Performance of Warm-Season Turfgrasses Under Salinity Stress

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- This research was part of a larger SCRI project which contributed to development of warm-season turfgrasses with enhanced *drought* and *salinity* stress tolerance

- Involves multi-institutional team of turfgrass breeders and physiologists

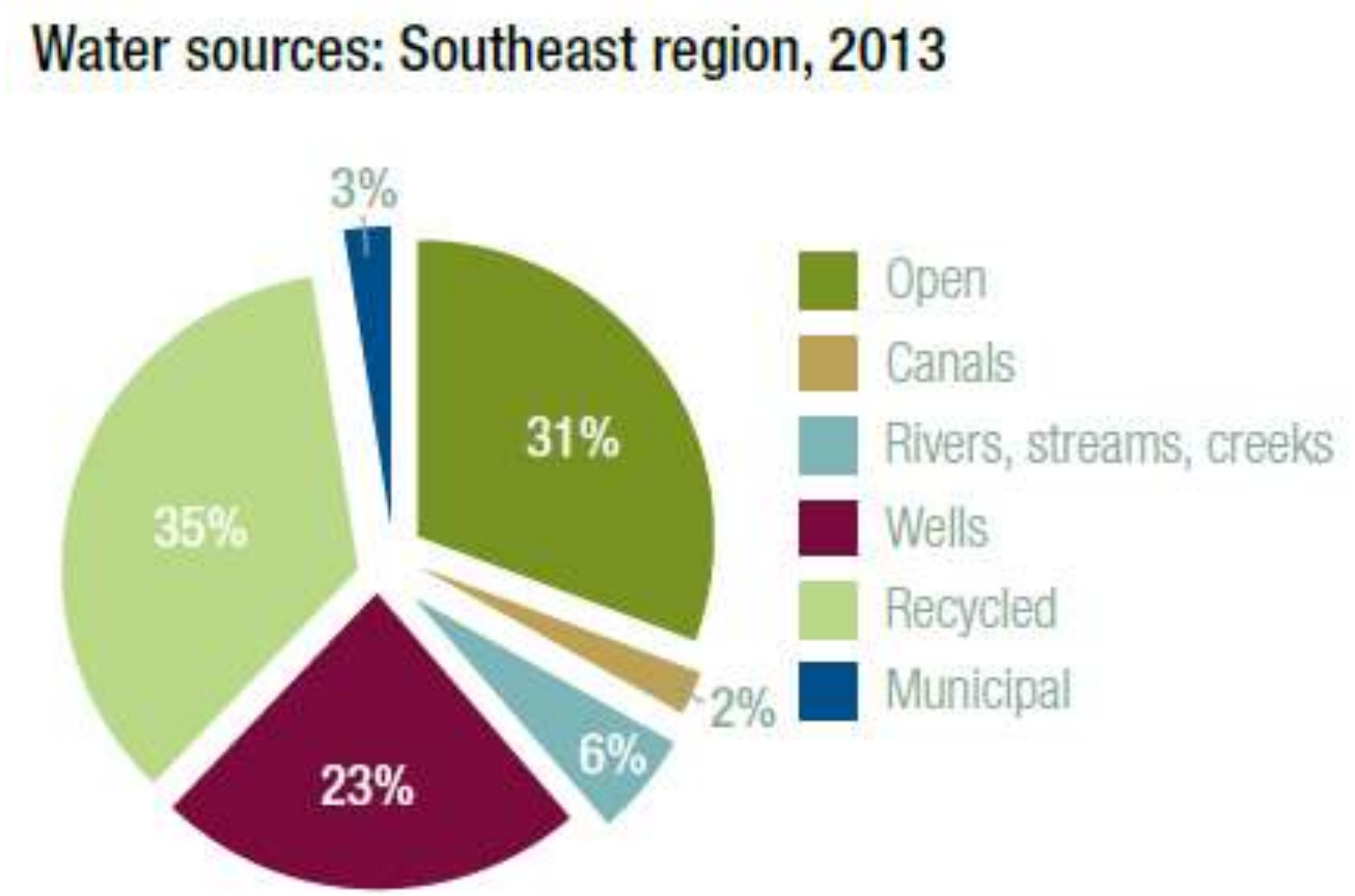
- *Texas A&M University, University of Georgia, University of Florida, N.C. State University, and Oklahoma State University*

The turfgrass breeding "dream team" is focused on creating environmentally sustainable turfgrass cultivars.

USDA NIFA

United States Department of Agriculture
National Institute of Food and Agriculture

