salinity map
(drip irrigated field-1 – June 2021)

(6-18 inches depth)



Soil salinity within the soil profile (drip irrigated field-1)



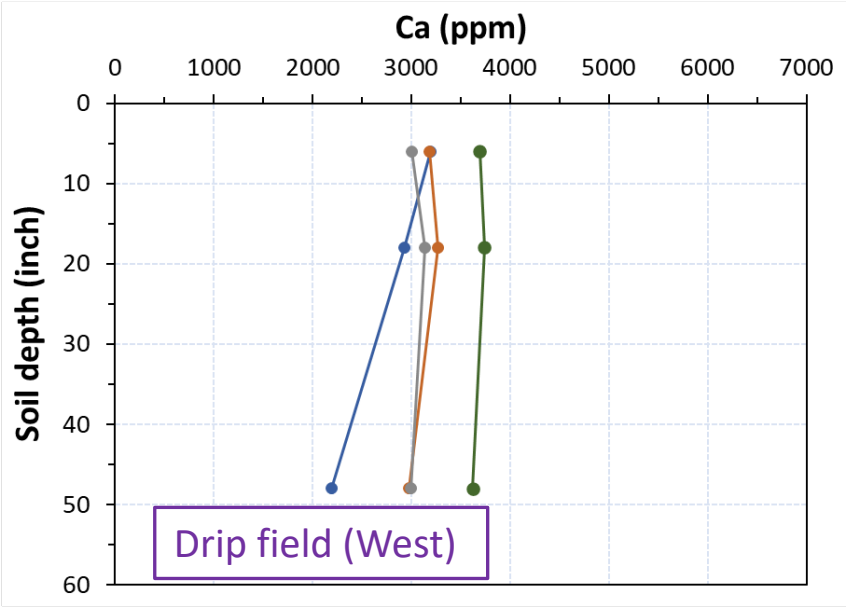


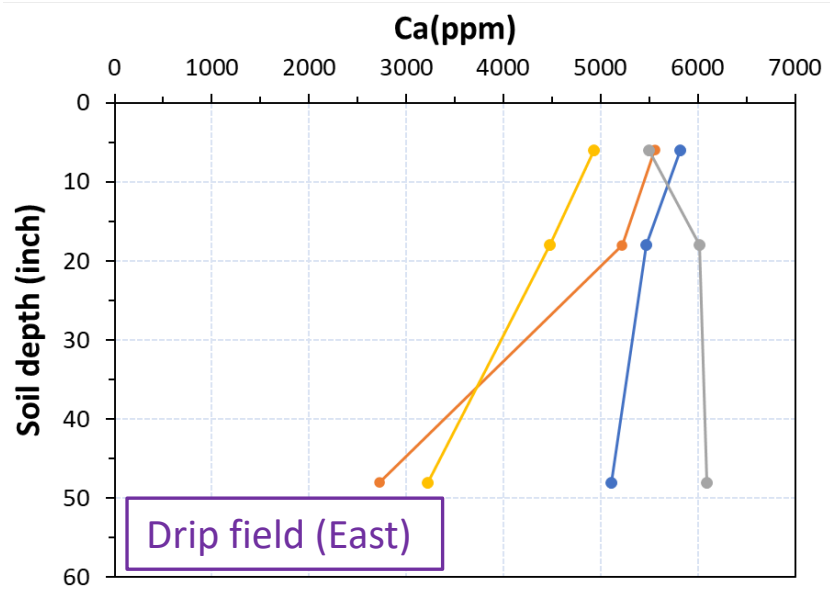
Before summer leaching

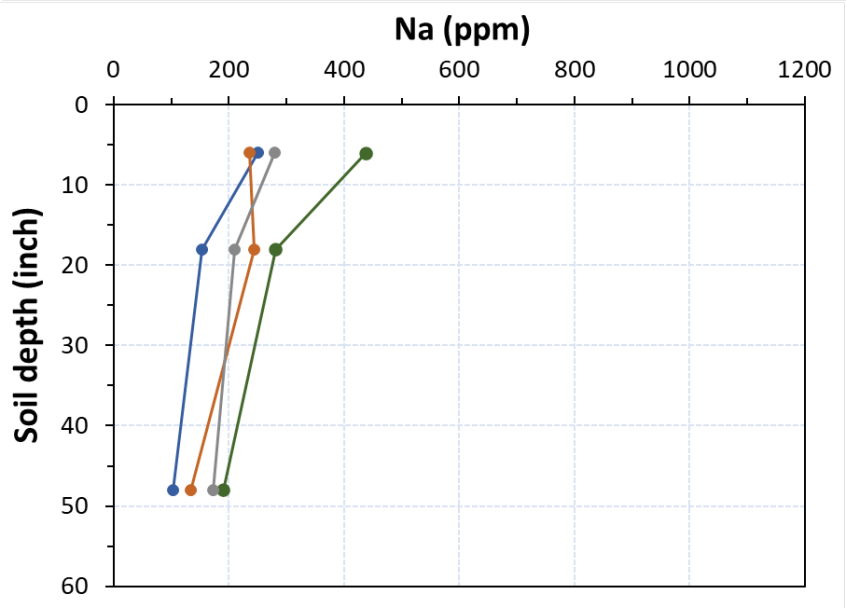
- Higher level of salinity on the east side of the field
- High soil salinity on the topsoil
- Drain tiles work effectively

