Response of *Salix purpurea* growth to fixed schedules of salinity exposure

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Introduction

Impact of Road Salt on Roadside Vegetation

- 15-18 million tons of salt deicer is applied to road each year in the United States.
- 20% to 50% of roadside vegetation experience loss due to high salinity.
  - Harms normal ecological processes.
    - Ex: photosynthesis - energy
  - Problems with the uptake of different nutrients.
    - Ex: Nitrogen - without nitrogen growth and reproduction is restricted.
- Salt splash and spray affects foliage and causes ingestion of salt through roots.
- Drought-like symptoms due to osmotic stress and water imbalance.

Salix purpurea

- Fast growing, deciduous shrub
- Native to most of Europe and western Asia - Introduced to North America for erosion control
- Generalist in where they can live and survive
- Overlapping and expanding roots
- Some tolerance to harsh, toxic environments
- Accumulate trace elements at a higher level than most plants

Salinity effects on *Salix purpurea*

- High levels of salt decreases the rate of evapotranspiration
- Have been known to adapt to high salt levels after some exposure
  - Ideal for bioremediation
- If salt content is high enough in the plant it will be removed back into the soil through osmosis.
  - Leads to dehydration

Our Questions

Our Questions

- How does salt concentration affect willow growth?
- How does duration of salt exposure influence growth of *Salix purpurea*?
- Is there an interactive effect between salt concentration and duration of exposure on the growth of *Salix purpurea*?

Background Factor 1

Salt Concentration:

- More salt means greater energy needs
  - Cannot maintain homeostasis
- Lower levels
  - Leads to better establishment of growth early
  - Worse long-term
- Willows are salt tolerant not halophytic plants
  - Transplants more sensitive

Background Factor 2

Duration:

- Salt never returns to baseline
  - Elevated levels through Spring and Fall
- Repeated extended exposures worse than shorter single time exposures
- Causes long term water loss

