

Determining Salt Tolerance Among Sunflower Genotypes

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Introduction

- Salt-Affected Soils
 - Salts affect over 6% of the world's arable land.
 - Lower seed germination>>>poor stands
 - Due to soil structure or toxicity
 - Cause stunting, leaf burn >>>>reduced yields



Introduction

- Options for dealing with saline/sodic soils
 - Flush out salts
 - Need abundant water
 - Good quality water
 - Place for water to go
 - Grow salt tolerant crops
 - Alfalfa
 - Sugarbeet (salt-sensitive at germination)
 - Barley
 - Sunflower?

Introduction

- Salt tolerance
 - Ability of a plant to maintain yield in presence of salts in soil solution
 - Attributed to multiple genes
 - Many involved in the regulation of calcium, potassium, and magnesium
 - Shared mechanisms for drought tolerance

Introduction

- Salt tolerance of sunflower
 - Moderately salt tolerant
 - Variation among species and cultivars
 - *Helianthus paradoxus*
 - Thrives in salt marshes



Objective

- Screen for salt tolerance among sunflower genotypes
 - Commercial hybrids- immediate data for growers
 - Oilseed & confection
 - USDA accessions-prospects for future breeding
 - Various backgrounds
 - Interspecific crosses
 - Includes sunflower with *H. paradoxus* in pedigree
 - PAR-#
 - HA-429 & HA-430

Methods

- Petri dish screening
 - ❖ Development of rapid screening method
 - Germination
 - Radicle length measurements, germination percentages
- Greenhouse screening
 - Vegetative stages
 - Morphological measurements in controlled environment
- Field trials
 - Through maturity
 - Heights, yield components, % oil

Methods

- Why screen 3 ways?
 - Correlate petri dish or greenhouse screening results to field results
 - Support development of “quick and easy” method of screening
 - Have more evidence to support recommendation
 - Evaluate how each stage of growth is effected by salt for each genotype

Petri Dish Screening

Materials and Methods

- Seeds of each genotype (24) placed in petri dish with varying concentrations of NaCl/DDW solution
 - 0, 100 & 300 mol m⁻³
- Placed in germinator
- Radicle lengths measured after 10 days
- % germination calculated
- Repeated 3 times



Petri Dish Screening

Results

- ANOVA of Radicle lengths

Source	df	MS	P-value
Salt	2	14,568.0	<0.00**
Genotype	21	449.4	<0.00**
Salt*Genotype	42	302.5	<0.00**
Error	659	102.4	

- Significant genotype x salt (concentration) interaction
- C.V. too high on this test to be reliable

Petri Dish Screening

Results

- C.V.s of tests too high to make recommendations based on radicle length test alone.
- Sample size too small to find significant differences in germination percentages among genotypes and differing solutions.