Manuel Chavarria
PhD Student,
TAMU

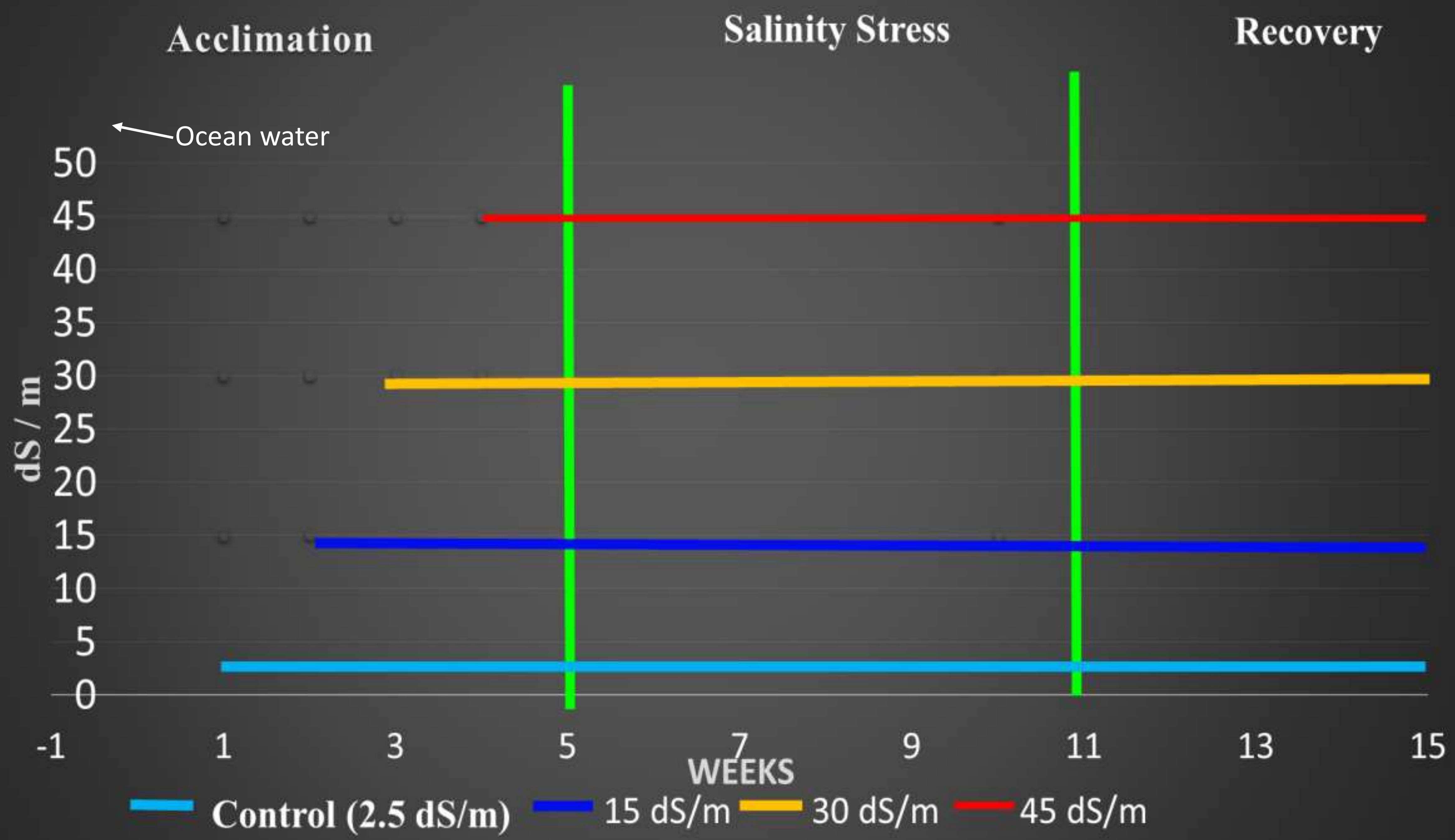


Source: GCSAA EIFG

Phase 1 Objectives

Compare warm-season turf cultivar salinity tolerance in greenhouse screenings

	Species	Cultivar	Origin
B	*Cynodon dactylon x C. transvaalensis* Burt. Davy	Tifway	University of Georgia
B	*Cynodon dactylon*	Celebration	Sod Solutions, Inc.
Z	*Z. japonica* Steud	Empire	University of Florida
Z	*Zoysia matrella*	Zeon	BladeRunner Farms
Z	*Z. japonica* Steud	Palisades	Texas A&M University
St A	*Stenotaphrum secundatum*	Raleigh	N.C. State University
St A	*Stenotaphrum secundatum*	Floratam	Univ. Florida/ Texas A&M
St A	*Stenotaphrum secundatum*	Palmetto	Sod Solutions, Inc.
SP	*Paspalum vaginatum*	Sea Isle I	University of Georgia
SP	*Paspalum vaginatum*	Seastar	University of Georgia



Acclimation
Salinity Stress
Recovery
Ocean water
50
45
40
35
30
25
20
15
10
5
0
dS / m
-1
1
3
5
7
9
11
13
15
WEEKS
Control (2.5 dS/m)
15 dS/m
30 dS/m
45 dS/m

Data Collection & Analysis

- Visual turf quality: 1-9 scale weekly (1= completely brown turf, 9= perfect green turf, 6= minimally acceptable) (Morris, 1982)
- Digital light box images : To determine percent green cover for each pot (Karcher and Richardson, 2003)
- NDVI (Normalized Difference Vegetation Index)

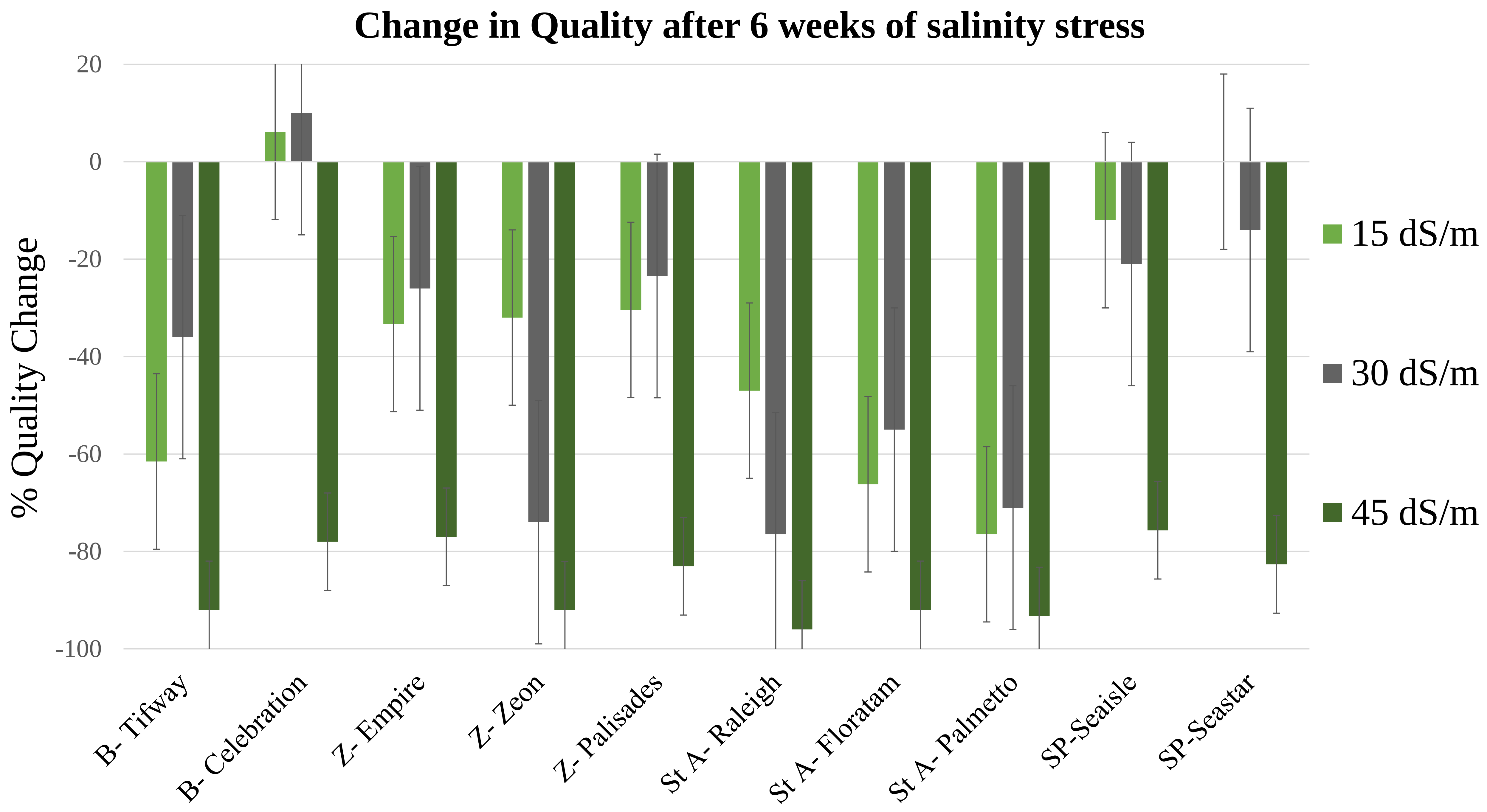
$$\text{NDVI}= \frac{NIR - VIS}{NIR+VIS}$$