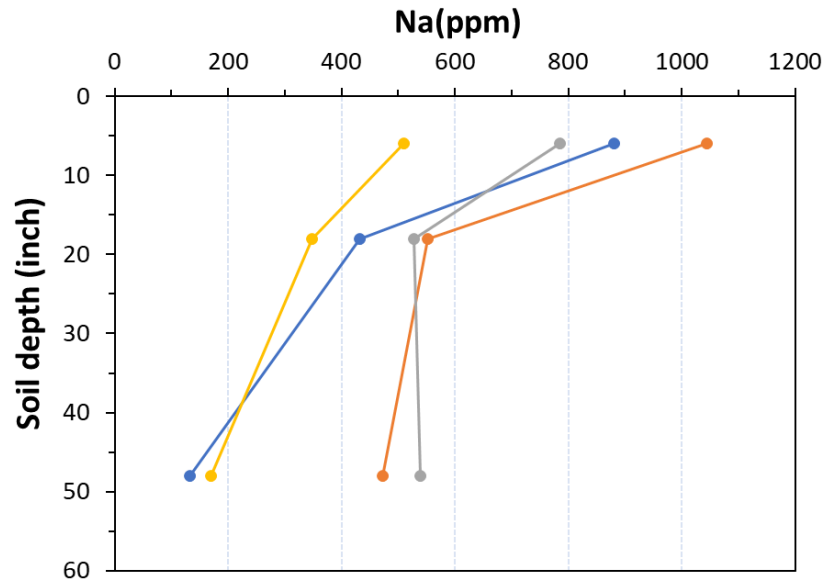
Grower applied 90 lbs./ac Gypsum before planting.

Soil Calcium and Sodium levels (drip field-1)