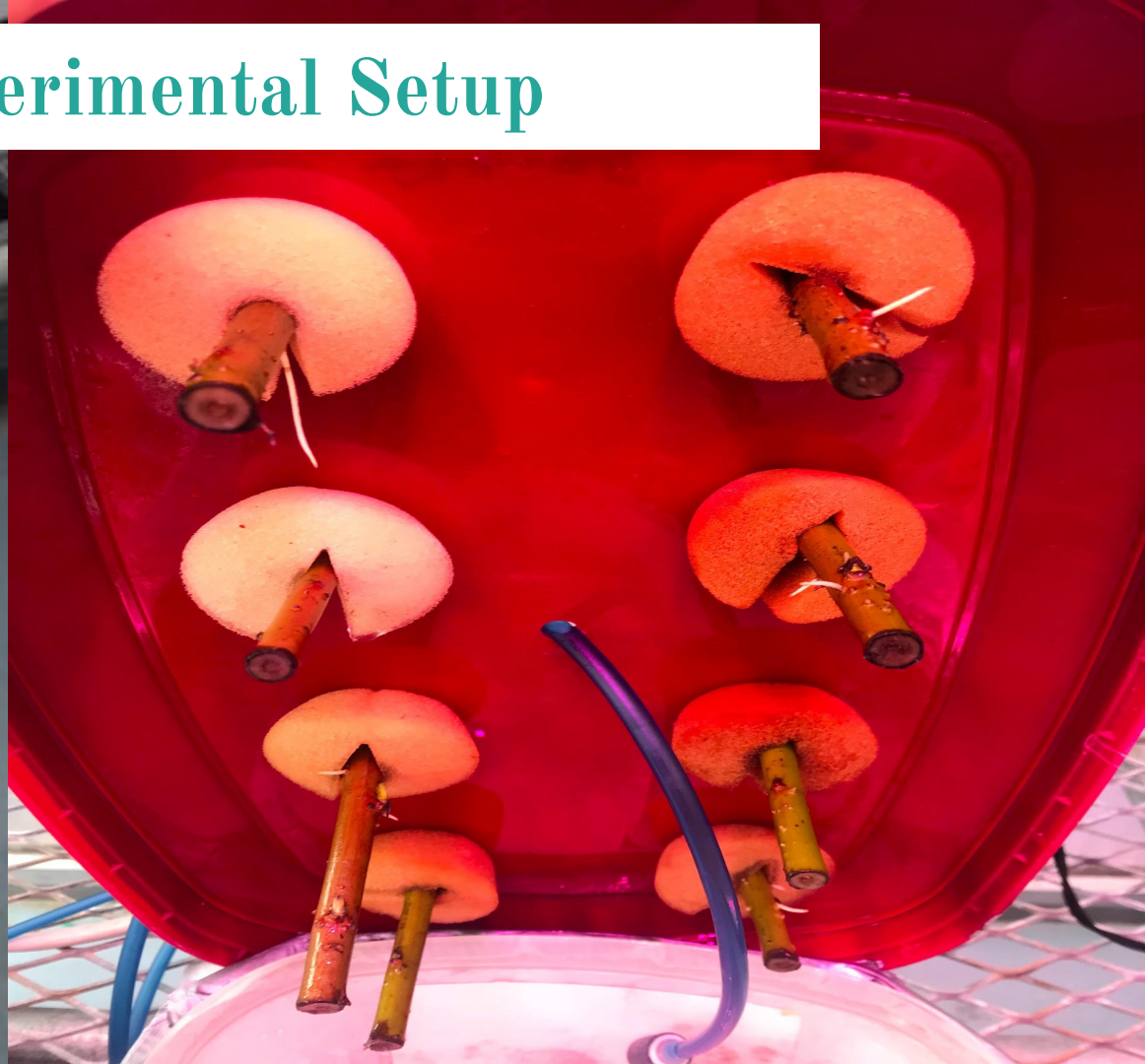
Hypothesis

Our Hypothesis

Plants exposed to higher concentrations of salt for longer periods of time will have a decrease in leaf length, root length, shoot length, and overall plant biomass.

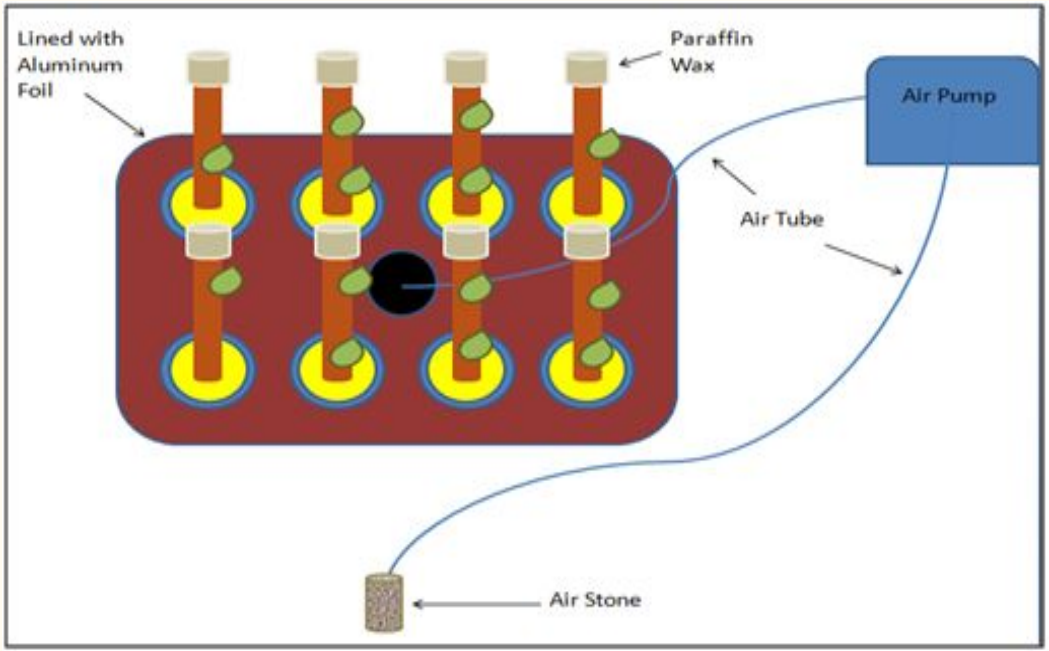
Experimental Design

Experimental Setup



Preparations

- Cutting Preparation
  - Soaked 64 cuttings
  - Disinfected with ZeroTol 2.0
  - Paraffin wax
- Hydroponic System Set-Up
  - Air pumps & air stones