Greenhouse Screening

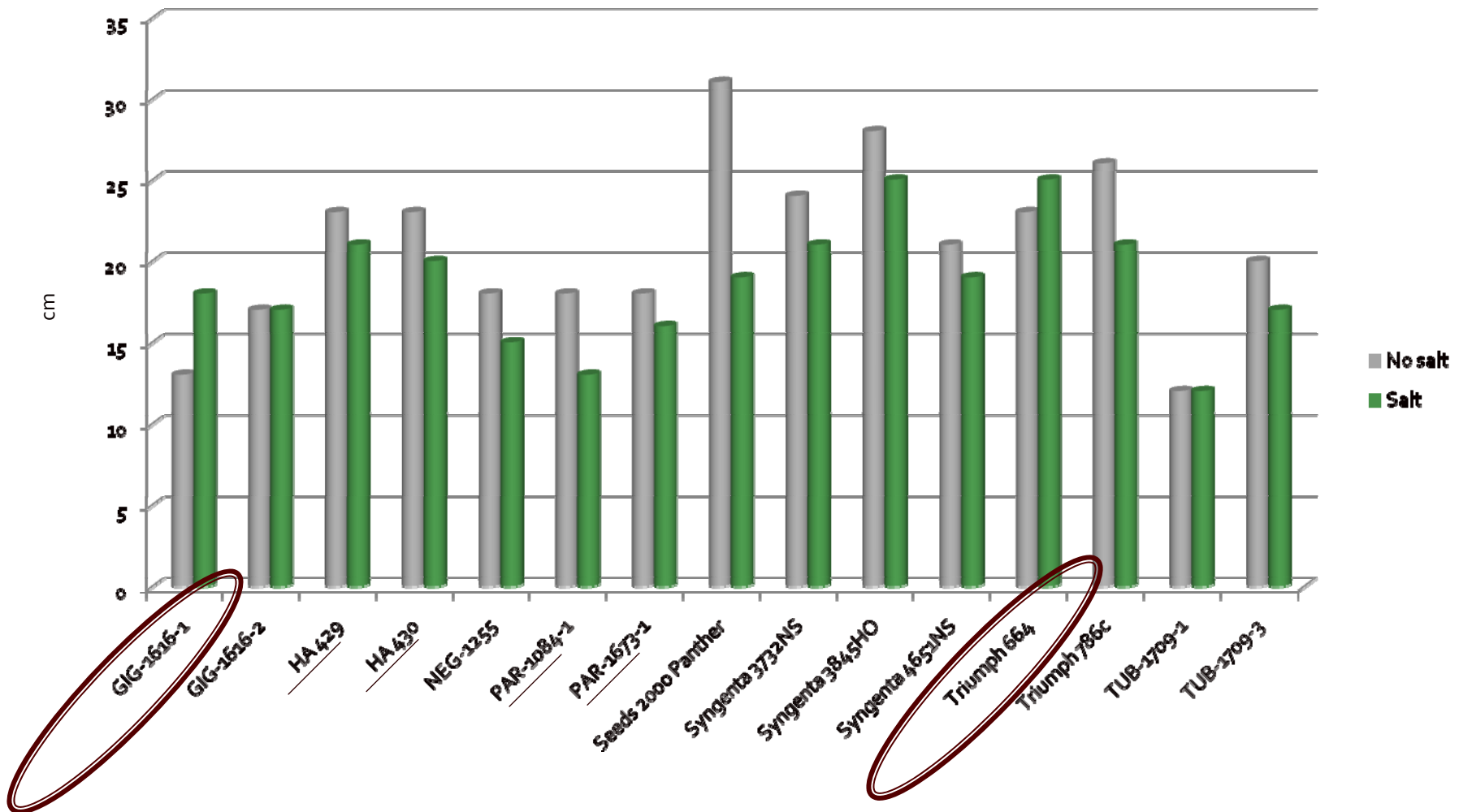
Materials and Methods

- 24 genotypes / 2 plants per genotype in CRD
- Watered with RO water or NaCl (EC 16 s/m) solution
- Solution applied once a week
- At harvest measurements
 - Leaf count
 - Plant height
 - Leaf area
 - SPAD™ meter readings
 - Fresh & Dry weight