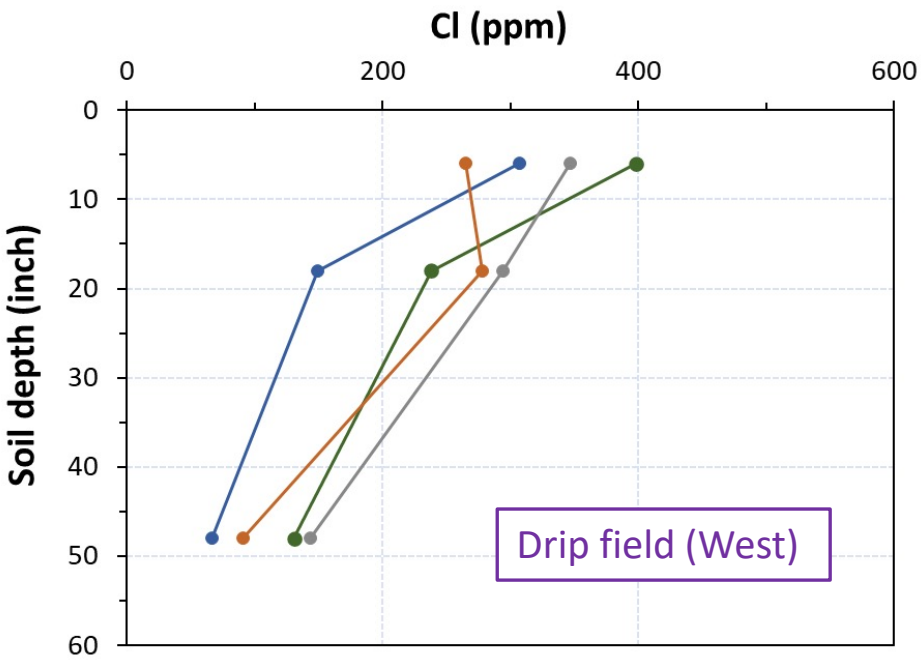


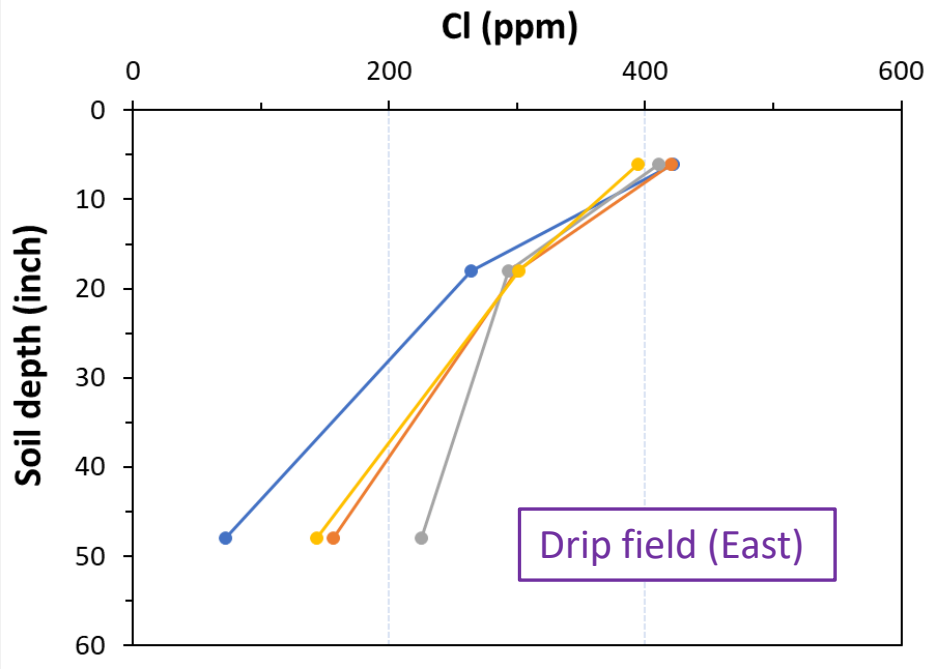




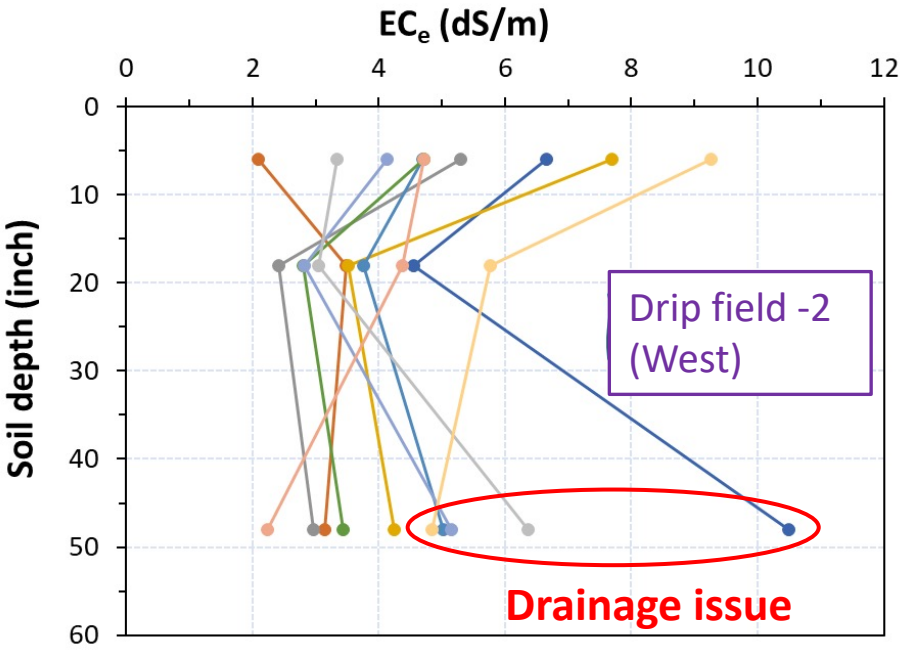


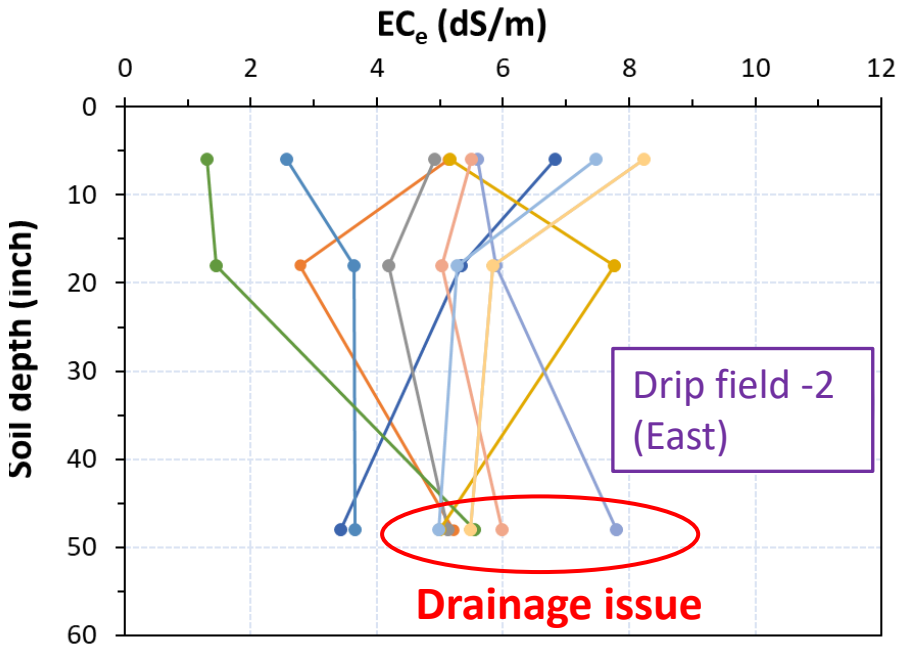
Soil Chloride levels (drip field-1)