Experimental Design

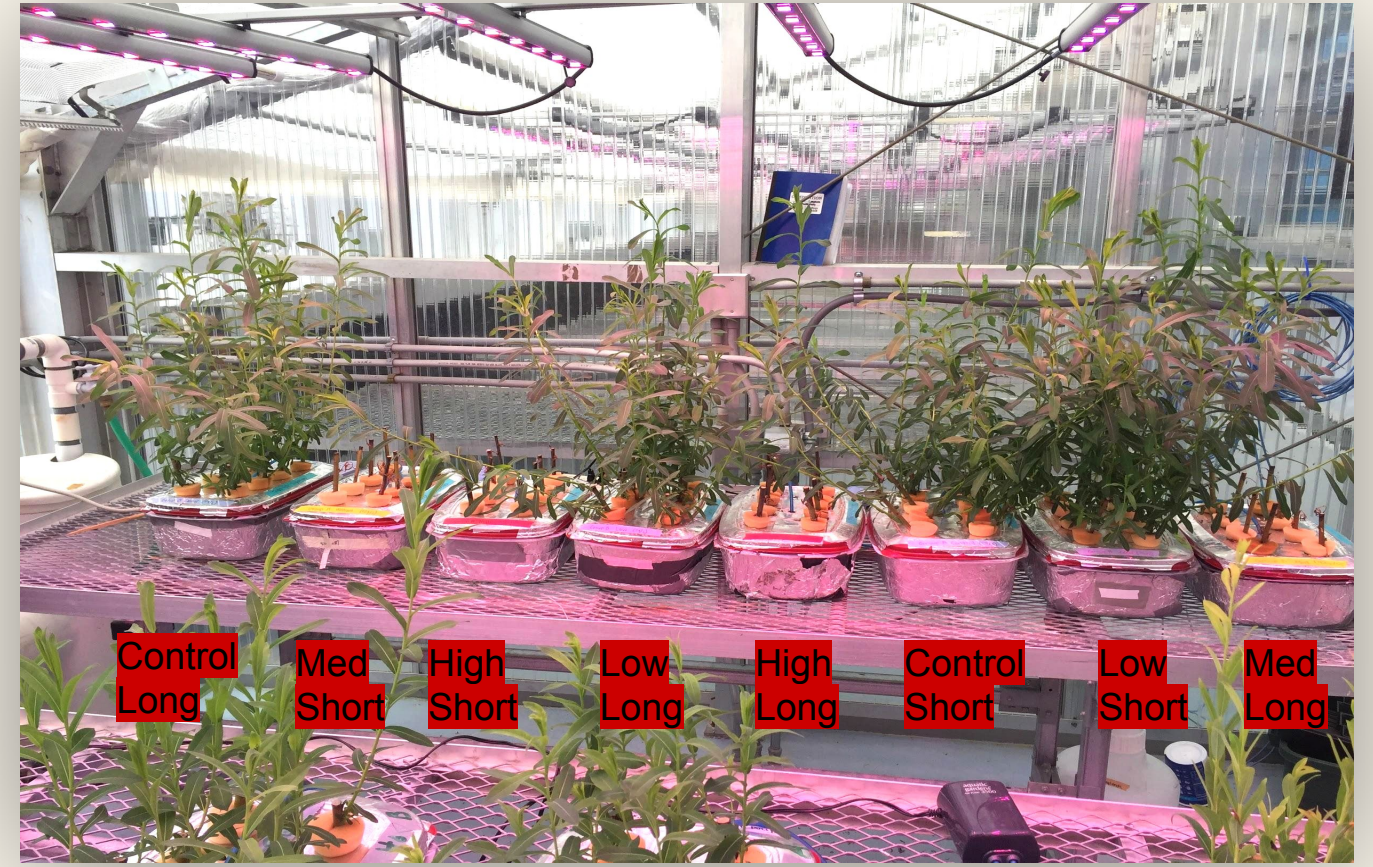
Salt Concentration	Short (1-week intervals)	Long (2-week intervals)
Control (0g/L)	Weeks 1, 3, 5	Weeks 1 & 2, 5 & 6
Low (1g/L)	Weeks 1, 3, 5	Weeks 1 & 2, 5 & 6
Medium (6g/L)	Weeks 1, 3, 5	Weeks 1 & 2, 5 & 6
High (12g/L)	Weeks 1, 3, 5	Weeks 1 & 2, 5 & 6