- Shoot growth: Weekly clipping collections
- Recovery Potential: After 4-week recovery period, visual quality and % green cover again evaluated
- Final Biomass: Verdure, thatch, & roots
- Relative shoot growth reduction due to salinity stress calculated

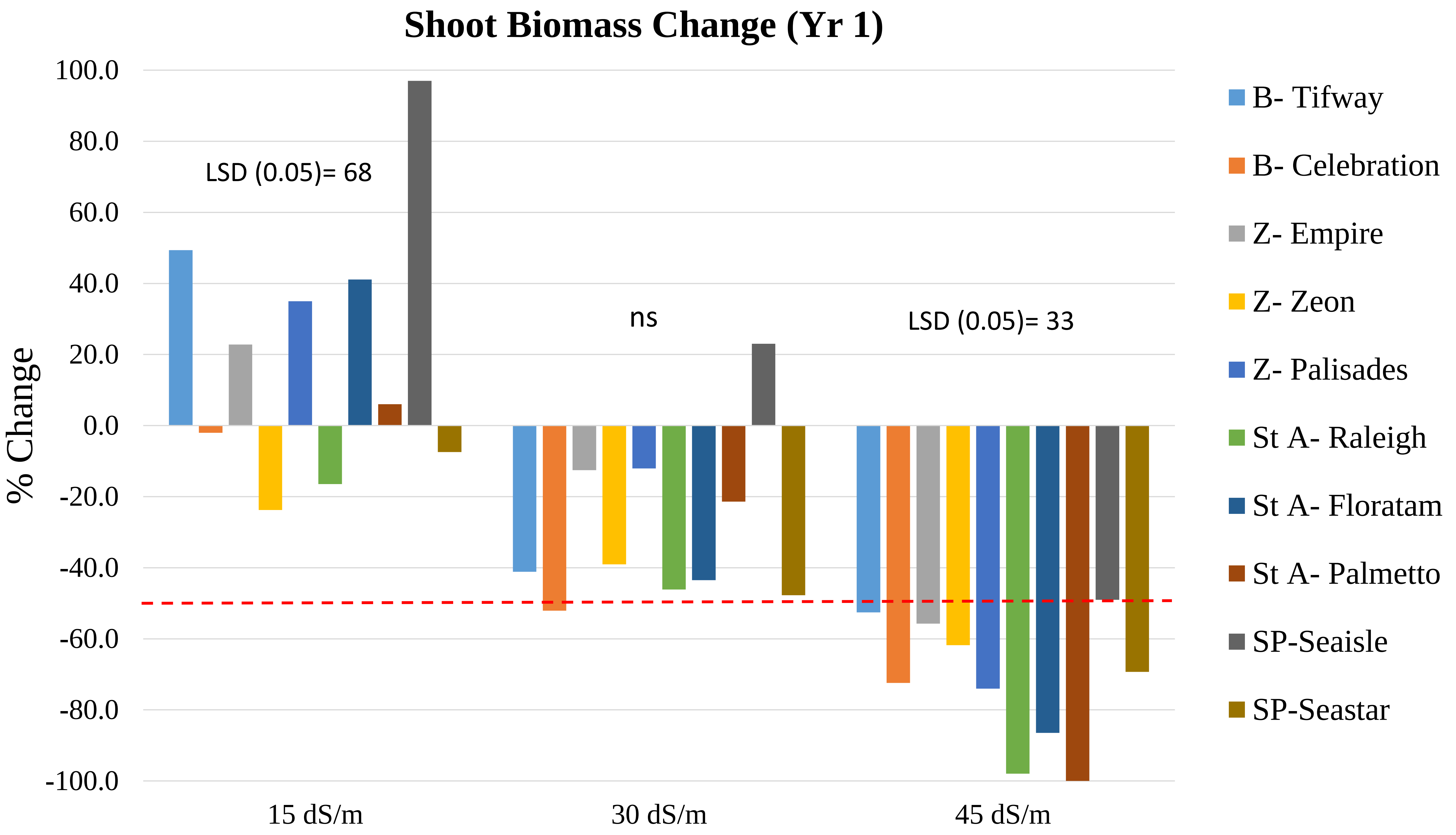
•Completely randomized block design with 4 reps