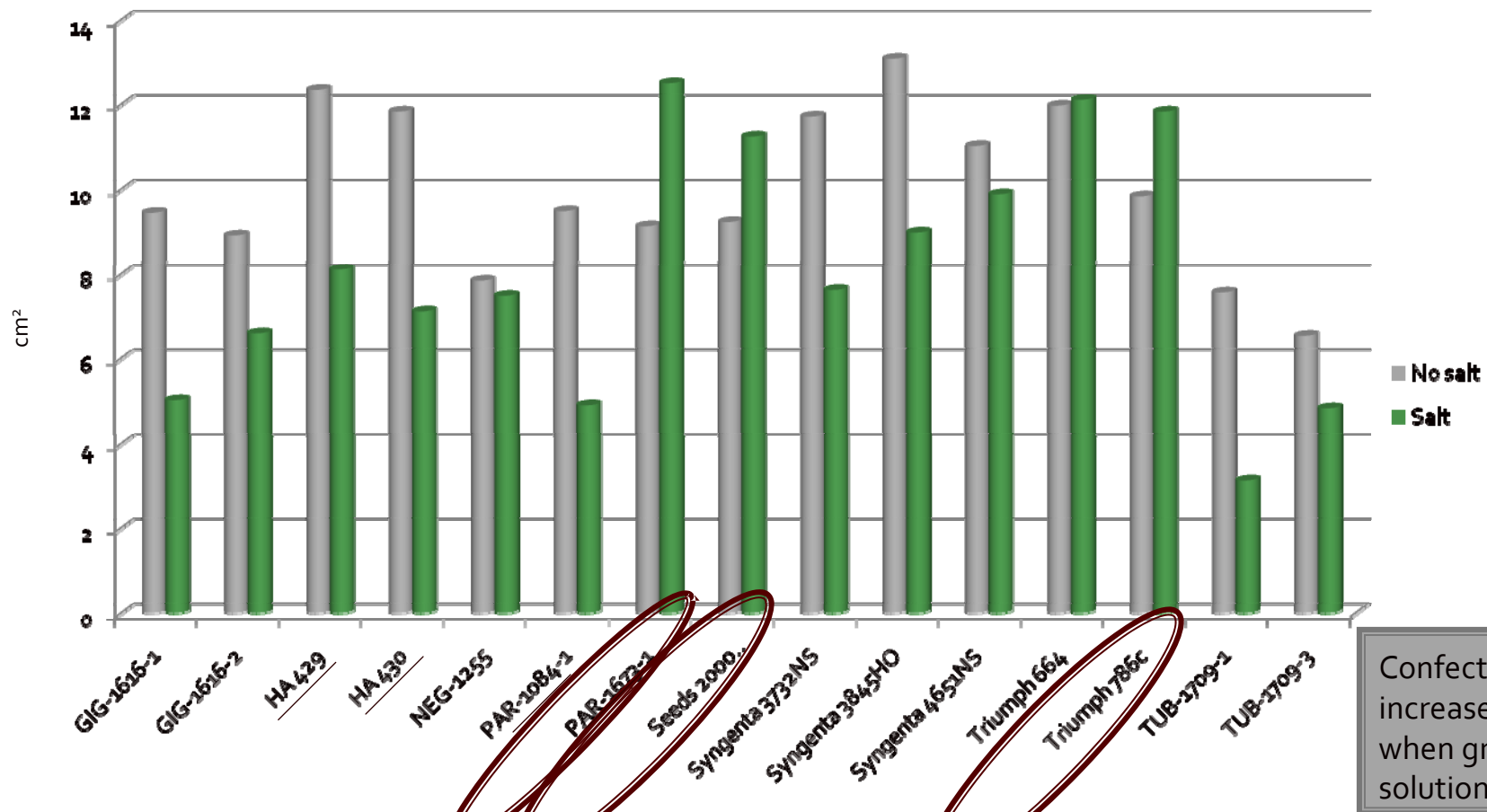
Greenhouse Screening Results

Affect of NaCl on sunflower height



Greenhouse Screening Results

Affect of NaCl on sunflower leaf area



Greenhouse Screening Results

	Plant Height			Leaf Area	
Source	df	MS		df	MS
Salt	1	162.14**		1	189.87**
Genotype	22	86.74**		22	46.34**
Salt*Genotype	22	12.96		22	9.35
Error	86	15.31		82	17.18

Greenhouse Screening Conclusions

- There were no significant genotype x salt interactions for any measurements taken.



Salt added

Control

- Demonstrated reduction of plant height with increased salt in root zone.
- Identify possible trends for future study