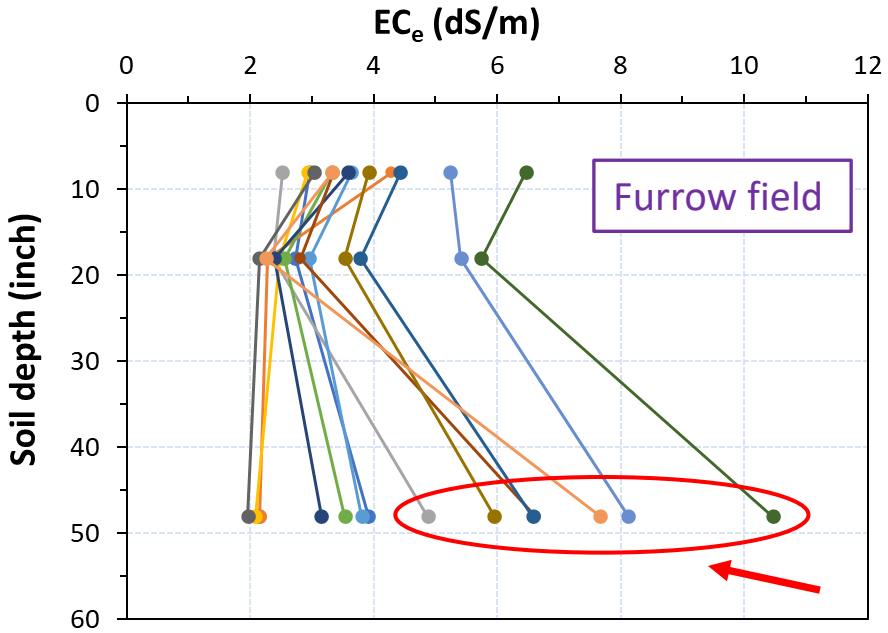
Soil salinity within the soil profile (drip irrigated field-2)



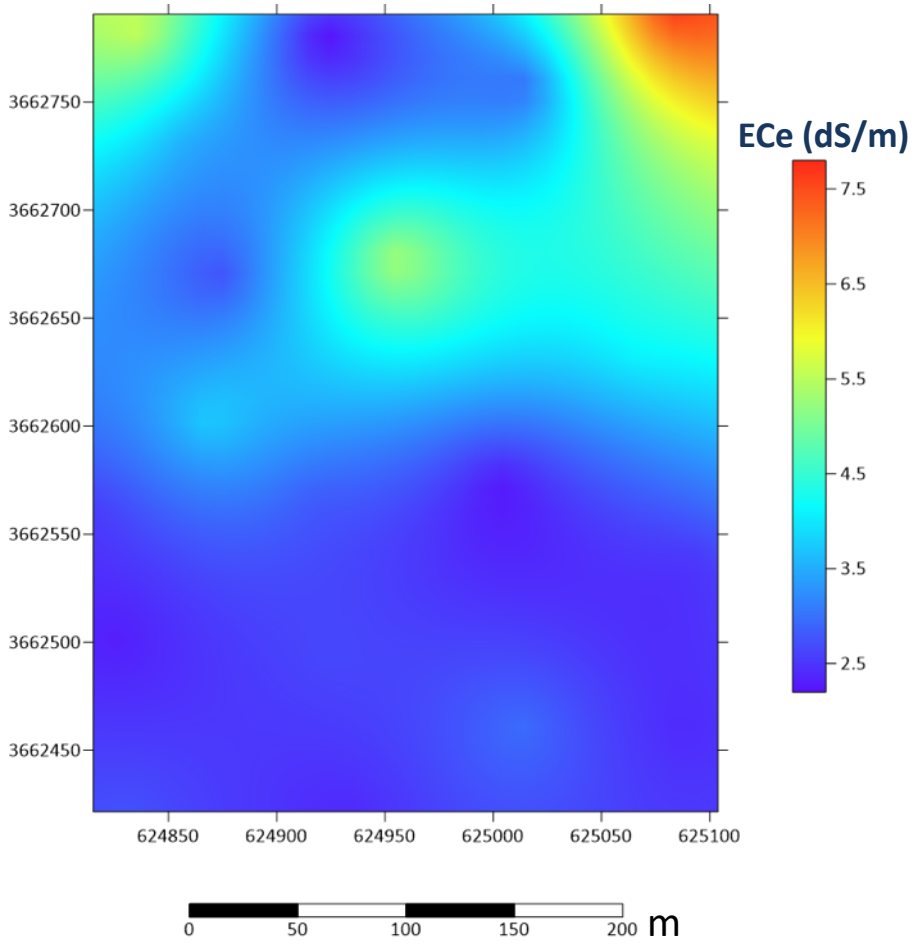


Some tile drains could work effectively, some couldn't .