•Data analyzed using general linear model of SPSS; Fisher’s LSD

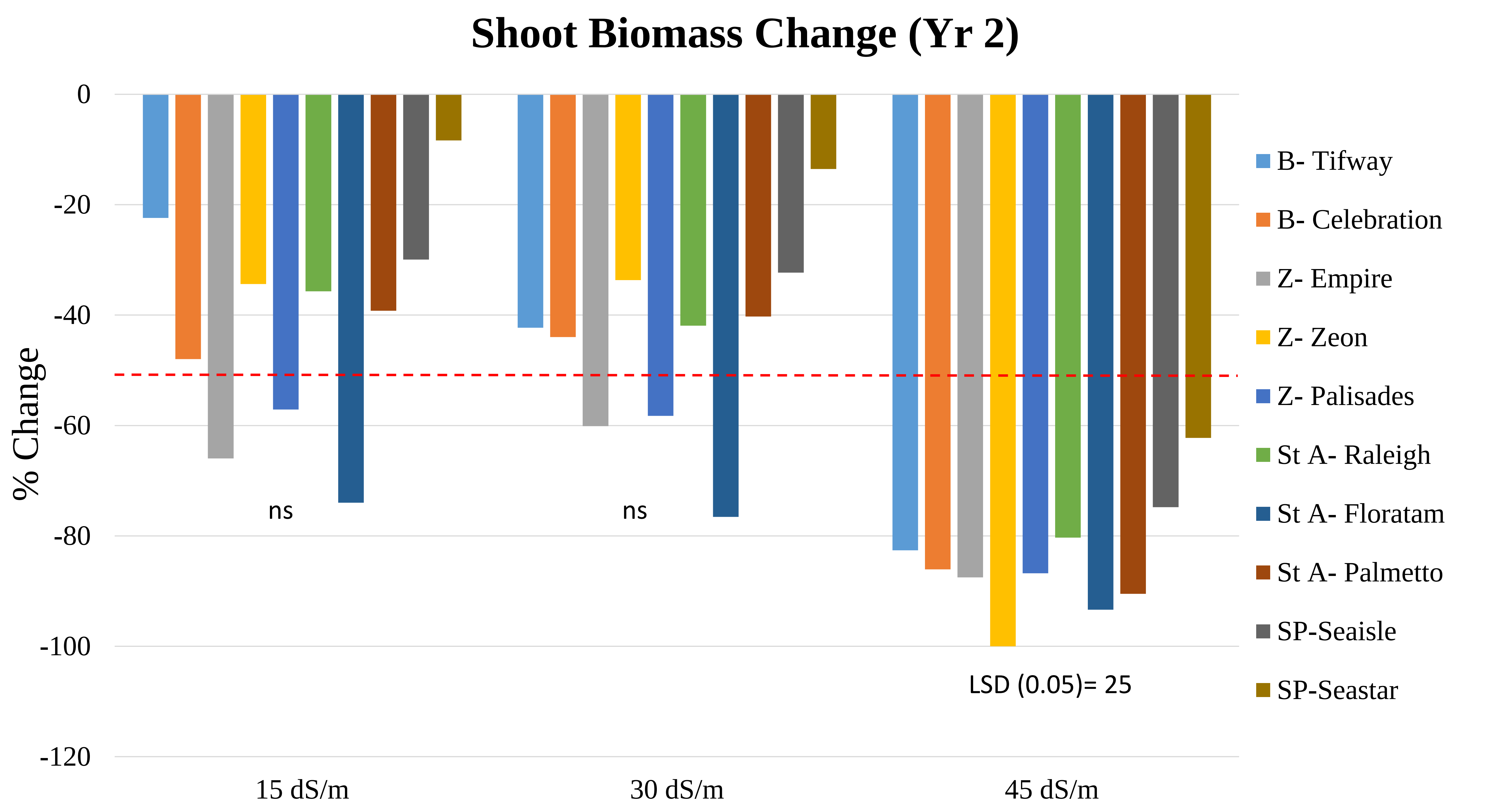
•Expt. 1 (summer 2014); Expt. 2 (summer 2015)



Change in Quality after 6 weeks of salinity stress
% Quality Change
20
0
-20
-40
-60
-80
-100
B- Tifway
B- Celebration
Z- Empire
Z- Zeon
Z- Palisades
St A- Raleigh
St A- Floratam
St A- Palmetto
SP-Seaisle
SP-Seastar
15 dS/m
30 dS/m
45 dS/m



Shoot Biomass Change (Yr 1)
% Change
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
LSD (0.05)= 68
ns
LSD (0.05)= 33
15 dS/m
30 dS/m
45 dS/m
B- Tifway
B- Celebration
Z- Empire
Z- Zeon
Z- Palisades
St A- Raleigh
St A- Floratam
St A- Palmetto
SP-Seaisle
SP-Seastar



Shoot Biomass Change (Yr 2)
% Change
0
-20
-40
-60
-80
-100
-120
ns
ns
LSD (0.05)= 25
15 dS/m
30 dS/m
45 dS/m
B- Tifway
B- Celebration
Z- Empire
Z- Zeon
Z- Palisades
St A- Raleigh
St A- Floratam
St A- Palmetto
SP-Seaisle
SP-Seastar

Phase 2 Objectives

Utilize SEM and EDS to evaluate leaf surface anatomy and salt exudation characteristics under increasing salinity using the most salt-tolerant lines of each species from prior testing.

Salinity Exposure Phase

- Texas A&M University, College Station, TX
- 30-day greenhouse expt.- Summer, 2015
- *Top performing entry* within each species from prior screenings used

	Species	Top Cultivar/Exptl. Designation	Origin
B	*Cynodon dactylon*	Celebration	Sod Solutions, Inc.
Z	*Z. Matrella x Z. japonica*	Dalz1313	Texas A&M University
St A	*Stenotaphrum secundatum*	Floratam	Texas A&M University
SP	*Paspalum vaginatum*	UGP3	University of Georgia

Materials & Methods

Salinity Exposure Phase

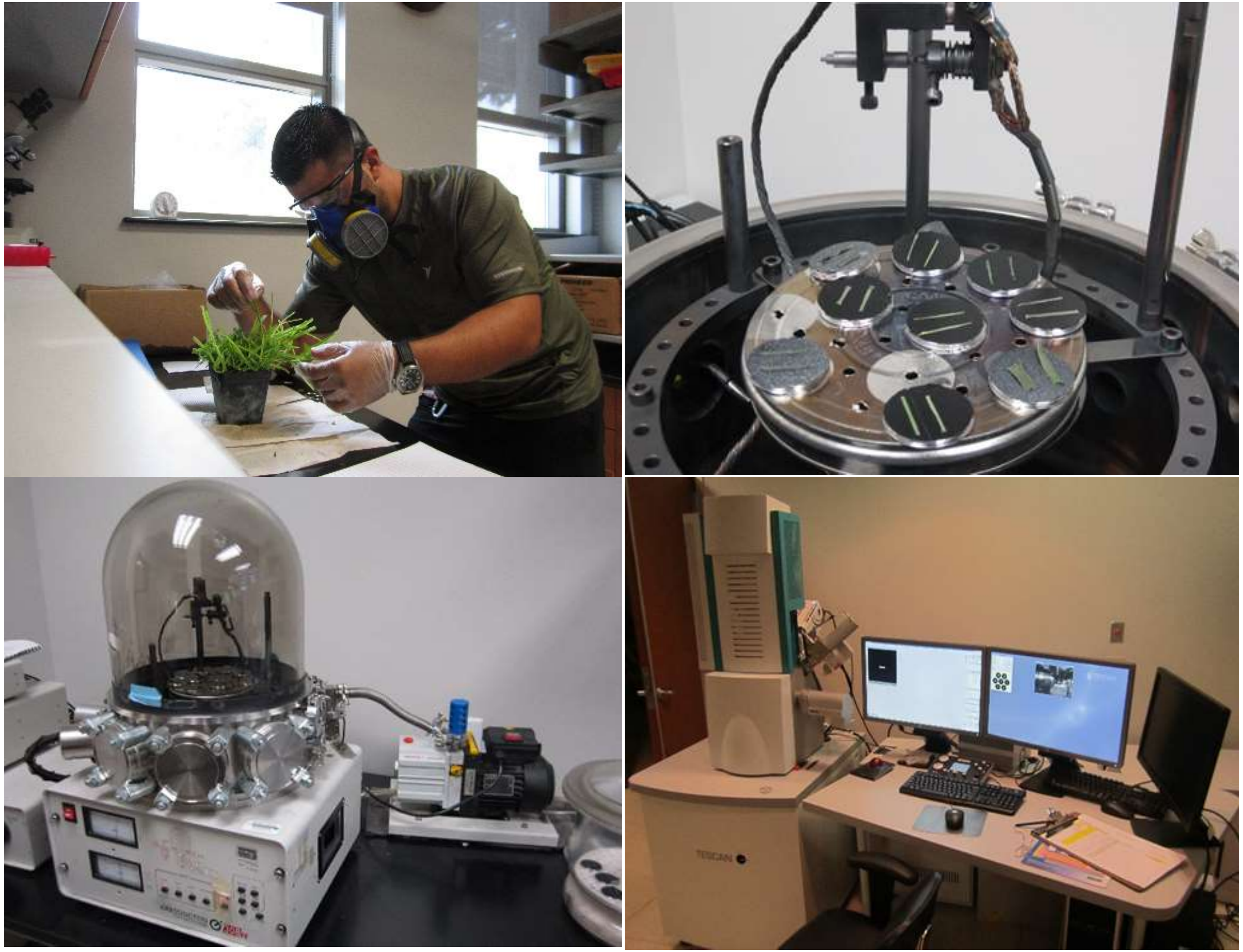
- Completely randomized block design with 4 reps