Water and salt were replaced three times a week. Each group had 8 replicates.

Measurements

- SPAD Meter: Chlorophyll Content
- Conductivity Probe: Water Conductivity
- Scale: Biomass
- Ruler: Root, Shoot and Leaf Length
- SAS JMP: Statistical Analysis

Results


Control
Long
Med
Short
High
Short
Low
Long
High
Long
Control
Short
Low
Short
Med
Long


SHORT-MEDIUM


SHORT-HIGH

Questions

How does salt concentration affect willow growth?

How does duration of salt exposure influence growth of *S. purpurea*?

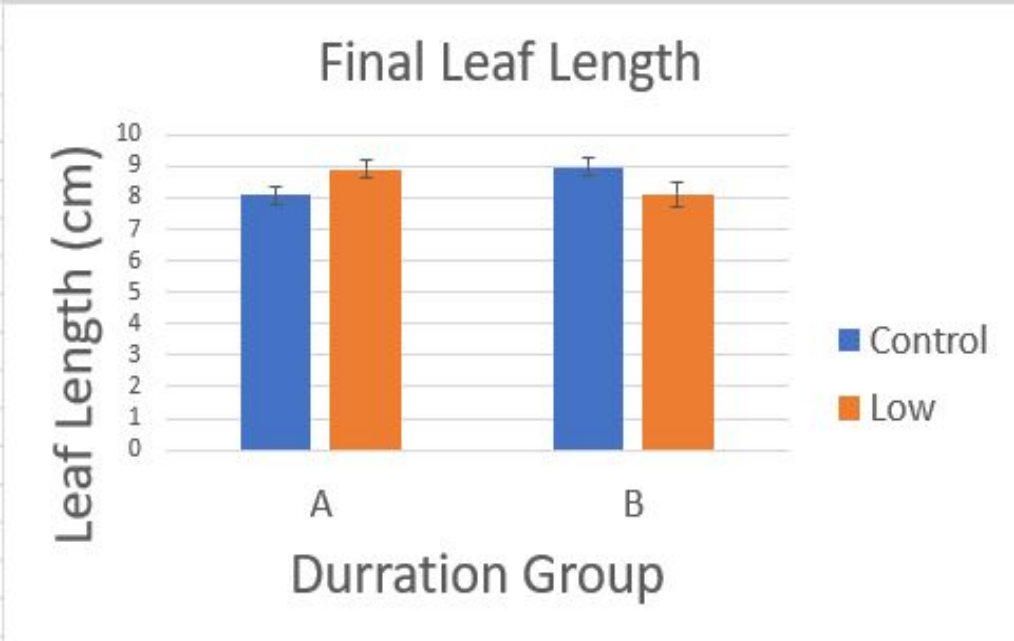
Is there an interactive effect between salt concentration and duration of exposure on the growth of *Salix purpurea*?

Final Leaf Length

Salt concentration: (F=0.0057, p= 0.9406)

Duration of exposure: (F= 0.0226, p=0.8816)

Salt concentration x Duration of exposure: (F=6.5337, p=0.0163)