Salinity assessment (furrow irrigated field)

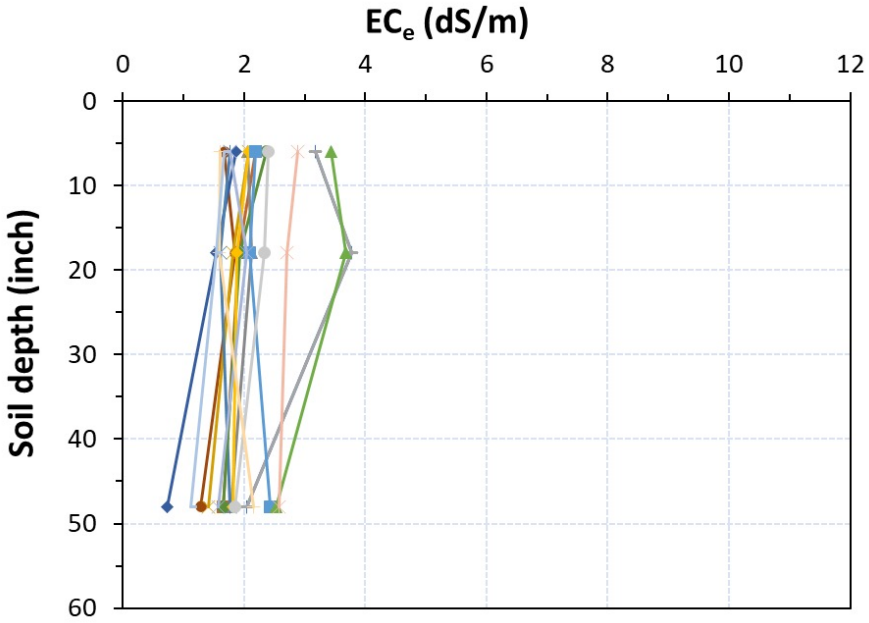


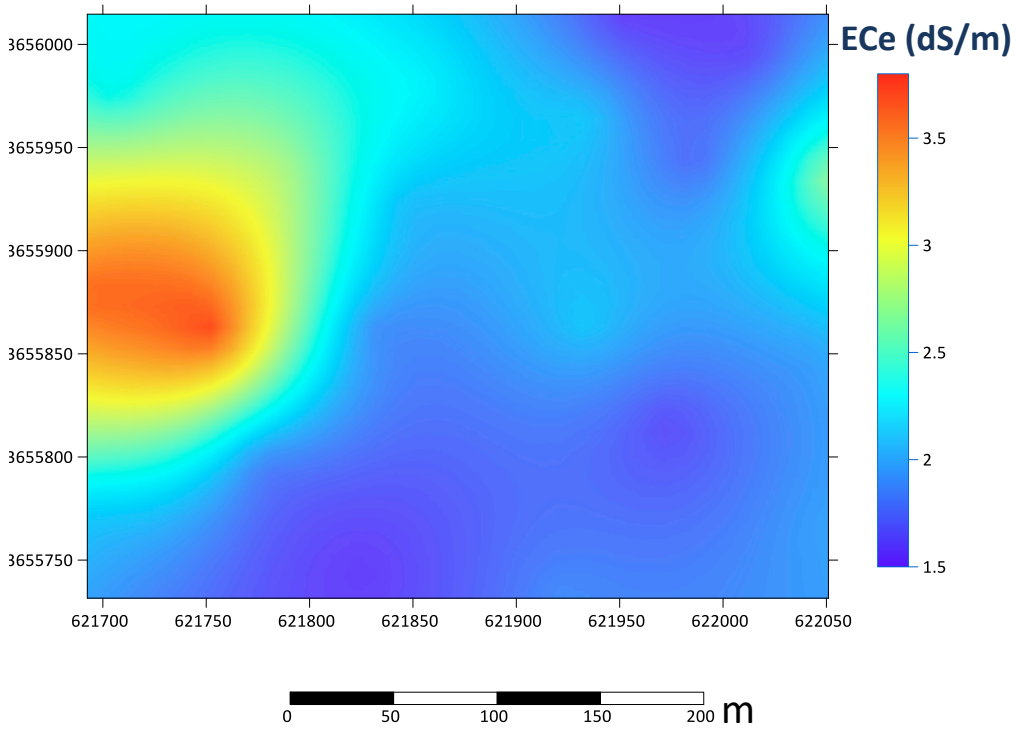
- A salt-affected field
- Drainage issue?



