Sustainable Use of Brackish Water and Concentrate for Agriculture in Arid Areas

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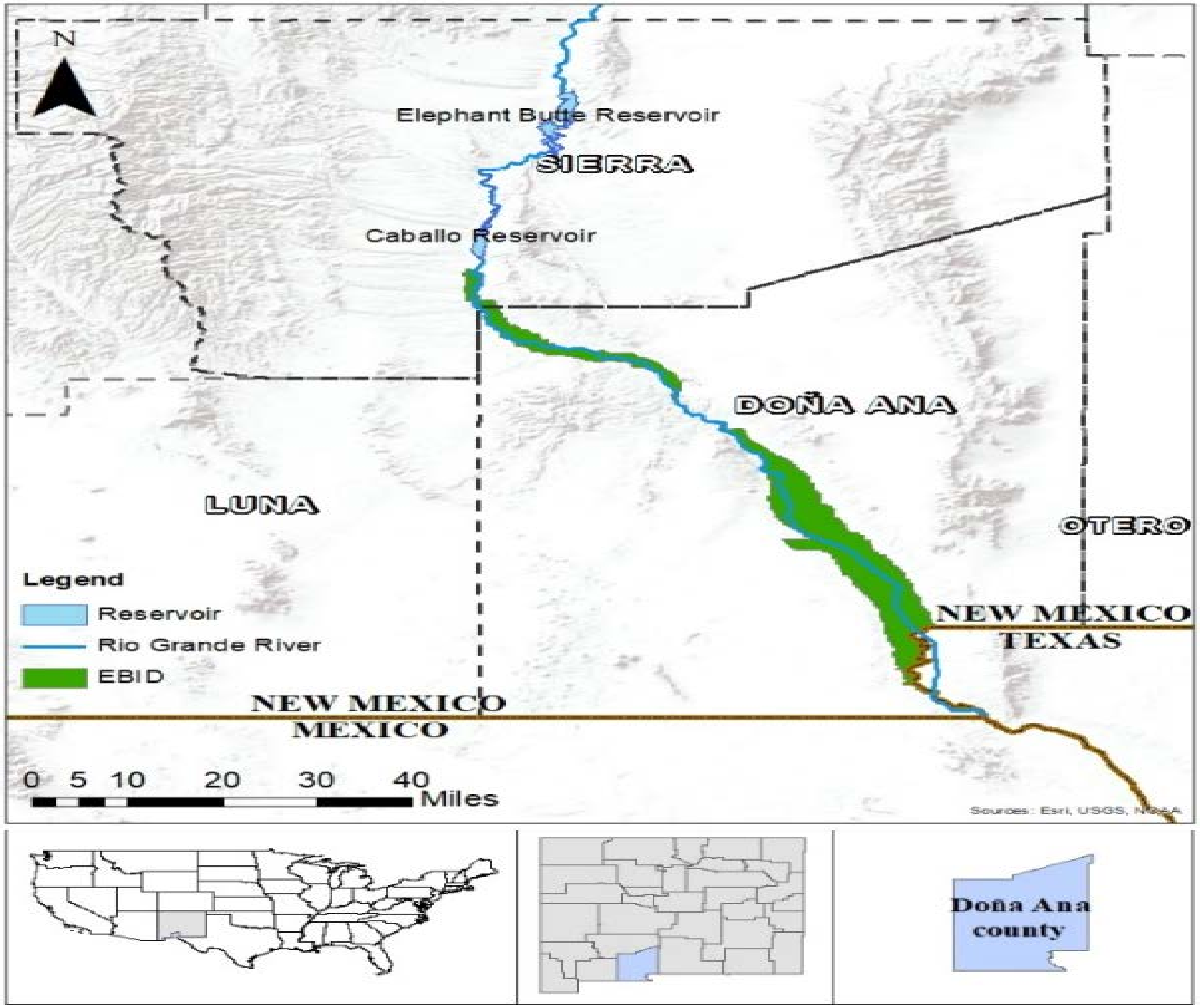


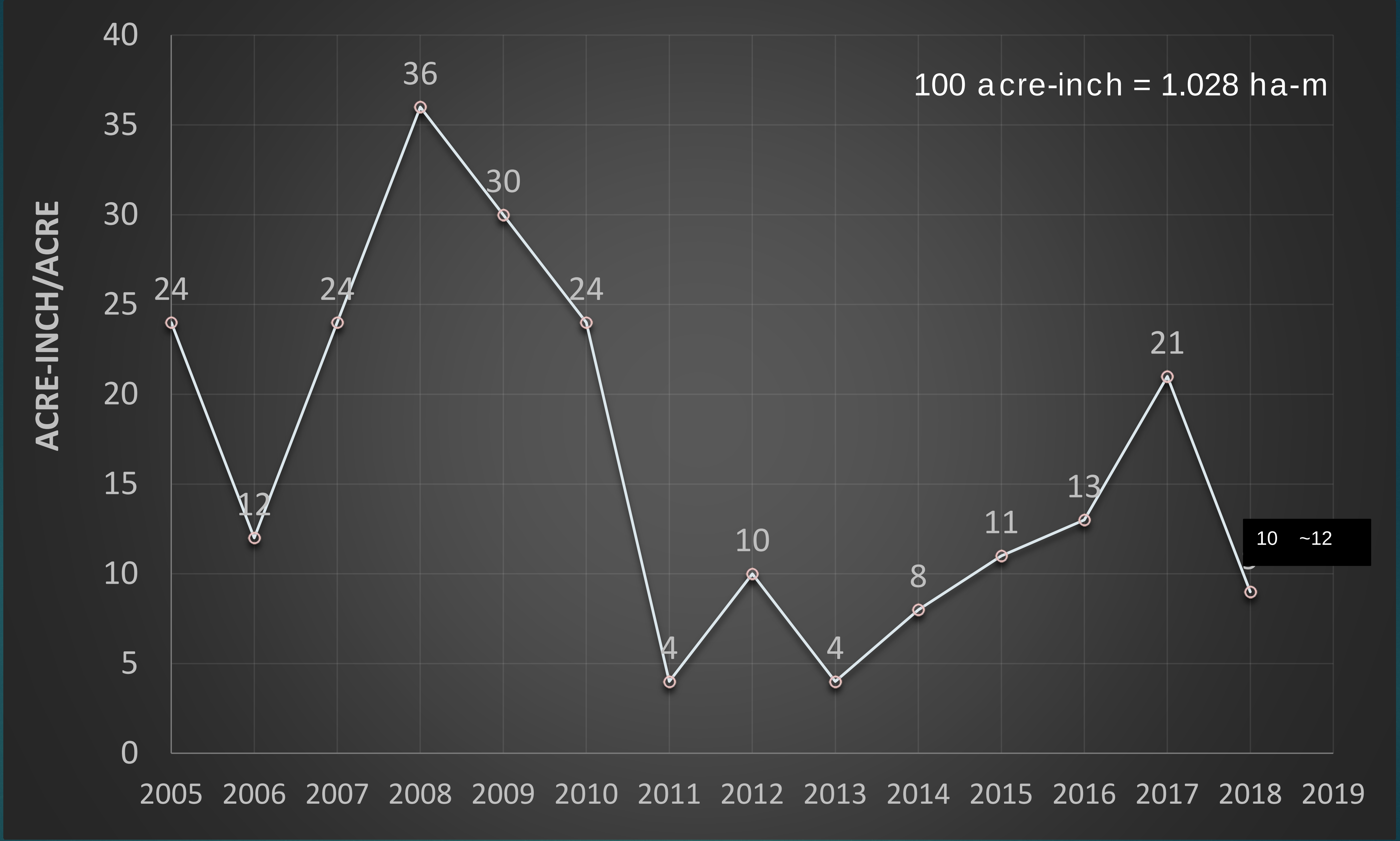
Elephant Butte Irrigation District (EBID)