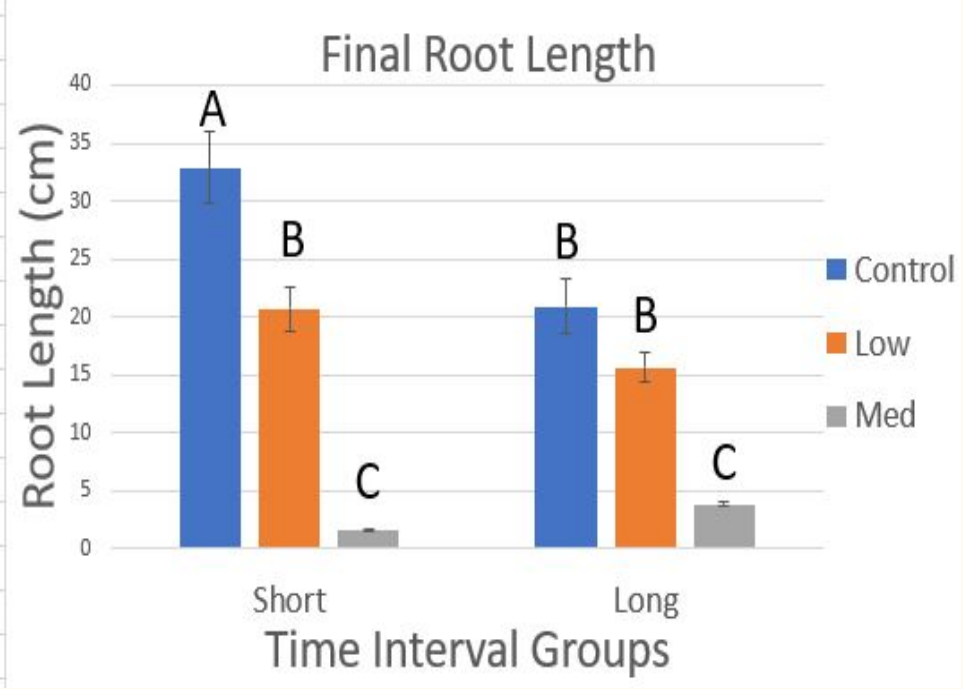
Final Root Length

Salt concentration: (F=13.8261, p= 0.0009)

Duration of exposure: (F=13.2374, p=0.0011)

Salt concentration x Duration of exposure:

(F=2.1995, p=0.1492).

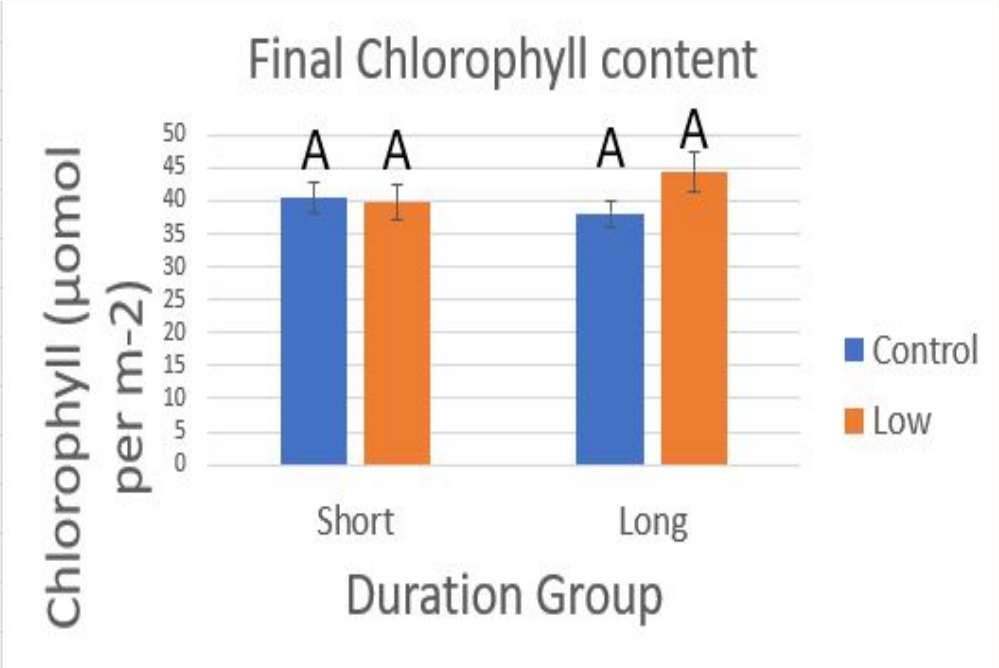


Final Chlorophyll Content

Salt concentration: (F=1.8792, p= 0.1813)