- Pots sub-irrigated at salinity levels of 2.5 (Control) and 30 dS m^{-1}

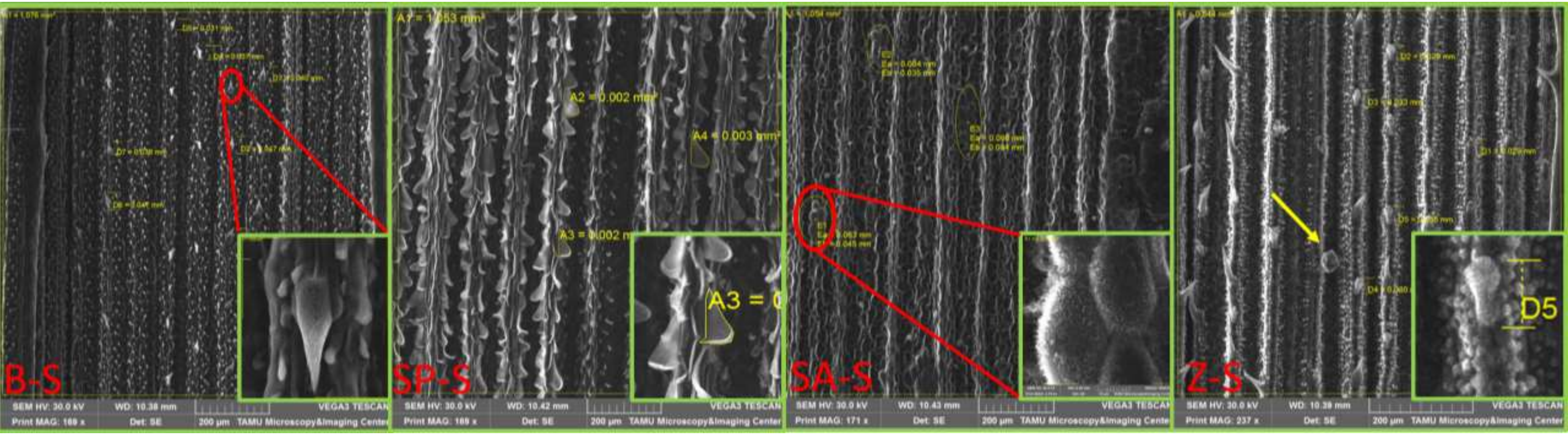
- Solution nitrate maintained at 300 mg/L NO_3-N

- Weekly increase of 10 dS m^{-1} acclimation to reach final salinity of 30 dS m^{-1}

Microscopic Leaf Examination Following 30-day Salinity Exposure



Leaf anatomical development in response to 30 dS/m salinity exposure



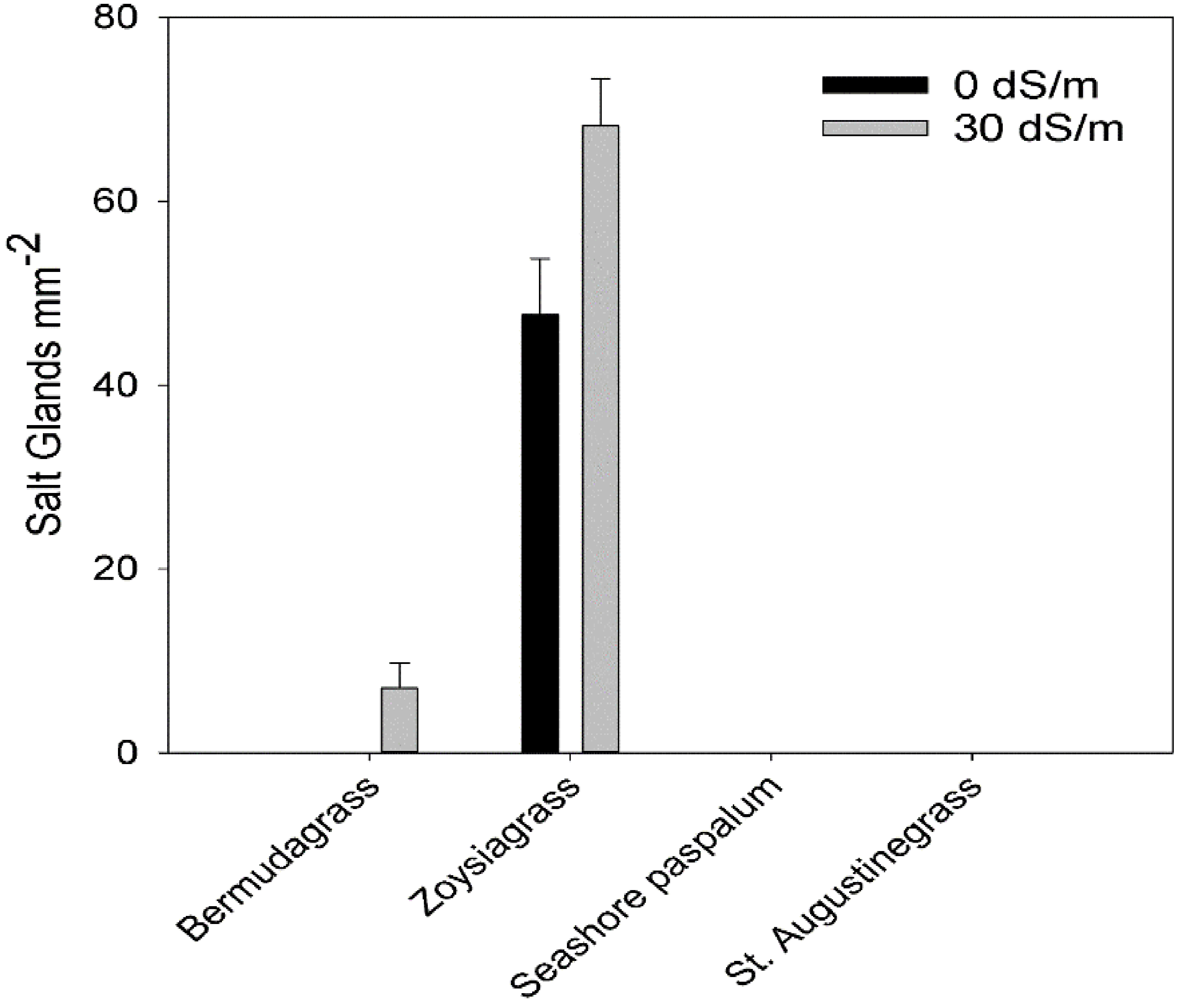
Bermudagrass- Appearance of salt glands on leaf surfaces