Elephant Butt Reservoir
T OR C, New Mexico

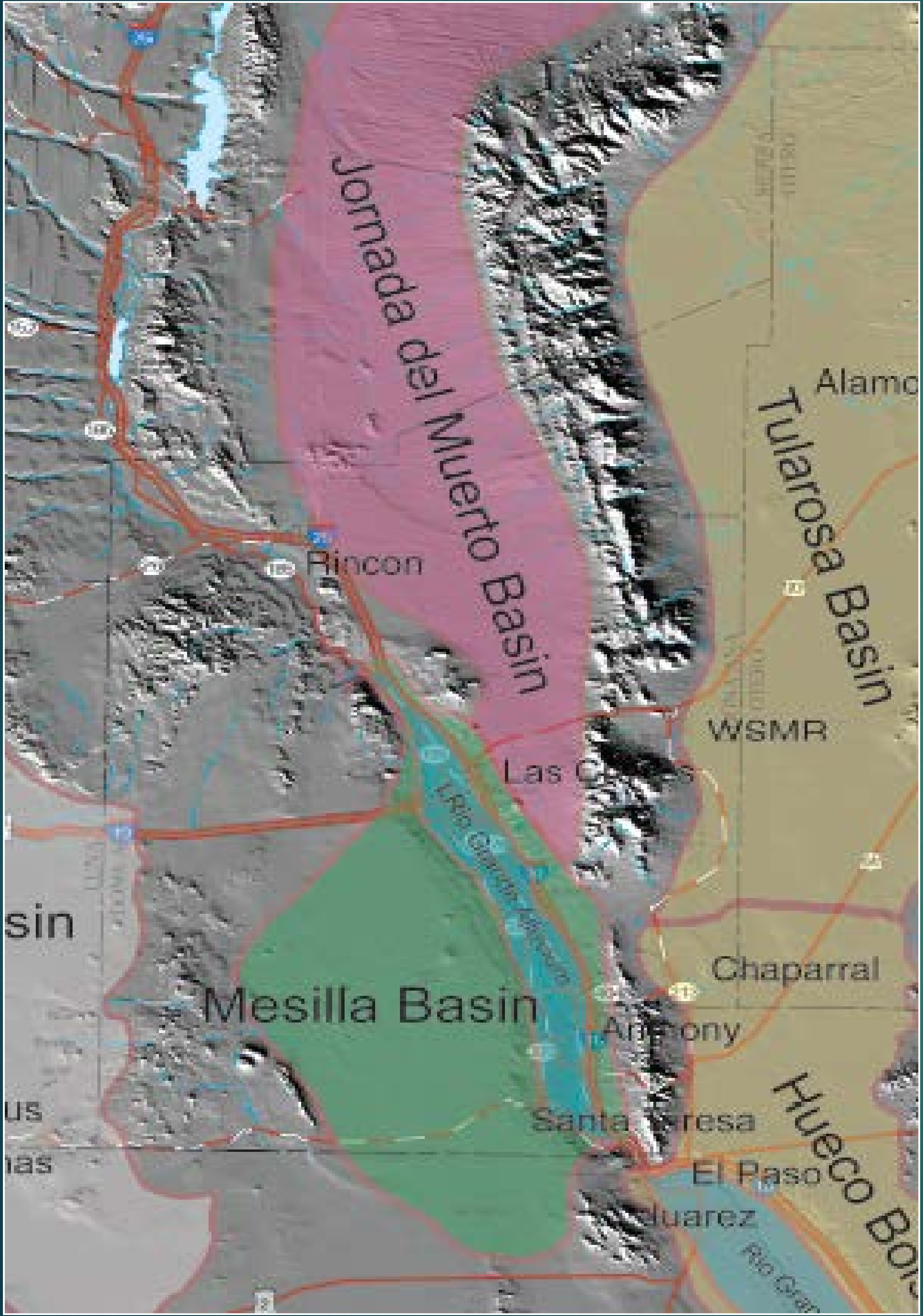
July 2013: 2% capacity from 2.6 M acre-ft

August 2016

August 2016



* 36 acre-inches per acre is considered the full allotment. Less than adequate for most years



Total volume of water in aquifers in New Mexico = 20 billion acre-feet

Not available everywhere

75% is too saline

25% < 2000 mg/L

NMWRRI Trans-boundary Aquifer Assessment (Hawley and Kennedy, 2004)

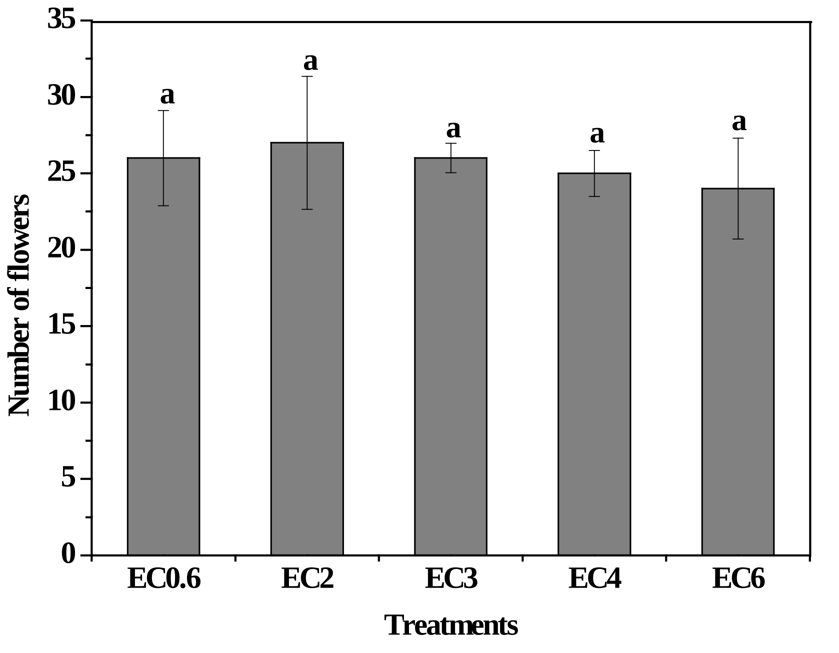
Is it sustainable to use brackish water for agriculture

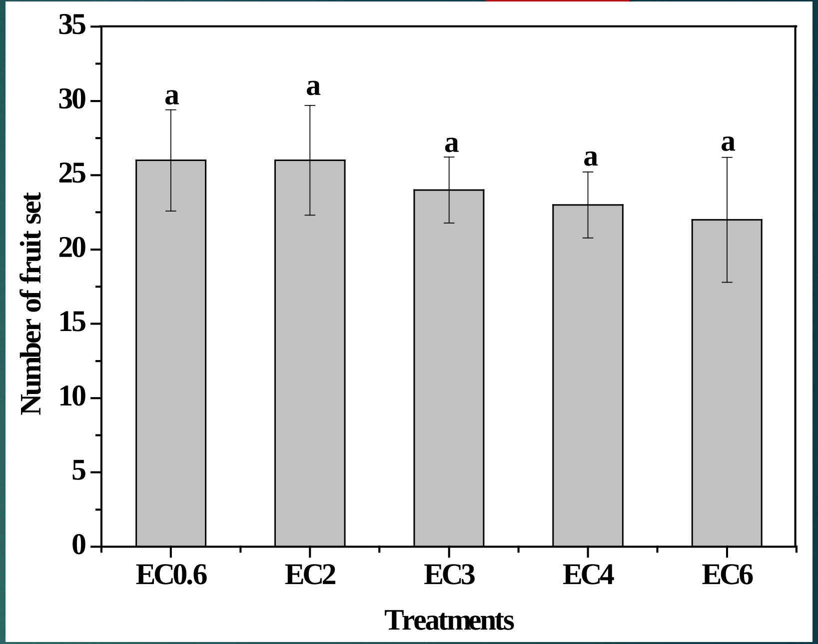
Is desalination needed?