Duration of exposure: (F=1.8792, p=0.1813)

Salt concentration x Duration of exposure: (F=1.8792, p= 0.1813)

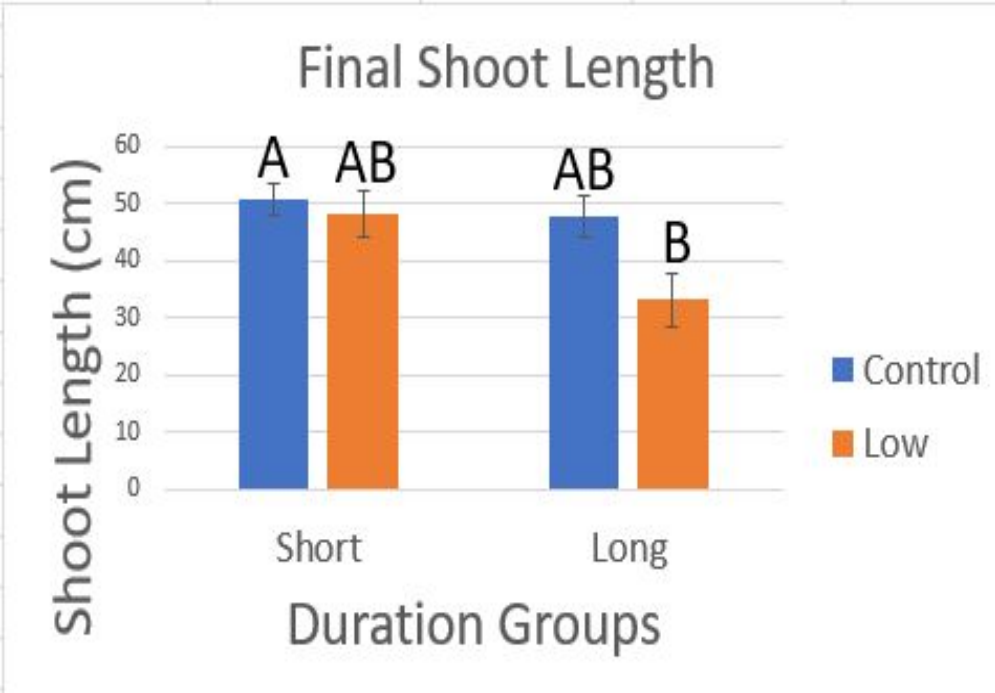


Final Shoot Length

Salt concentration: (F=4.8133, p= 0.0367)

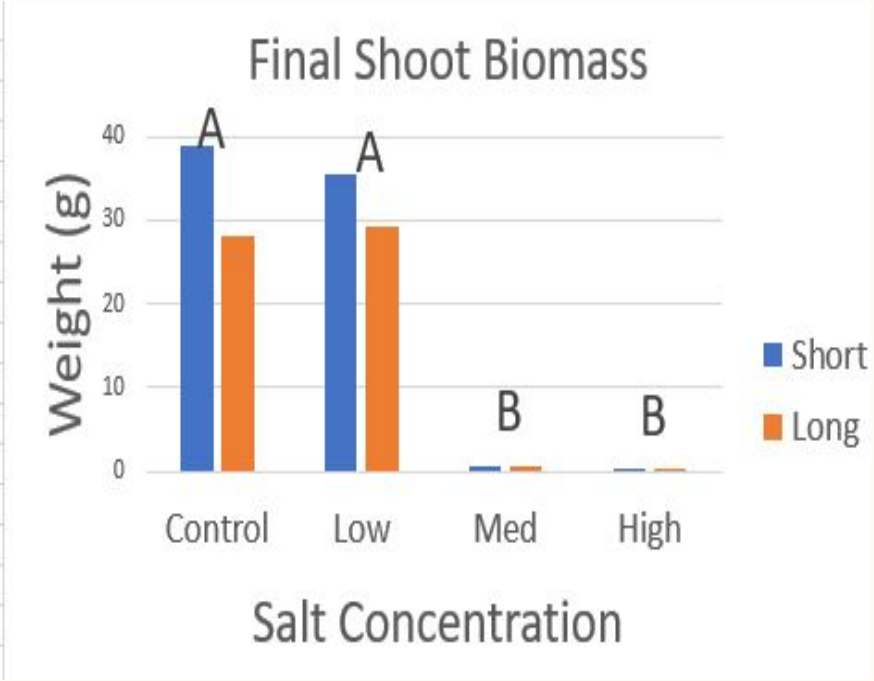
Duration of exposure: (F=5.3485, p=0.0283)