Field Trials

Materials and Methods

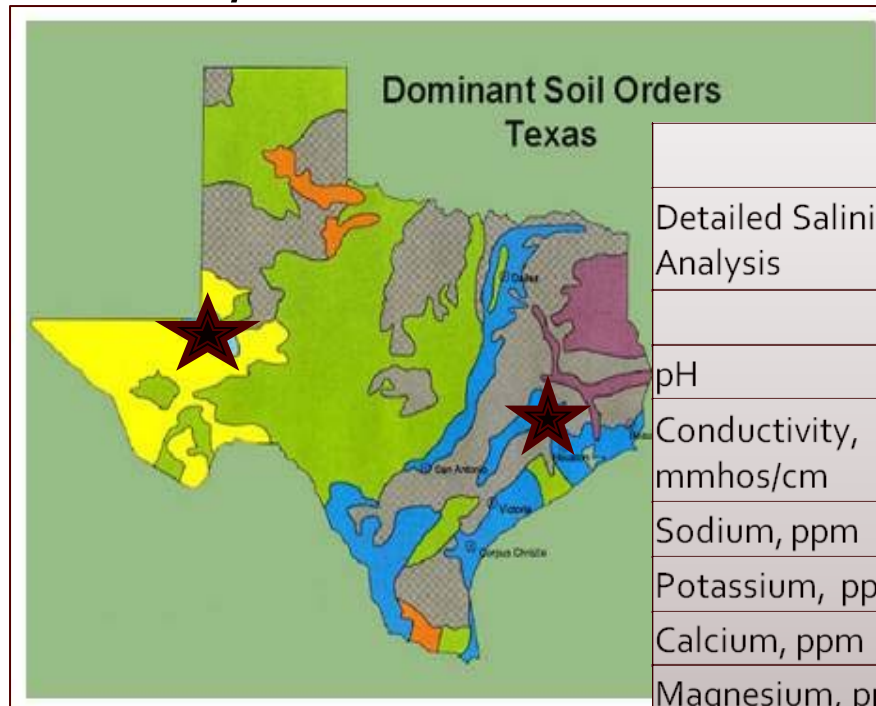
- 24 genotypes in RCBD
- 2 years
- Measurements taken
 - Morphological
 - Plant heights
 - Yield components
 - Total yield
 - 100 seed weight
 - Percent seed oil



Field Trials

Materials and Methods

- Two locations
 - College Station, TX-low salts in soil
 - Pecos, TX-salt affected soil & irrigation water



Detailed Salinity Analysis	Soil Analysis			
	College Station, TX		Pecos, TX	
	2010	2011	2010	2011
pH	7.1	7.2	7.1	7.5
Conductivity, mmhos/cm	0.1	0.9	5.4	877.9
Sodium, ppm	55	88	875	15372
Potassium, ppm	15	17	37	220
Calcium, ppm	93	119	426	1747
Magnesium, ppm	9.0	11.5	67.0	501.5
SAR	1.5	2.0	10.4	86.9