(6-18 inches depth)
Meloland and Holtville Loam

Salinity assessment (sprinkler irrigated field)





- Uniformity in salinity level
- No salinity and drainage issues

(6-18 inches depth)

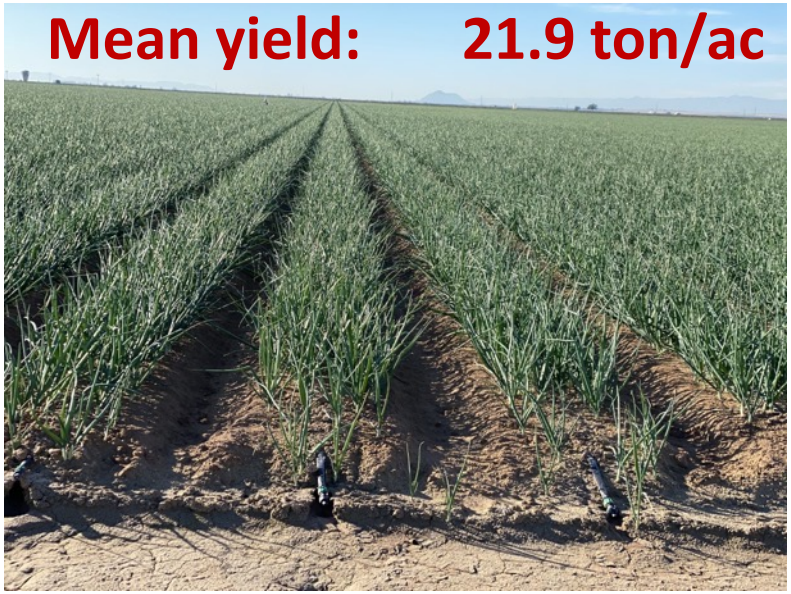
Vint and Indio very fine sandy

"**Land productivity** is highly depending on the effectiveness of salinity management."

Salinity reduces actual crop water use and yields.

Drip irrigated onion field (February 7, 2021)

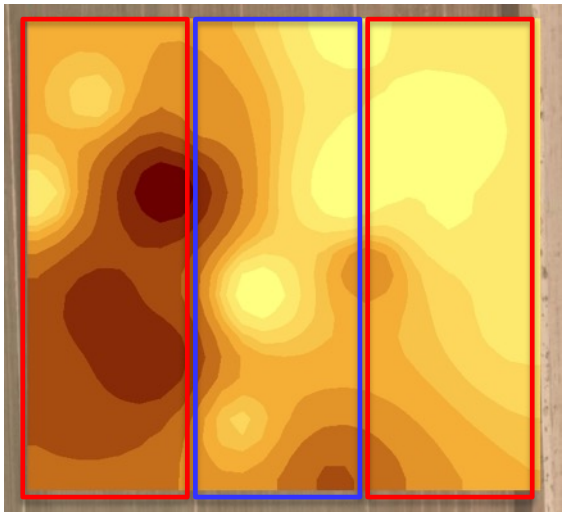
Mean yield: 21.9 ton/ac **vs.** **17.7 ton/acre**



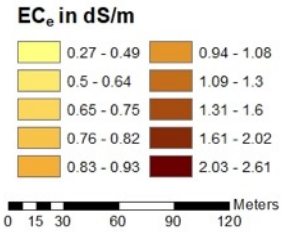
Soil salinity map in alfalfa fields

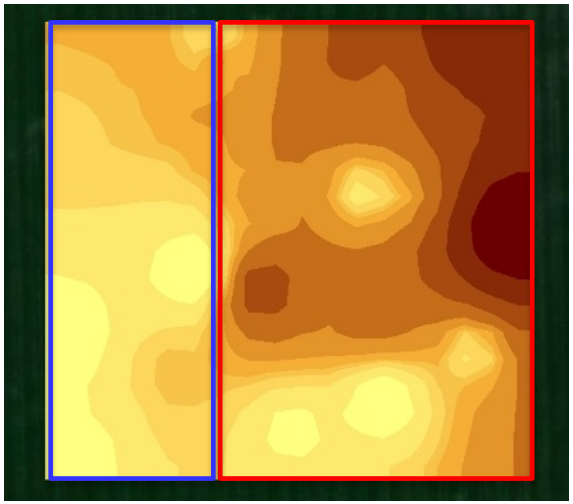
(1 - 2 feet depth)

October 2020

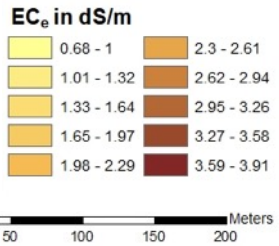


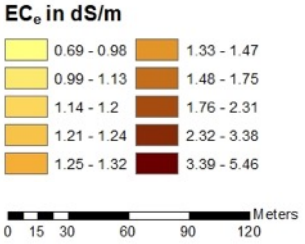
Field 3 (flat)

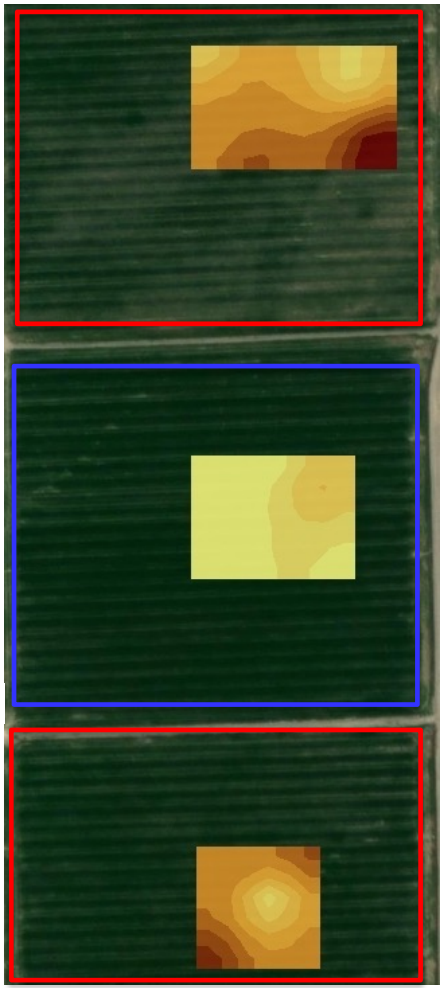




Field 2 (furrow)