Salt concentration x Duration of exposure: (F=2.3680, p=0.1351)



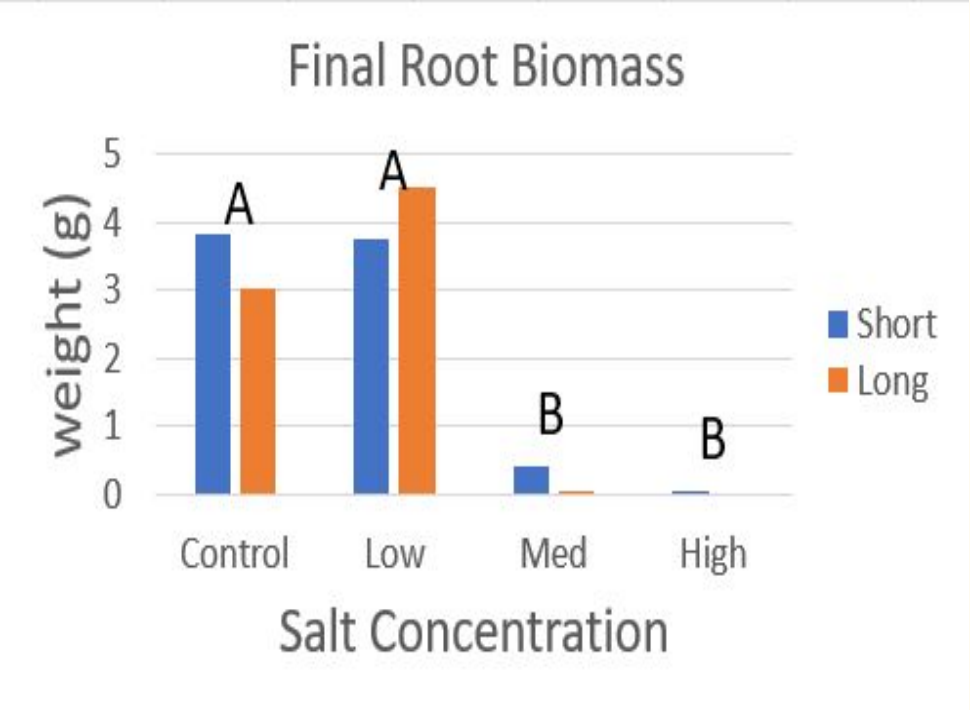
Shoot Biomass

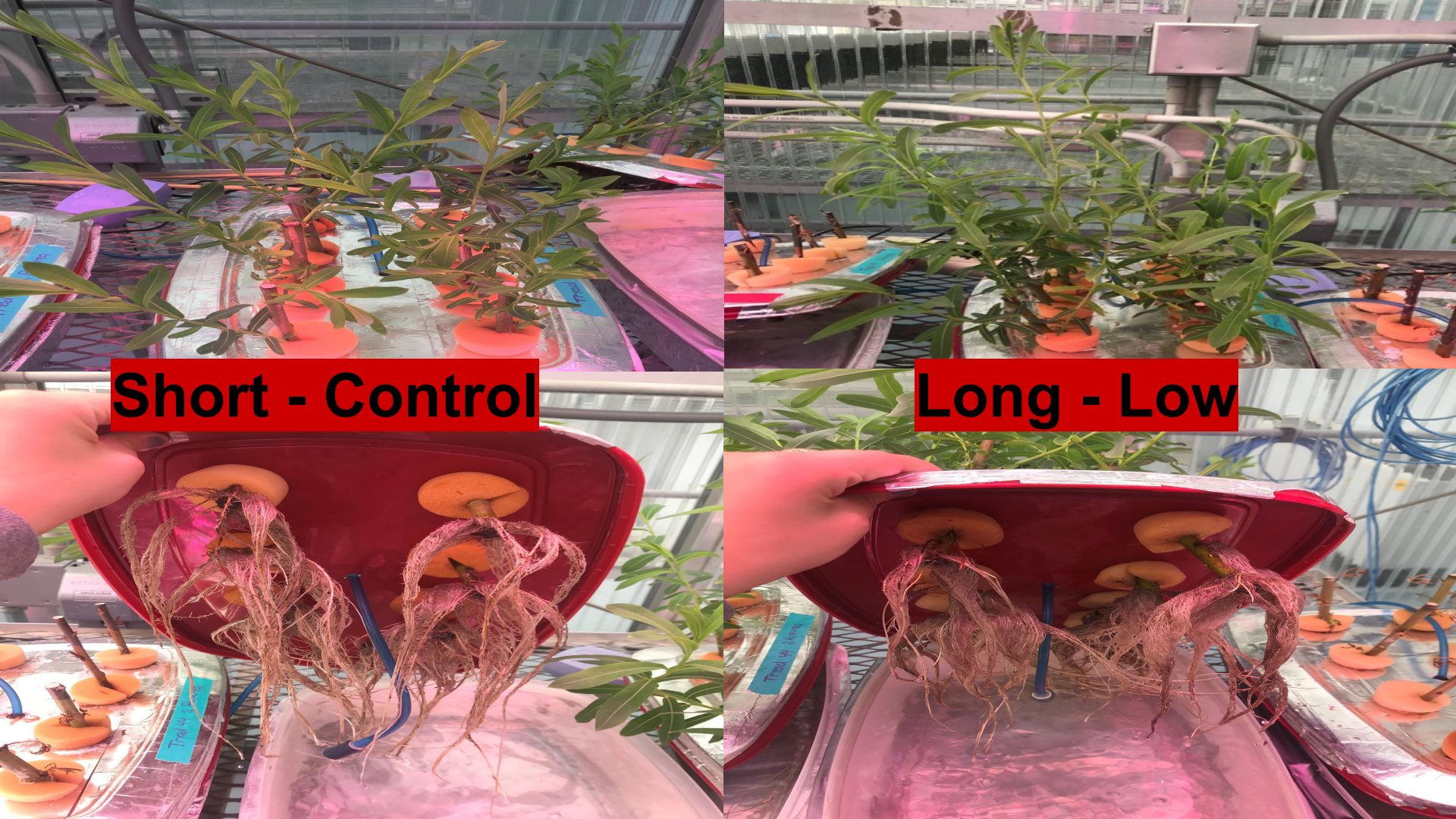
Salt concentration:(F=48.7114, p= 0.0048)



Root Biomass

Salt Concentration: (F=41.8366, p= 0.0060)




Short - Control
Long - Low

Findings and Limitations

Conclusion

Growth affected by salt concentration and duration of exposure:

- Final leaf length (positive interactive effect)
- Final root length
- Final shoot length
- Total biomass

Potential trends in:

- Carbon allocation
- Chlorophyll content
- Recovery after two weeks

Discussion

Rain Gardens

- Filters other toxic components of water and soil
  - Benefit aquatic animals and surrounding plants
  - Good for cities

Old Mining Land

- Reestablish healthy plant growth
- Use wasted land

Bioenergy

- Root and Shoot Biomass

Future Research

- Extend the experiment - make enough time for multiple intervals of no treatment weeks
  - Recovery persists over time
  - Shoot length
  - Chlorophyll content: higher salt = higher chlorophyll content
- Keep salt concentration below 6g/L to prevent death of treatment groups.
- More treatment groups to see trends in carbon allocation.
- Gene splicing - filtration

Acknowledgements

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Questions?

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Limitations

- Control Group B
  - Higher average leaf length
  - Lower average root length
- Chlorophyll content
  - (Yuan *et al.* 2016)
- Salt Conductivity
  - Salt Burn (Appleton *et al.* 2015)