Field Trials

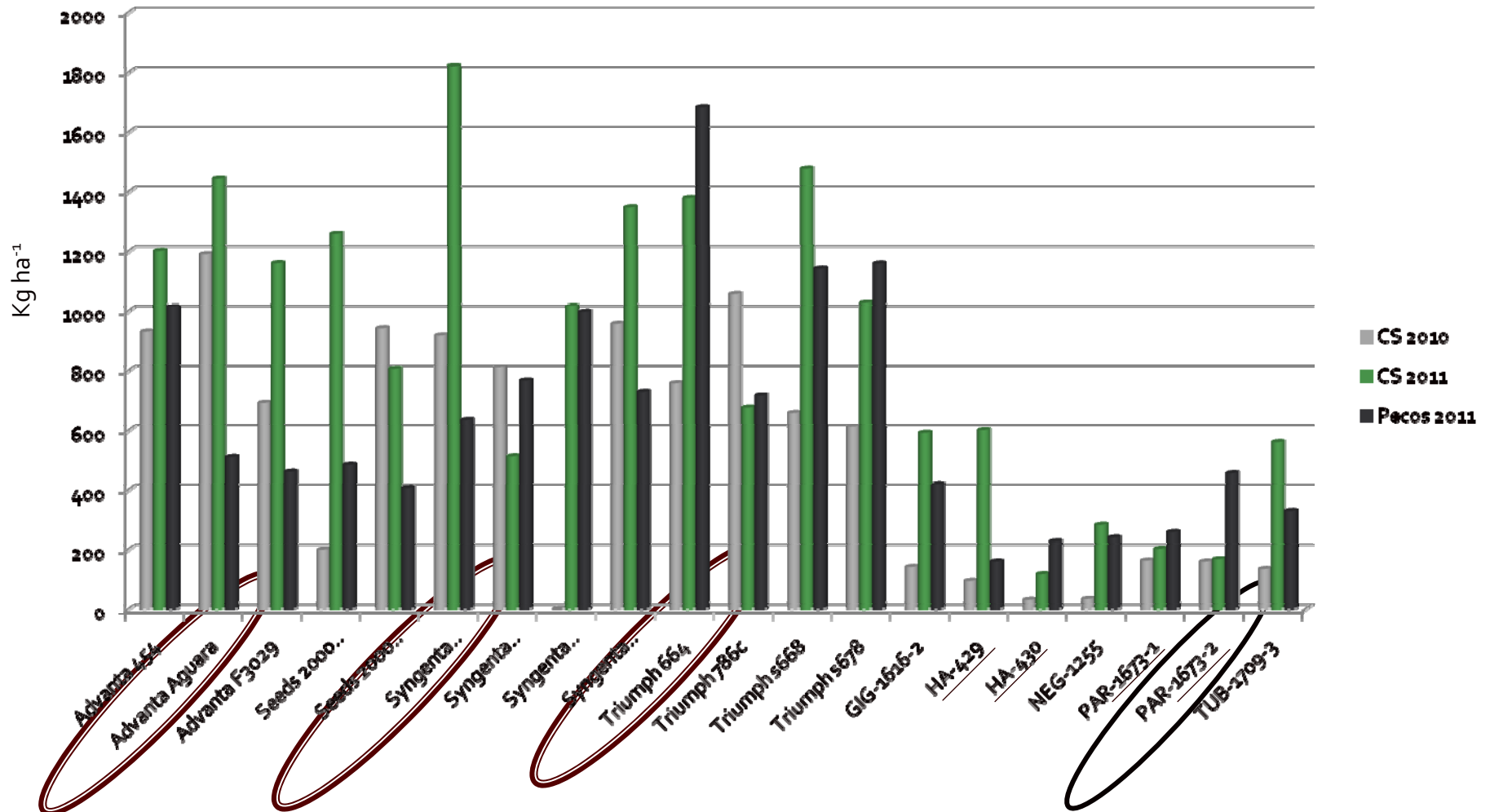
Results

- Pecos 2010 yield data lost due to sunflower head moth, *Homeosoma electellum*, feeding.



Field Trials Results

Sunflower Seed Yield



Field Trials

Results

	Seed yield		Hundred-weight seeds	
Source	df	MS	df	MS
Location	1	2,545,991	1	10.24
Genotype	23	1,287,583**	23	25.18**
Genotype*Location	23	303,809*	23	2.60**
Error	132	175,445	131	1.27

2011 Yields and 100-weights

Field Trials

Results

- Location did not have a significant effect on oil content.

	Seed Oil %	
Source	df	MS
Location	1	8.93
Genotype	21	88.43**
Genotype*Location	21	8.72
Error	119	5.96

Genotype	Seed oil %
TUB-1709-3	38.7 a
Triumph s668	36.7 ab
Syngenta 3732 NS	36.7 ab
Syngenta 4651 NS	36.2 bc
Triumph s678	36.0 bc
Syngenta 3845 HO	36.1 bc
HA 429	35.6 bc
Triumph 664	35.5 bc
Advanta 454	34.8 c-e
PAR-1673-1	34.7 b-d
TUB-1709-1	34.1 c-e
TUB-365	33.1 d-f
Seeds 2000 Firebird	32.8 e-h
PAR-1084-1	32.1 e-h
NEG-1255	31.9 e-h
Advanta Aguara	31.8 e-h
HA 430	30.7 gh
PAR-1673-2	27.9 i
Syngenta 4596 HO	27.1 i

Field Trials

Results

- Genotypes were significantly different for height, yield, 100 seed weight and oil content within locations and years.
- The interaction of genotype x location was significant for yield and 100 seed weight.

Conclusion

Grower Recommendations

- College Station
 - Advanta Aguara
 - Syngenta 4651NS
 - Syngenta 3732NS
 - Triumph 664
 - Triumph s668
- Pecos*
 - Triumph 664
 - Triumph s668
 - Triumph s678

*based on one year of data

Conclusions

- Candidates for further testing/breeding
 - Syngenta 4596 HO
 - ARG-1575-1
 - GIG-1616-1
 - TUB-1709-3
 - PAR-1673-2

Conclusion

- Rapid screening protocols show differences in radicle length elongation among genotypes in differing concentrations of salt, but needs to be further developed.
- Greenhouse trials should have more precise environmental controls and larger sampling size.
- Height and oil content are not good indicators of salt tolerance.

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Questions?