Seashore Paspalum- Appearance of bladders on leaf surfaces

St. Augustinegrass- Devoid of salt glands or bladders

Zoysiagrass- Appearance of salt glands on leaf surfaces

Salt Gland Density x Species as Influenced by Salinity Stress

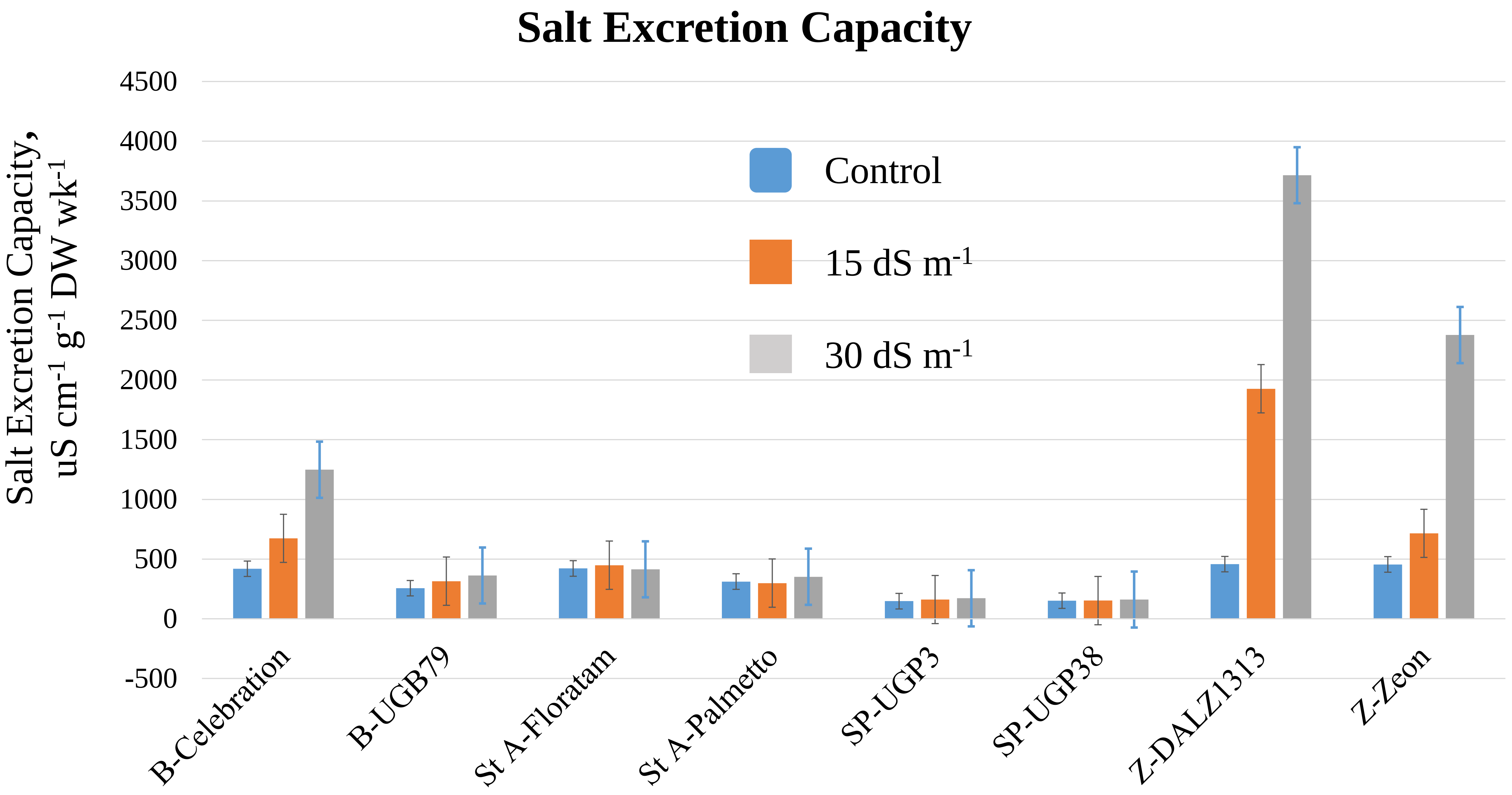


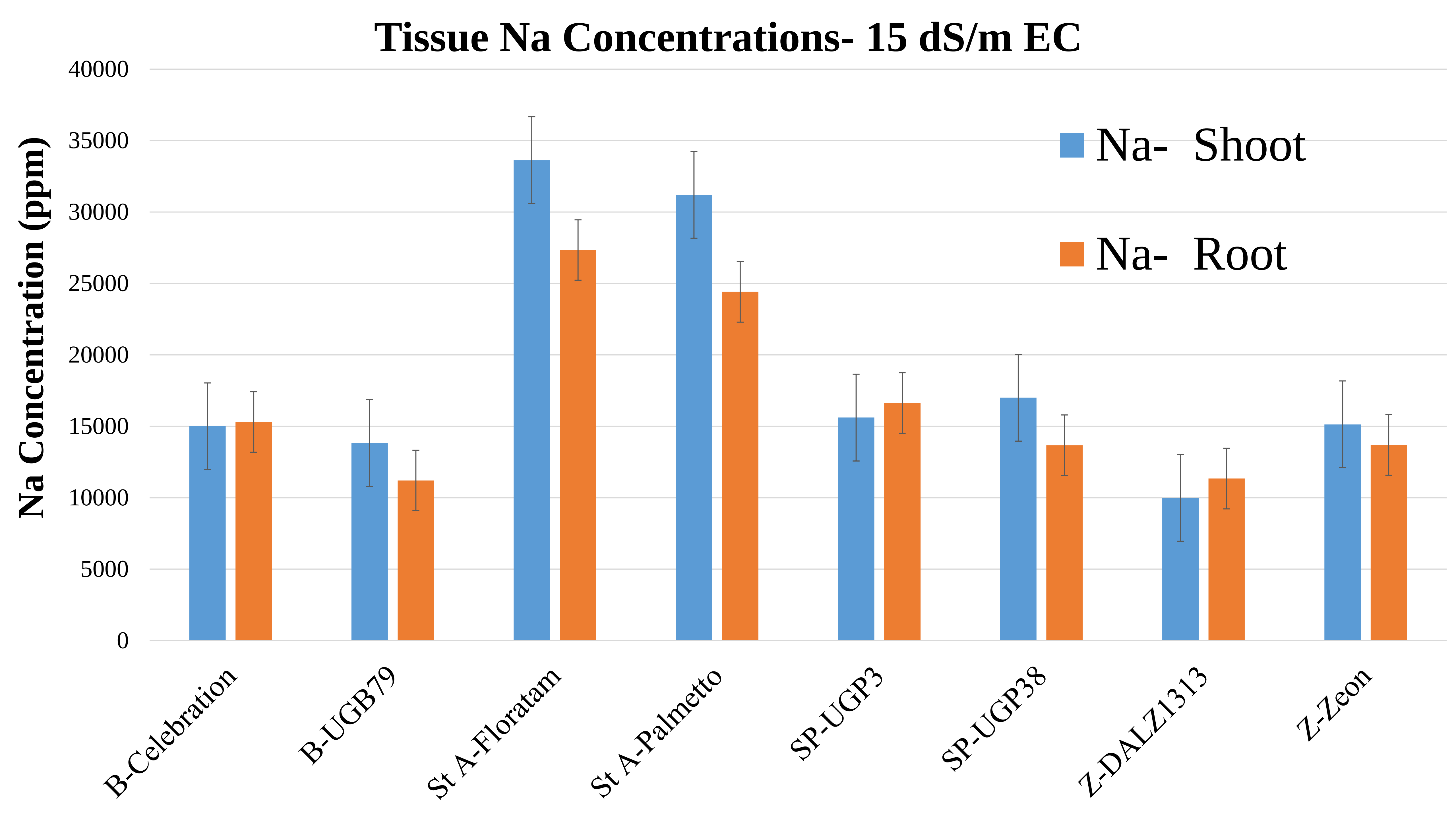
SEM + EDS used to aid qualitative & quantitative measurement of elemental