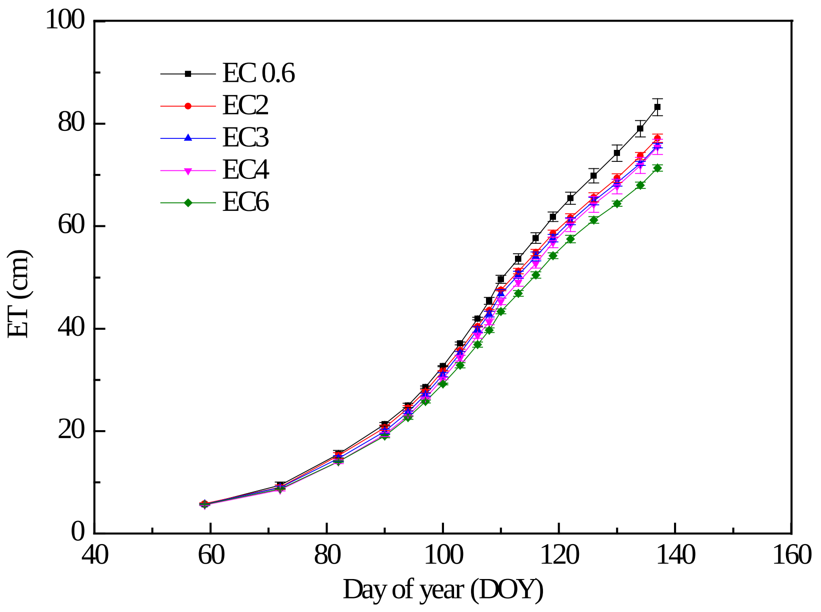
What happens with Concentrate generated?

- Glycophytes
- Halophytes

Tomato



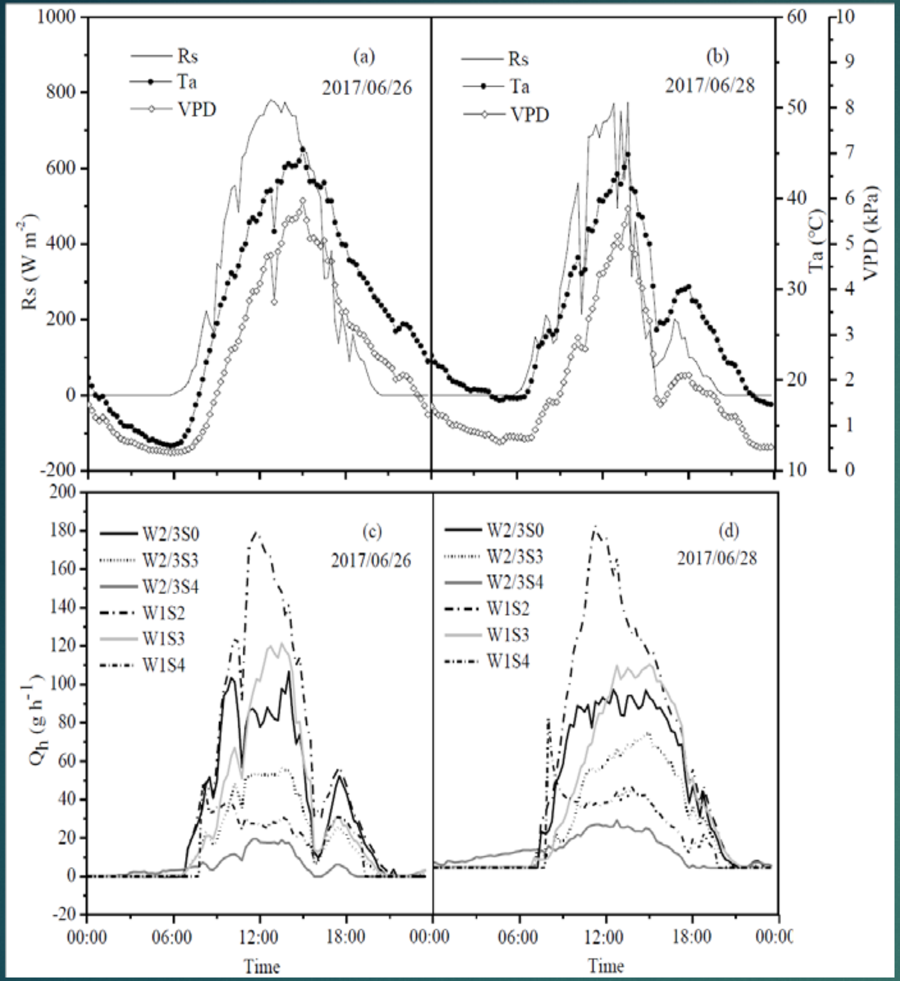




Irrigation water salinity decreases:

- **Number of flowers,**
- **Fruit set and**
- **ET of tomato**

SAP Flow Measurements for tomato

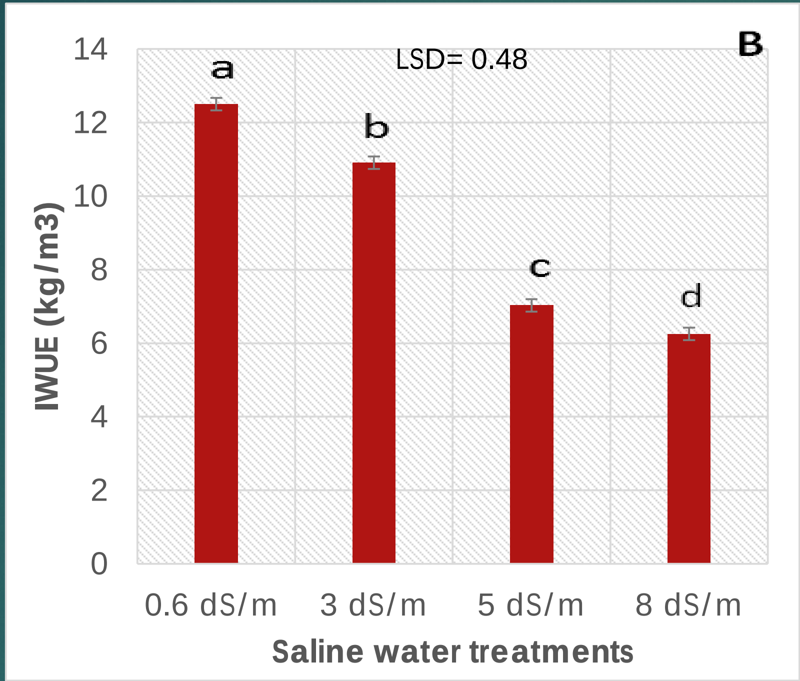


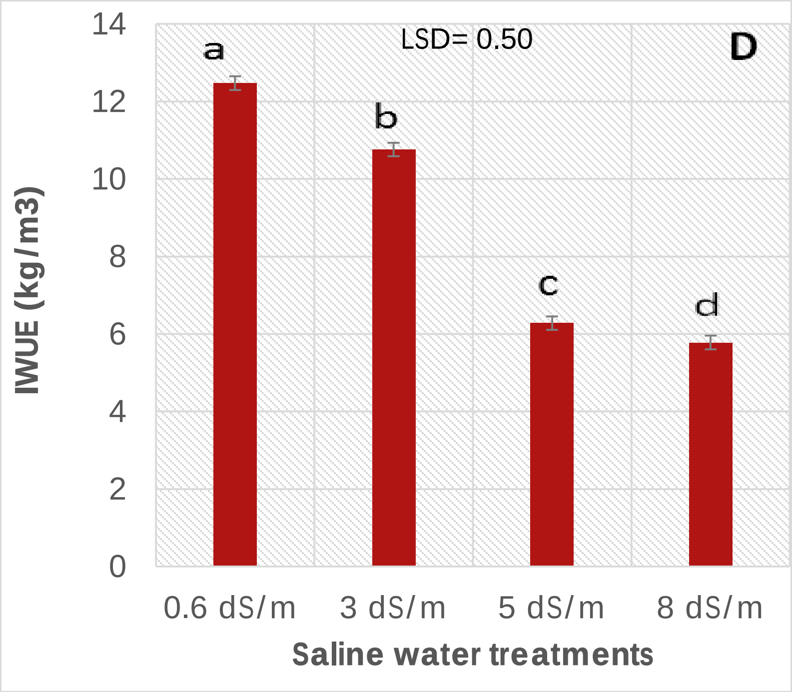
SGB9, SGB13, Dynamax, USA, during fruit development and ripening stage

- A multimodal curve on cloudy days
- Sap flow was significantly related to soil salt content
- Salt stress prominently decreased sap flow rate and delayed start in the morning

Reduced irrigation and salt stress decreased tomato water use efficiency at leaf and plant scales; Yang et al., 2019. Frontiers of Plant Science