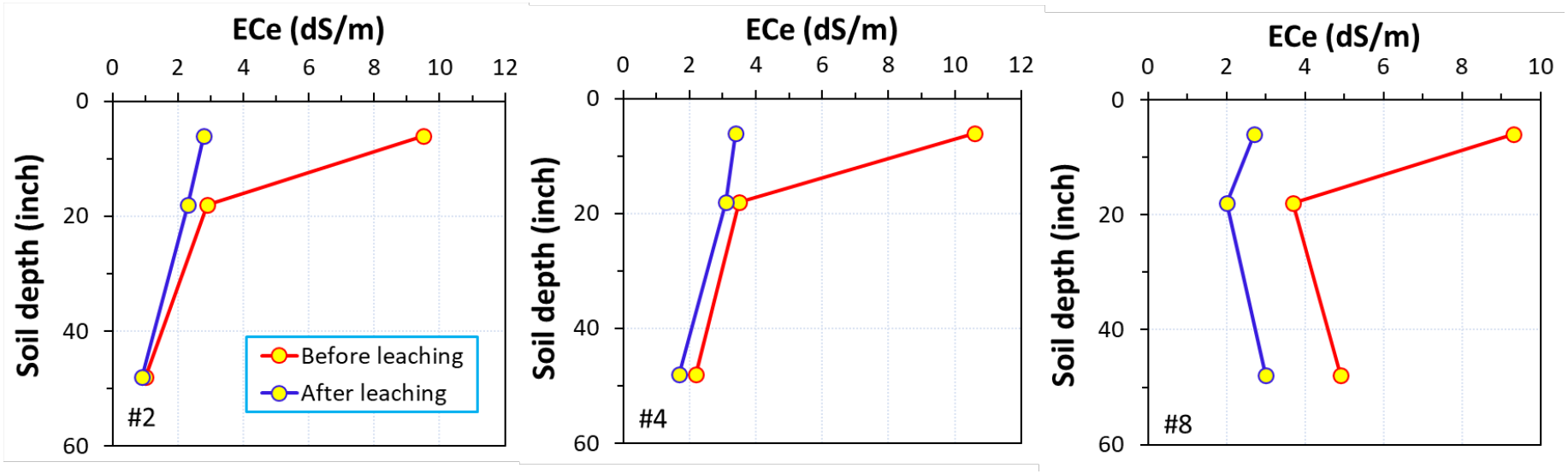


Field 1 (furrow)