analysis of salts and other compounds associated with leaf surfaces, with particular emphasis on sodium (Na) and chloride (Cl) ions

Phase 3 Objectives

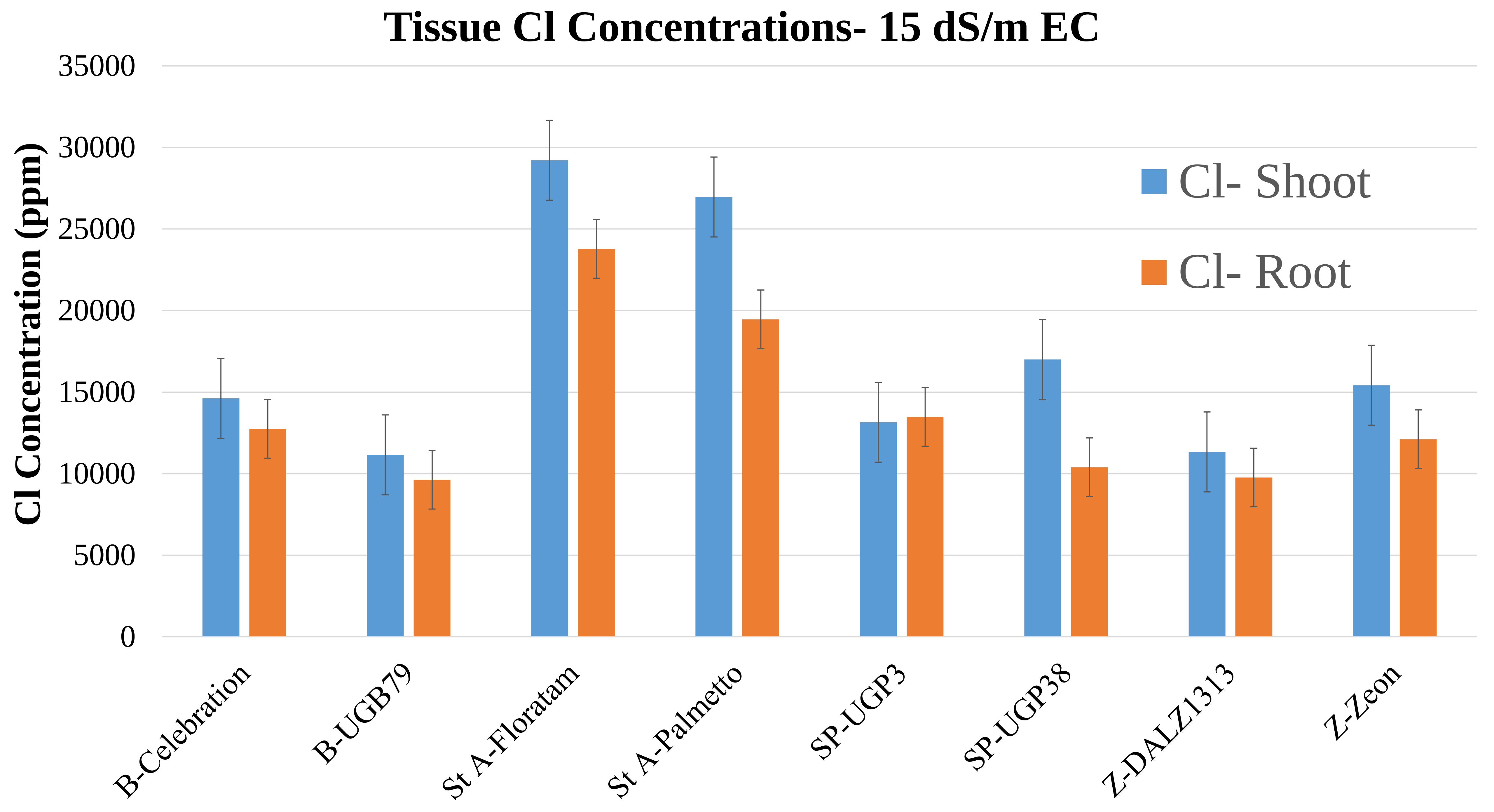
Determine salt excretion capacities & root/shoot tissue accumulation profiles under increasing salinity levels for top and bottom performing lines of each species from earlier salinity screenings