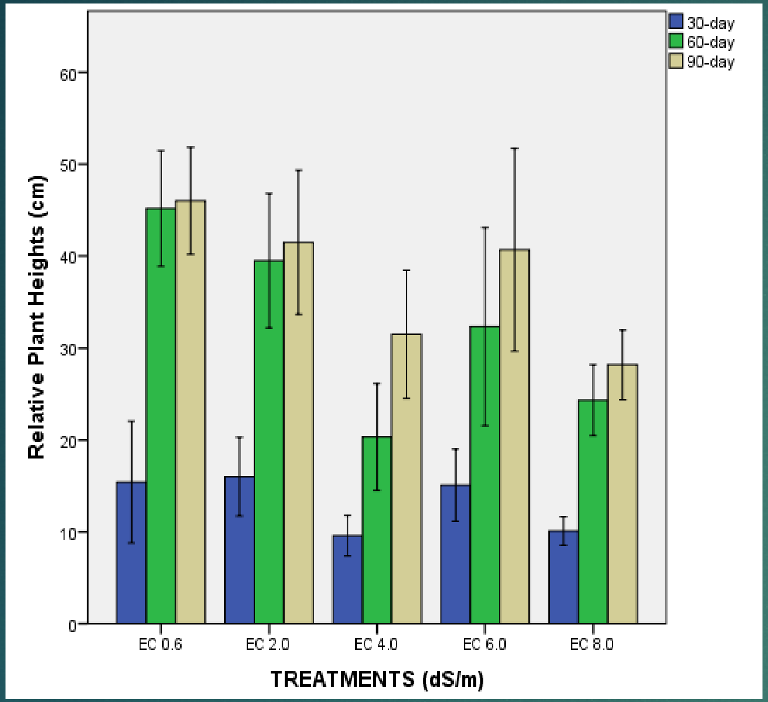
Chile peppers

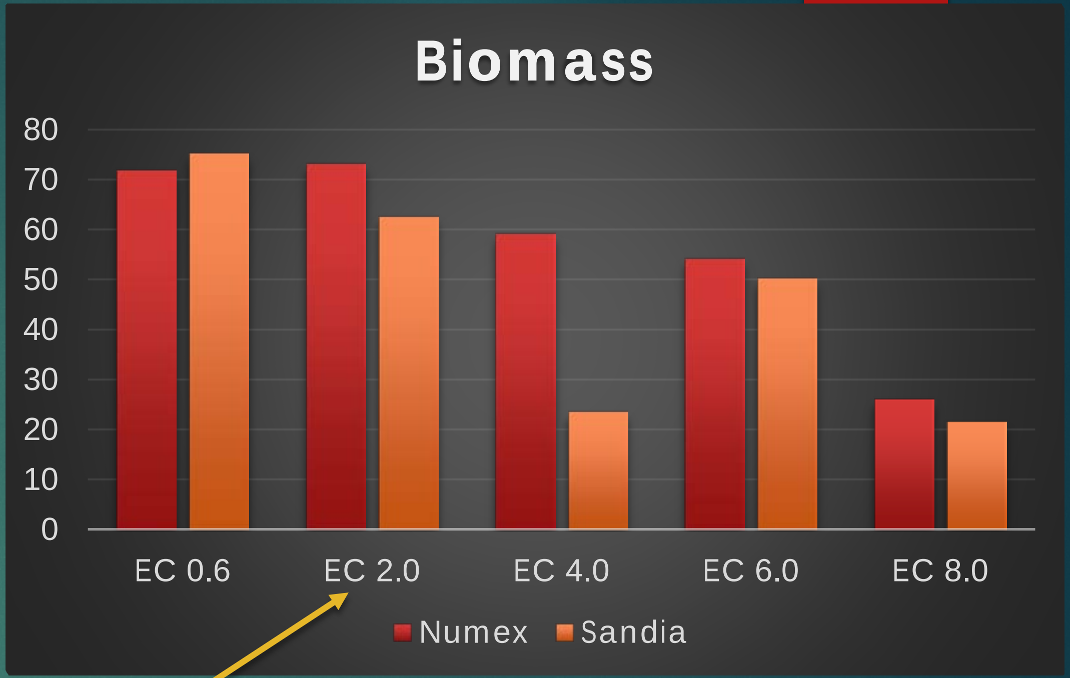


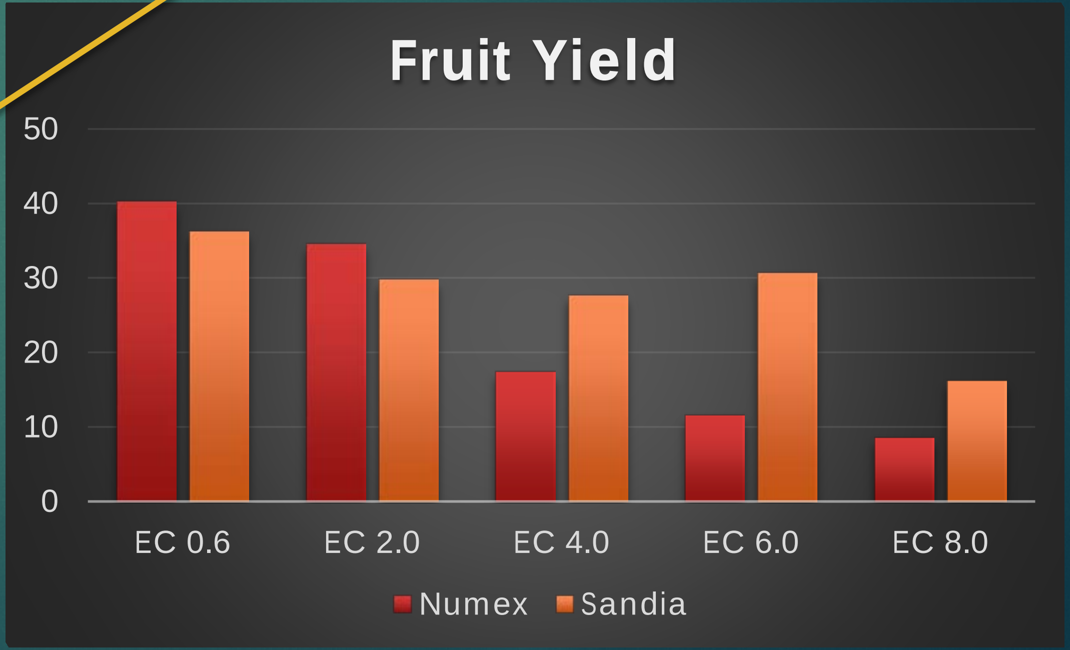


- **Flowering occurred early**
- **More flowers in brackish water treatments**
- Continuous brackish water application decreased yield and size of chile peppers
- At or after flower onset, irrigation strategy needs to change

Chile peppers







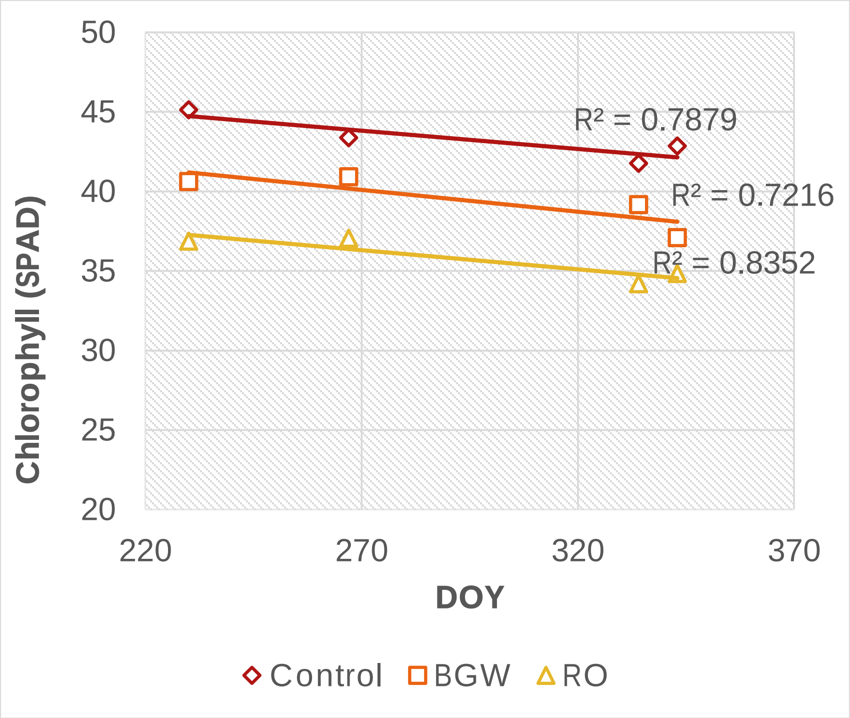
At Flowering in some pots:

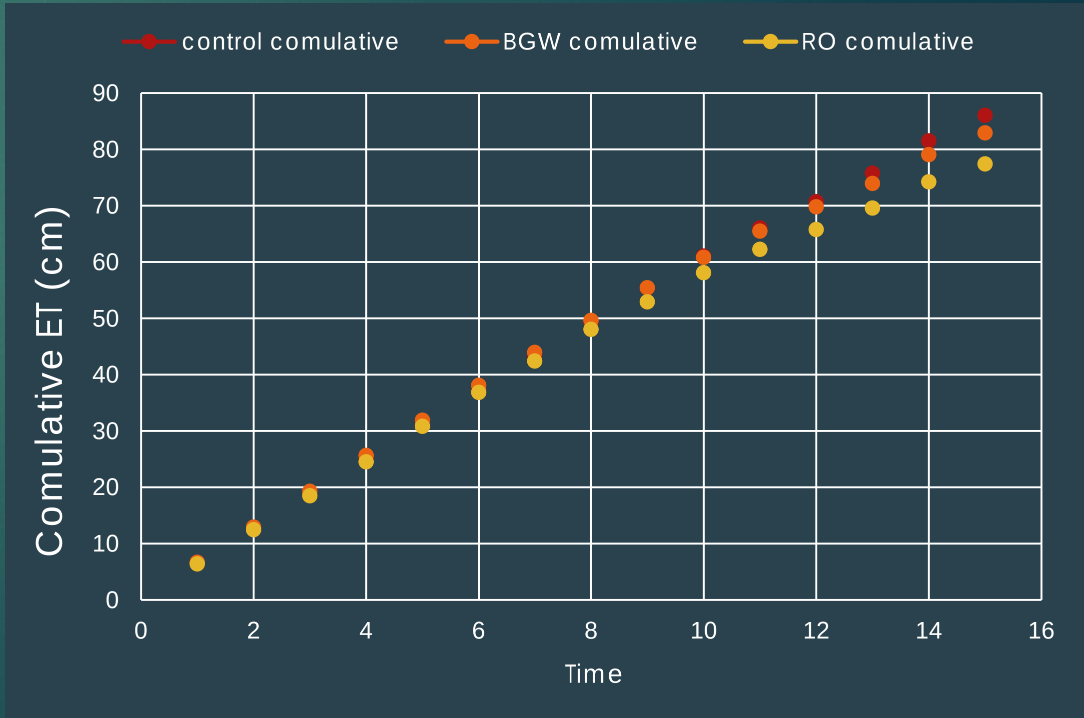
- Irrigation switched from 4 dS/m to 2 dS/m
- Irrigation switched from 8 to 8 dS/m

Pecan

		Season 2017		Season 2018	
Treatment EC (ds/m)	Time Month	Bottom leaf (μmol /m²/s)	Top leaf (μmol /m²/s)	Bottom leaf (μmol /m²/s)	Top leaf (μmol /m²/s)
			Mean ± SE		
0.8	Aug	1.67 ± 0.45 c	2.24 ± 0.89 b	3.89 ± 0.41 a	4.81 ± 0.65 a
	Sep	3.20 ± 0.45 b	4.25 ± 0.89 b	1.84 ± 0.41 b	2.38 ± 0.65 b
	Nov	7.98 ± 0.45 a	8.01 ± 0.89 a	4.43 ± 0.41 a	4.73 ± 0.65 a
4.0	Aug	1.23 ± 0.45 b	1.60 ± 0.89 b	3.00 ± 0.41 a	3.09 ± 0.65 a
	Sep	1.80 ± 0.45 b	1.04 ± 0.89 b	0.89 ± 0.41 b	0.43 ± 0.65 b
	Nov	4.11 ± 0.45 a	6.04 ± 0.89 a	1.94 ± 0.41 ab	2.58 ± 0.65 a
8.0	Aug	1.28 ± 0.45 a	1.05 ± 0.89 a	1.96 ± 0.41 a	2.07 ± 0.65 a
	Sep	1.68 ± 0.45 a	1.00 ± 0.89 a	0.71 ± 0.41 b	1.06 ± 0.65 a
	Nov	2.09 ± 0.60 a	3.69 ± 1.13 a	1.77 ± 0.48 ab	2.03 ± 0.74 a

Photosynthetic rates





Halophyte and Marginal halophytes

Hordeum vulgare
(Barley)

×*Triticosecale*
(Triticale)

Atriplex canescens
(Fourwing Saltbush)

Distichlis stricta
(Inland Saltgrass)

Lepidium alyssoides
(Mesa Pepperwort)

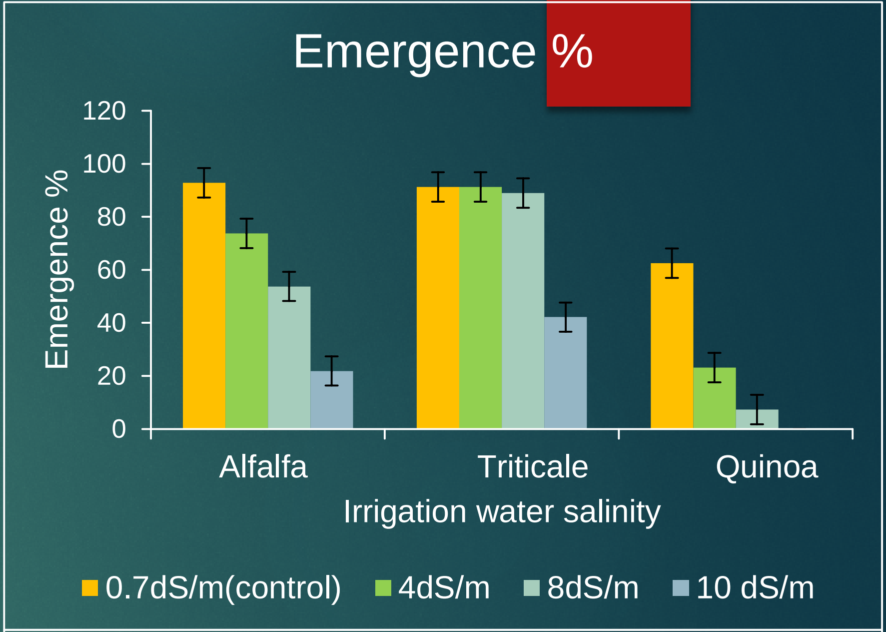
Panicum virgatum
(Switchgrass)

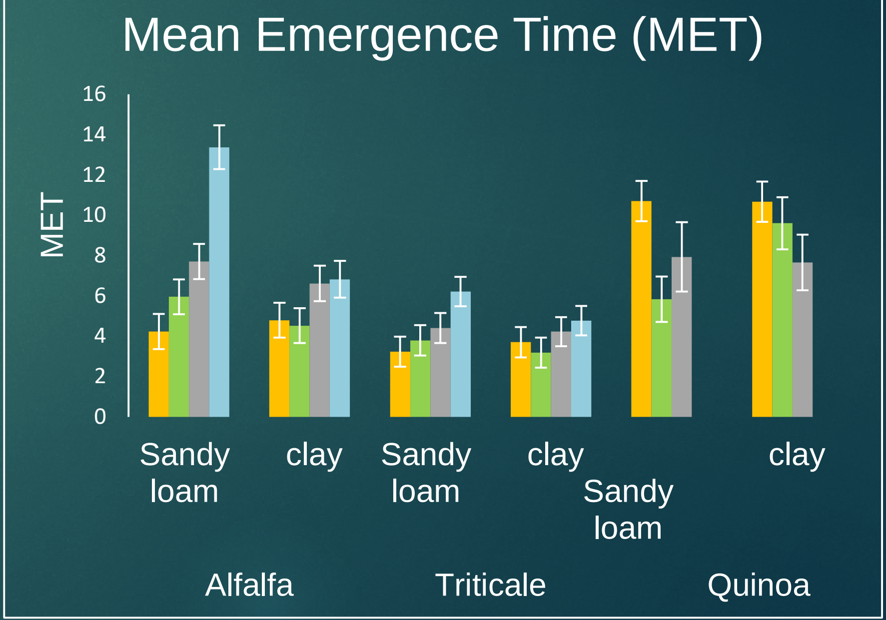
Alfalfa (*Medicago sativa*)