Red plots: deficit

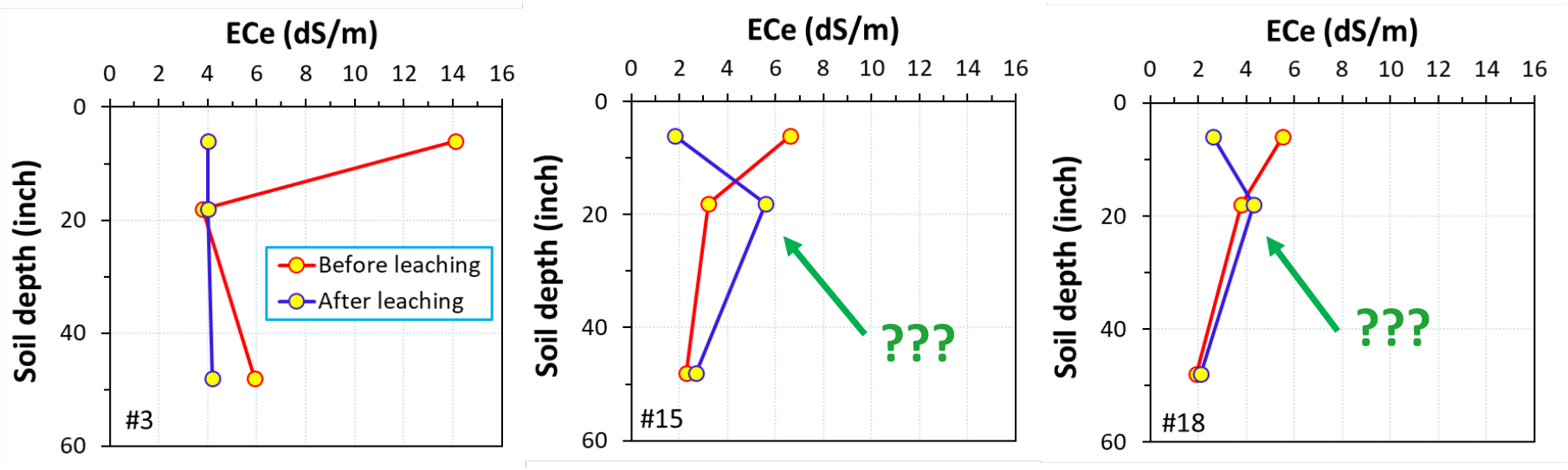
Blue plots: grower practice

Soil salinity before and after leaching



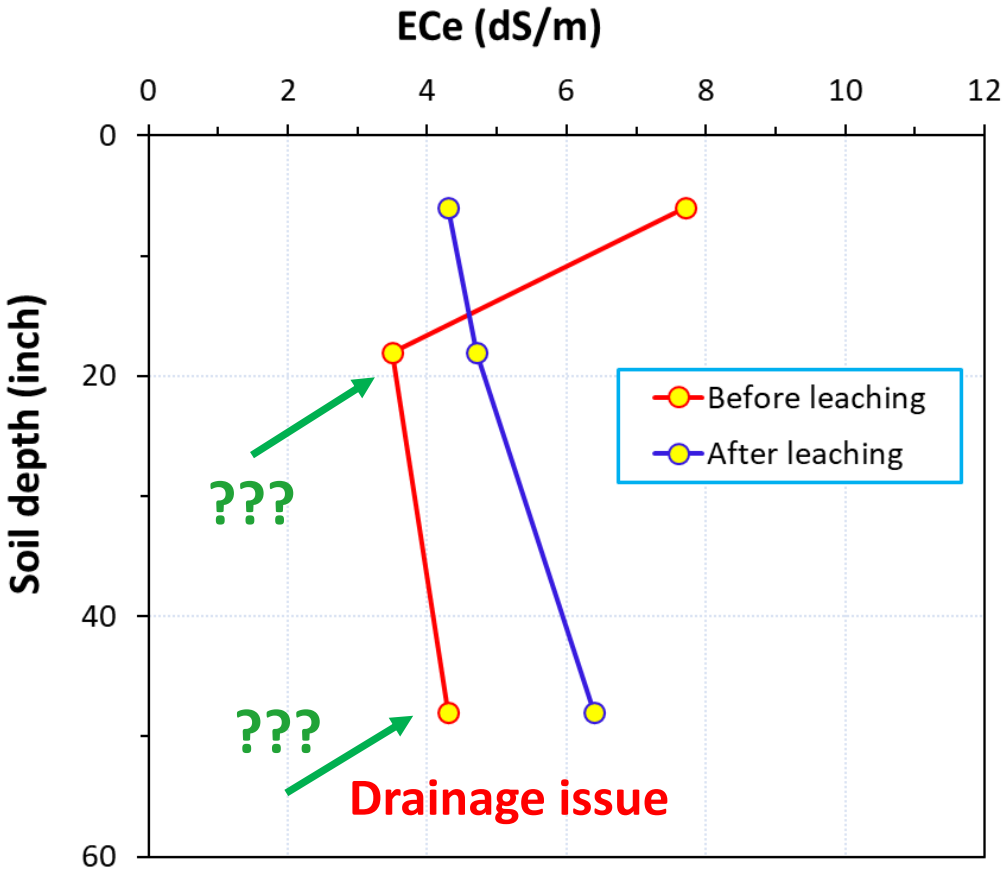
- This field was leached using flood irrigation during September 2021.
- Leaching was effective and the salts were drained from the soil profile.

Soil salinity before and after leaching



- This field was leached using sprinklers during September (data demonstrates salinity on SEP 24, 2021).
- Leaching was effective, but NOT completed.

Drip irrigated field with drainage issue



Drian tiles at 4-5 ft depth

Leaching (flood) won't be effective to sustain land productivity if drainage system doesn't work properly.

Sub-surface drainage (tile) system delivers water to surface drainage system. All the drainage water (Imperial and Coachella Valleys) ends up in the Salton Sea.

Objects found inside tile drains in commercial fields (Imperial Valley)

Importance of maintaining drainage system!

Key Takeaways

- **L**eaching is the most effective tool to maintain salinity

  (the optimal strategy depends on irrigation practice, soil types, and cropping systems. Research Needs!)

- **E**ffective drainage system is a MUST to sustain land productivity over time (Drainage issues! More Efforts!)

- **M**ore salinity hazard than sodium hazard in the desert

  (high levels of Calcium, Sodium, Magnesium, Chloride)

- **G**ypsum is appropriate amendment for fields with sodium hazards NOT necessarily for salt-affected fields

  (**S**ulfur-based amendments???)

Thank You (Q & A)

Special thanks to:

- Cooperative farms
- USDA-NRCS, CDFA, CA Commodity Boards & Imperial County Agricultural Benefits Program
- UC academics/staff, USDA Salinity Lab, and students