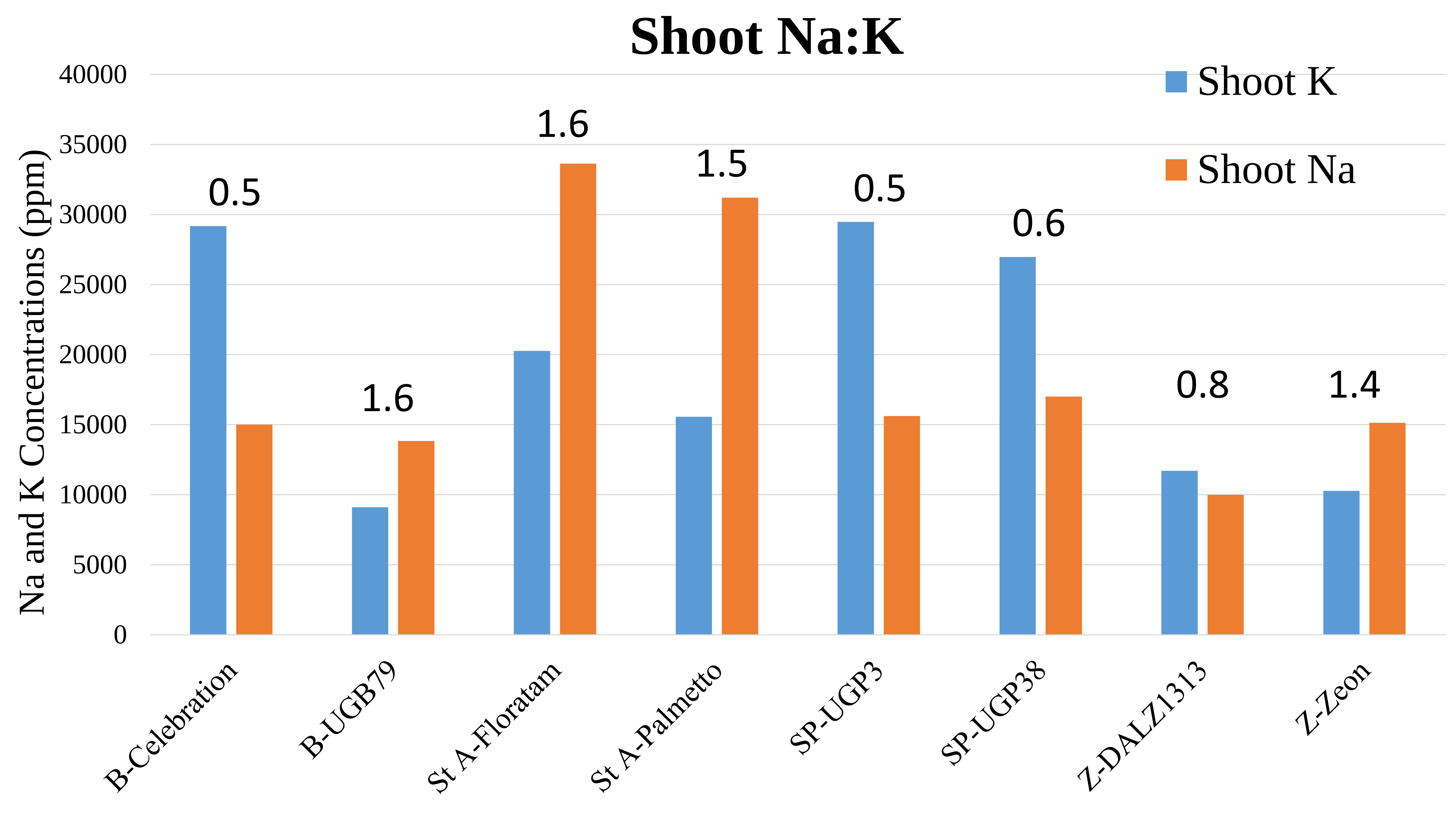
	Species	Tested Salinity Tolerance	Cultivars	Origin
B	*Cynodon dactylon*	Highest	Celebration	Sod solutions
B	*C. transvaalensis x C dactylon = (3x)*	Lowest	UGB79	University of Georgia
Z	*Z. matrella x Z. japonica*	Highest	DALZ1313	Texas A&M University
Z	*Zoysia matrella*	Lowest	Zeon	University of Florida
St A	*Stenotaphrum secundatum*	Highest	Palmetto	Sod Solutions, Inc.
St A	*Stenotaphrum secundatum*	Lowest	Floratam	Univ. Florida/ Texas A&M
SP	*Paspalum vaginatum*	Highest	UGP3	University of Georgia
SP	*Paspalum vaginatum*	Lowest	UGP38	University of Georgia


Salt Excretion Capacity
Salt Excretion Capacity, uS cm-1 g-1 DW wk-1
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
Control
15 dS m-1
30 dS m-1
B-Celebration
B-UGB79
St A-Floratam
St A-Palmetto
SP-UGP3
SP-UGP38
Z-DALZ1313
Z-Zeon



Tissue Na Concentrations- 15 dS/m EC
Na Concentration (ppm)
40000
35000
30000
25000
20000
15000
10000
5000
0
Na- Shoot
Na- Root
B-Celebration
B-UGB79
St A-Floratam
St A-Palmetto
SP-UGP3
SP-UGP38
Z-DALZ1313
Z-Zeon


Tissue Cl Concentrations- 15 dS/m EC
Cl Concentration (ppm)
35000
30000
25000
20000
15000
10000
5000
0
Cl- Shoot
Cl- Root
B-Celebration
B-UGB79
St A-Floratam
St A-Palmetto
SP-UGP3
SP-UGP38
Z-DALZ1313
Z-Zeon



Shoot Na:K
Shoot K
Shoot Na
Na and K Concentrations (ppm)
40000
35000
30000
25000
20000
15000
10000
5000
0
0.5
1.6
1.6
1.5
0.5
0.6
0.8
1.4
B-Celebration
B-UGB79
St A-Floratam
St A-Palmetto
SP-UGP3
SP-UGP38
Z-DALZ1313
Z-Zeon

Conclusions

- These results help to further elucidate salinity tolerance mechanisms contributing to intra- and interspecific differences observed during earlier screenings.

- Collectively, the data support the notion that salinity tolerant genotypes employ one or more physiological mechanisms including salt excretion, root exclusion, limitation of Na and/or Cl transport to shoots, and maintenance of ion balance in coping with saline conditions.

- While DALZ1313, Zeon, and Celebration demonstrated high ion excretion; Celebration, UGP3, and UGP38 limited Na transport to shoots, and thus, maintained favorable ion balance under salinity stress. Conversely, Floratam and Palmetto demonstrated limited ability to tolerate salinity.

Thank you!

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It's A Good Day For Turf In Texas!

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