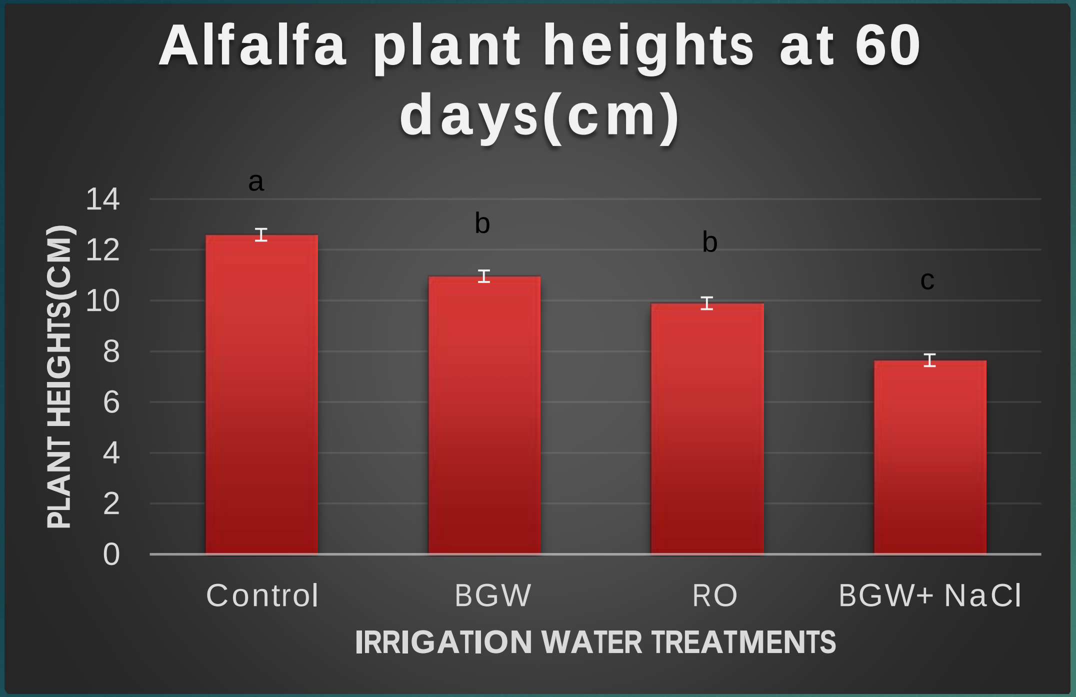
Quinoa
(*Chenopodium quinoa*)

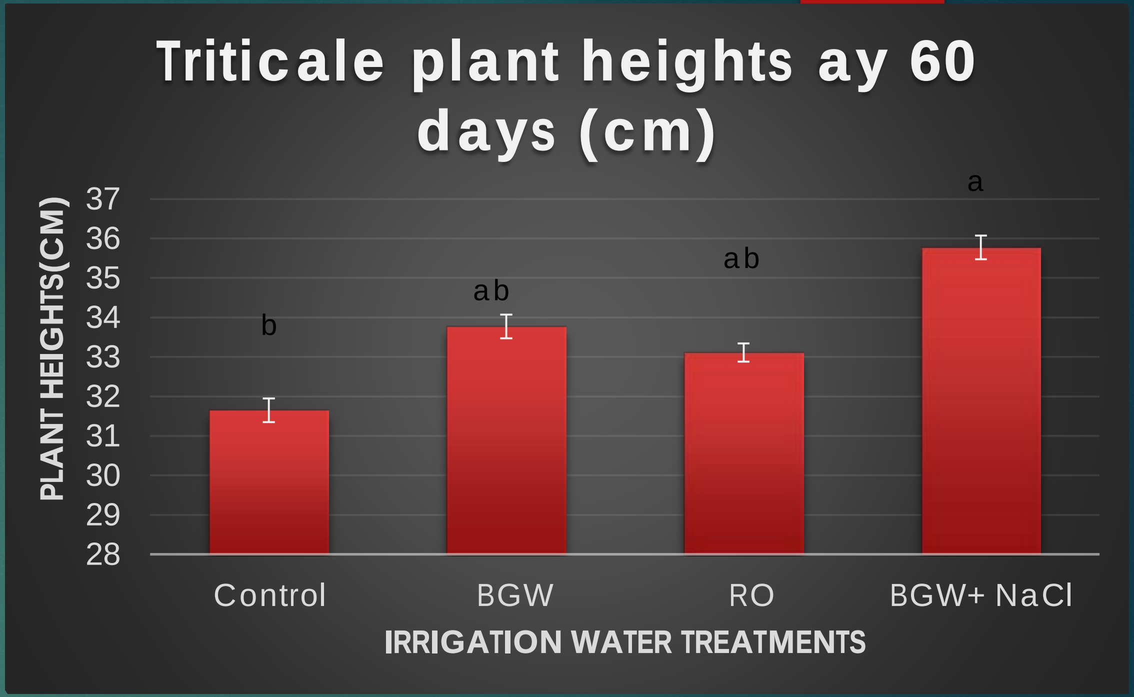
Marginal Halophyte Experiments on a irrigation salinity gradient

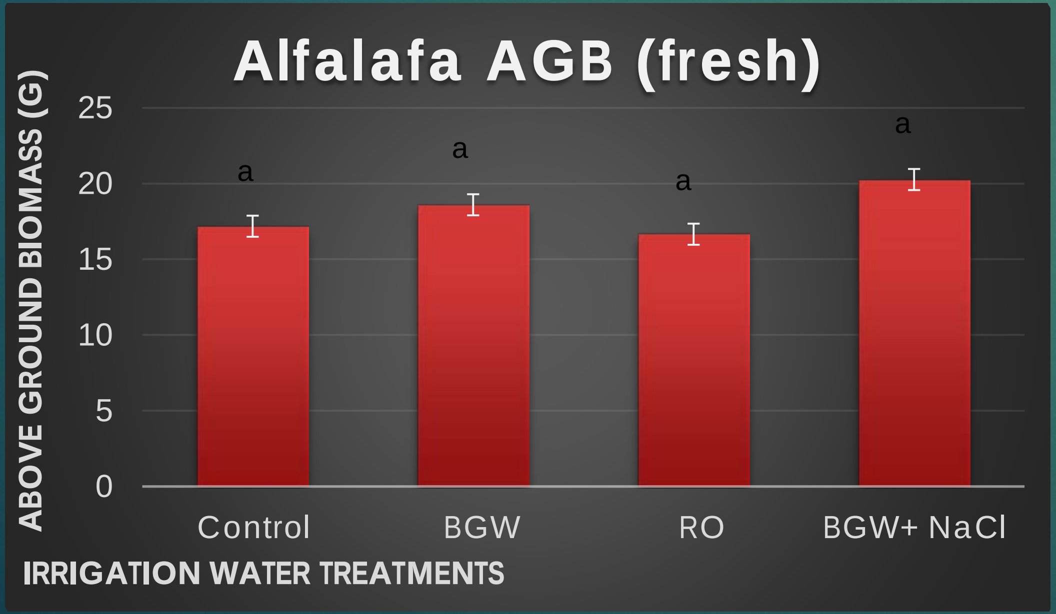
	Germinability %	GI
Soils main effects		
Sandy loam	80.50 (A)	12.03 (A)
Clay	69.23 (B)	10.28 (B)
Species main effects		
Alfalfa	67.66 (AB)	11.88 ± 0.79 (B)
Triticale	87.84 (A)	14.99 ± 0.77 (A)
Quinoa	69.09 (B)	6.60 ± 0.76 (C)

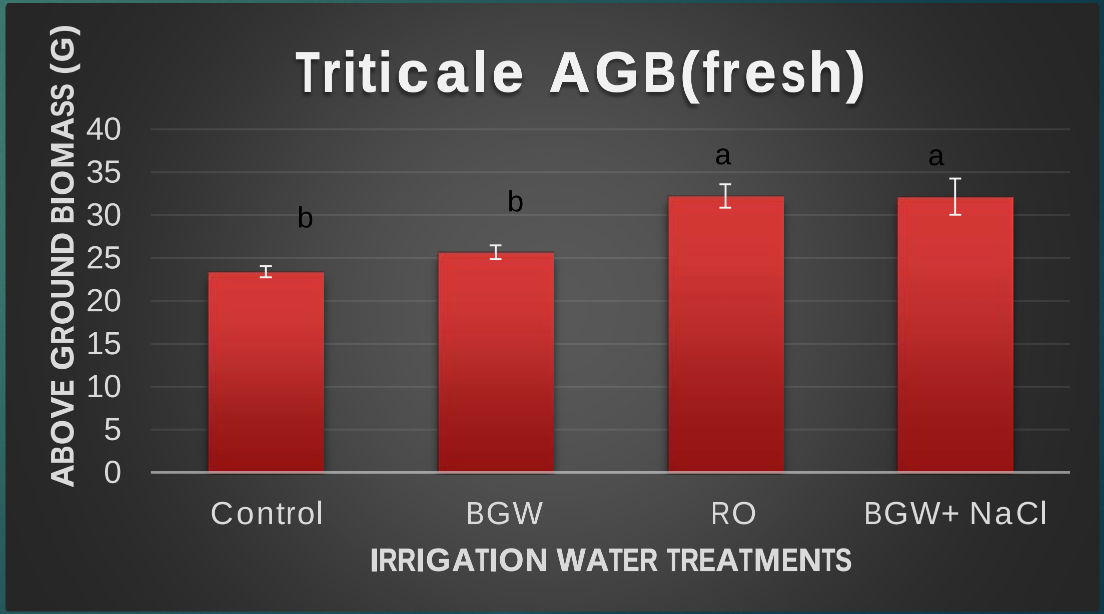


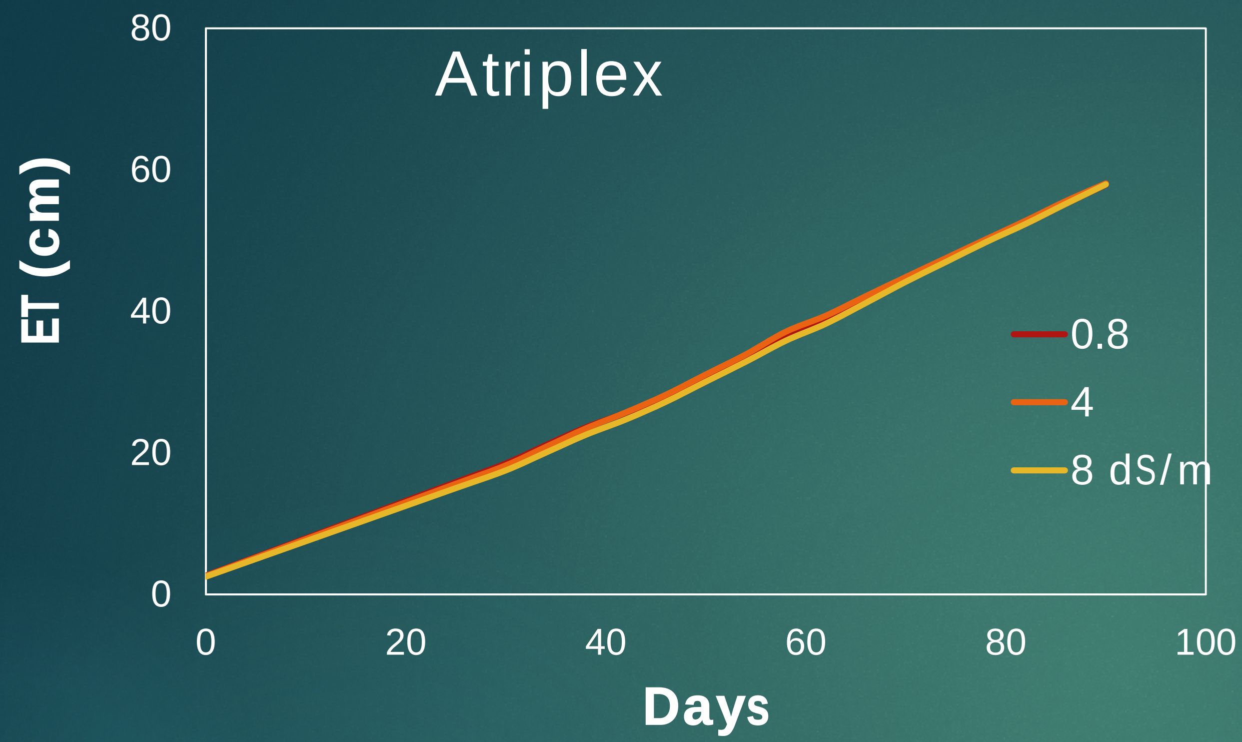


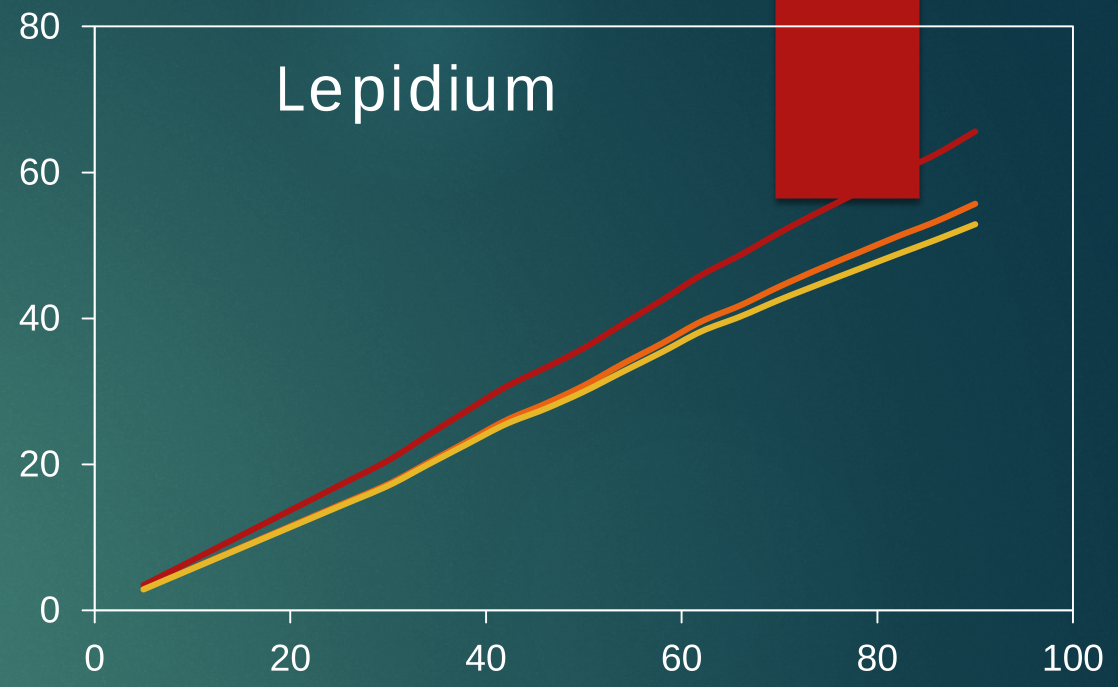

Alfalfa plant heights at 60 days(cm)
PLANT HEIGHTS(CM)
14
12
10
8
6
4
2
0
a
b
b
c
Control
BGW
RO
BGW+ NaCl
IRRIGATION WATER TREATMENTS

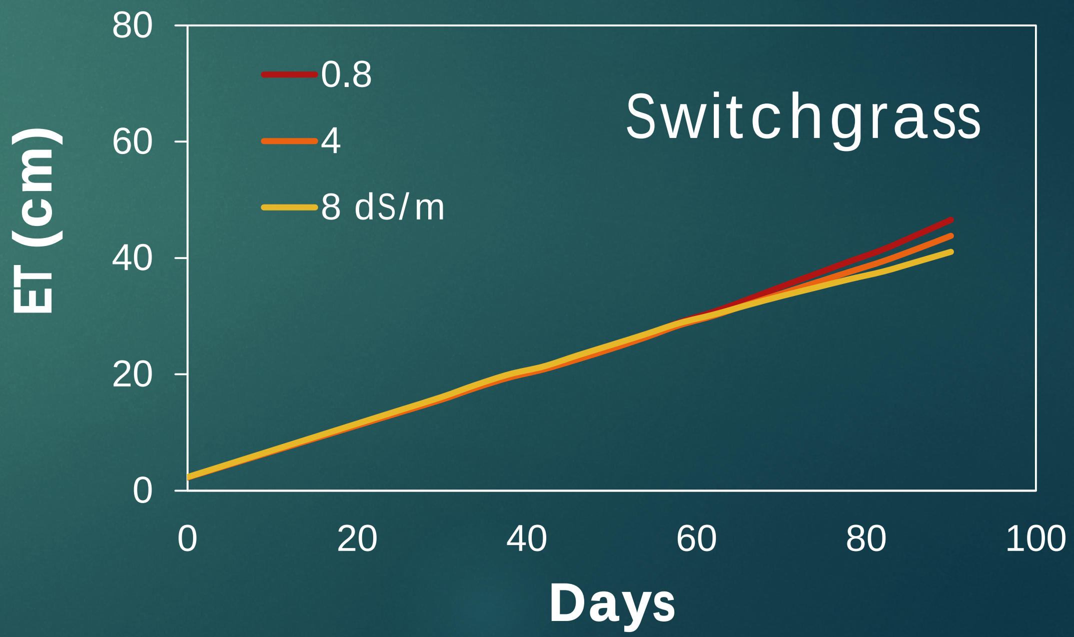

Triticale plant heights ay 60 days (cm)
PLANT HEIGHTS(CM)
37
36
35
34
33
32
31
30
29
28
b
ab
ab
a
Control
BGW
RO
BGW+ NaCl
IRRIGATION WATER TREATMENTS


Alfalafa AGB (fresh)
ABOVE GROUND BIOMASS (G)
25
20
15
10
5
0
a
a
a
a
Control
BGW
RO
BGW+ NaCl
IRRIGATION WATER TREATMENTS


Triticale AGB(fresh)
ABOVE GROUND BIOMASS (G)
40
35
30
25
20
15
10
5
0
b
b
a
a
Control
BGW
RO
BGW+ NaCl
IRRIGATION WATER TREATMENTS





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journal homepage: www.elsevier.com/locate/jaridenv

ELSEVIER

Evapotranspiration changes with irrigation using saline groundwater and RO concentrate

CrossMark

Alison M. Flores [a,*], Manoj K. Shukla [a], David Daniel [b], April L. Ulery [a], Brian J. Schutte [c], Geno A. Picchioni [a], Sam Fernald [d]

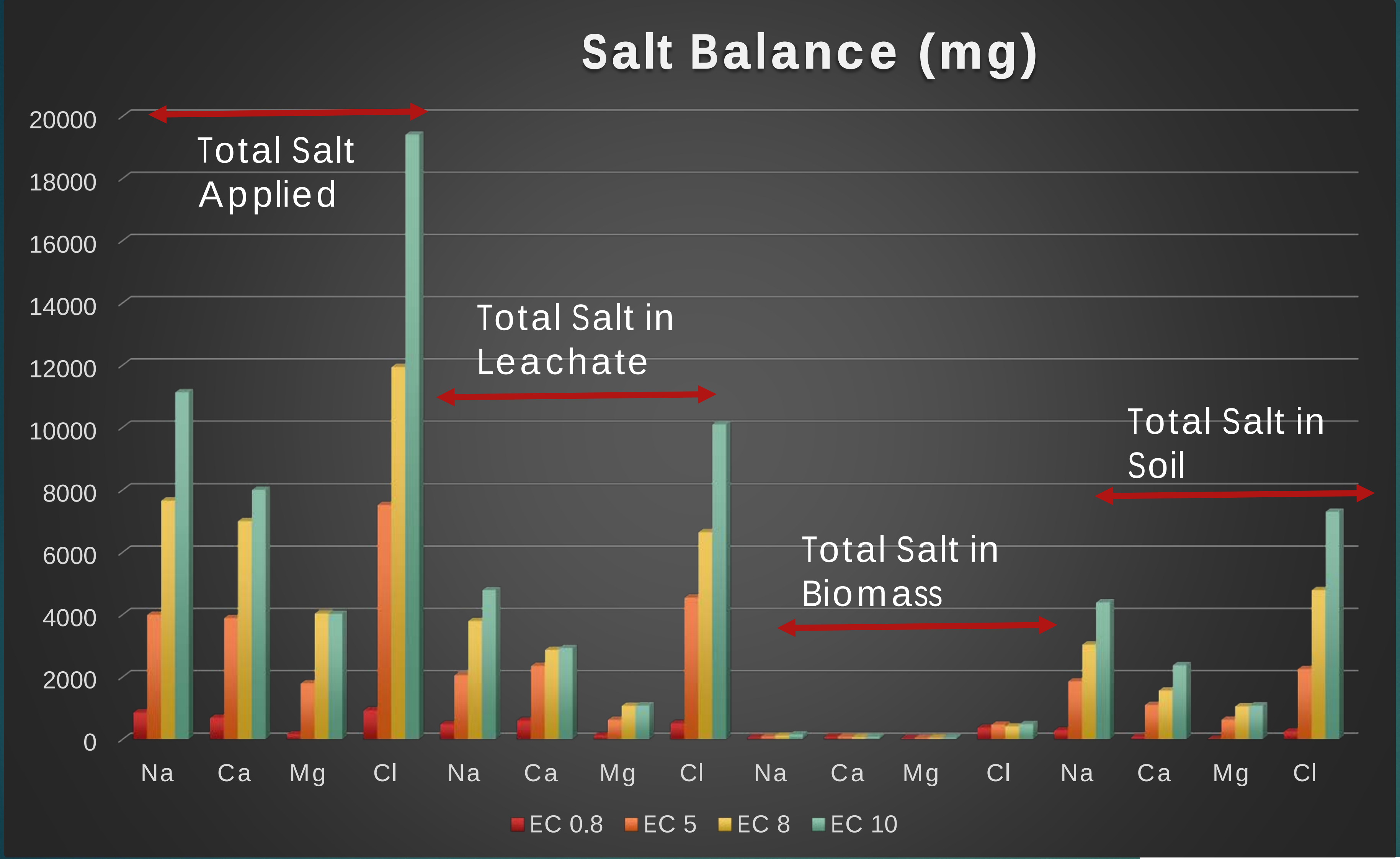
Research in BGNDRF

Atriplex canescens and a. lentiformis

Soil Depth and Treatment	0-20 cm	20-40 cm
Total hits	72790	68743
Halophytic hits	4887	4603

Soil Depth and Treatment	0-20 cm Low water	20-40 cm Low water	0-20 cm High water	20-40 cm High water	0-20 cm Control	20-40 cm Control
Total hits	34462	16329	38332	42384	17186	11669
Halophytic hits	362	77	290	312	79	35

Microbial hits- Baseline and end of Season. Beginning of the season found a greater diversity in the halophytic hits (of Archaea and Bacteria), and greater total numbers of halophytic microbes (a). Less hits of total microbes at the baseline collection date but a greater total number of microbes, but the diversity and number of halophytic microbes was much less



- Halophytes not removing enough salts
- Able to block it without changing ET or growth
- Soil salinization is occurring even with BGW
- Higher leaching fractions will be needed to control soil salinization

Ion balance for Mg^{2+}, Na^{+}, Ca^{2+}, and Cl^{-} ions in the irrigation water, BGW (EC 5), RO1 (EC 8) and RO2 (EC 10)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Research Paper

Irrigation with brackish water changes evapotranspiration, growth and ion uptake of halophytes

Omer Faruk Ozturk[a], Manoj K. Shukla[b,*], Blair Stringam[b], Geno A. Picchioni[b], Charlotte Gard[c]

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- Bureau of Reclamation
- NIFA

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