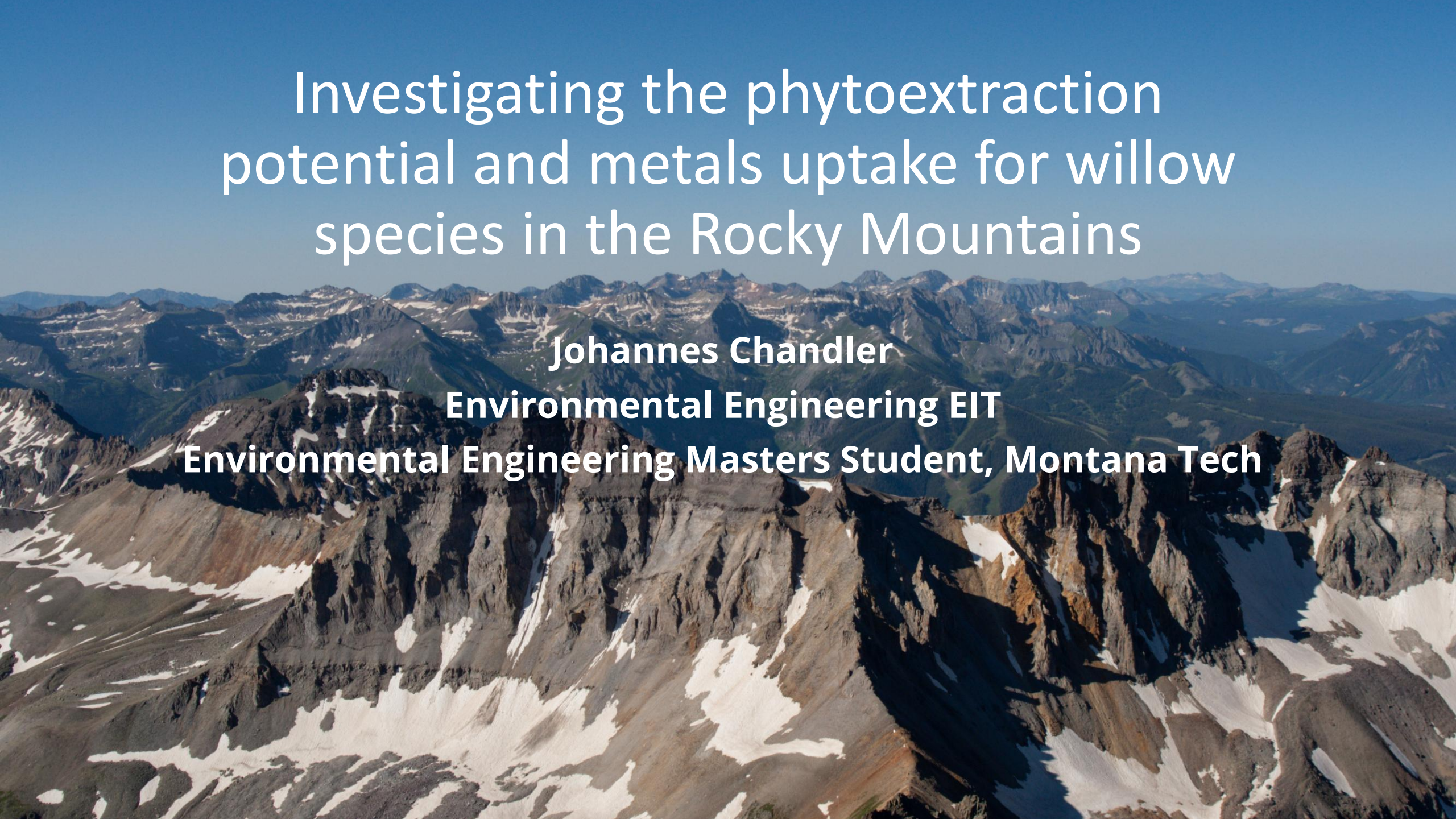
Investigating the phytoextraction potential and metals uptake for willow species in the Rocky Mountains



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Overview

- **Project Introduction**
- **Background**
- **Phytoremediation Basics**
- **2024 Summer work**
- **Growing Willows**
- **UMEC Greenhouse**
- **UMEC Surface**
- **Analytes**
- **Thank you**

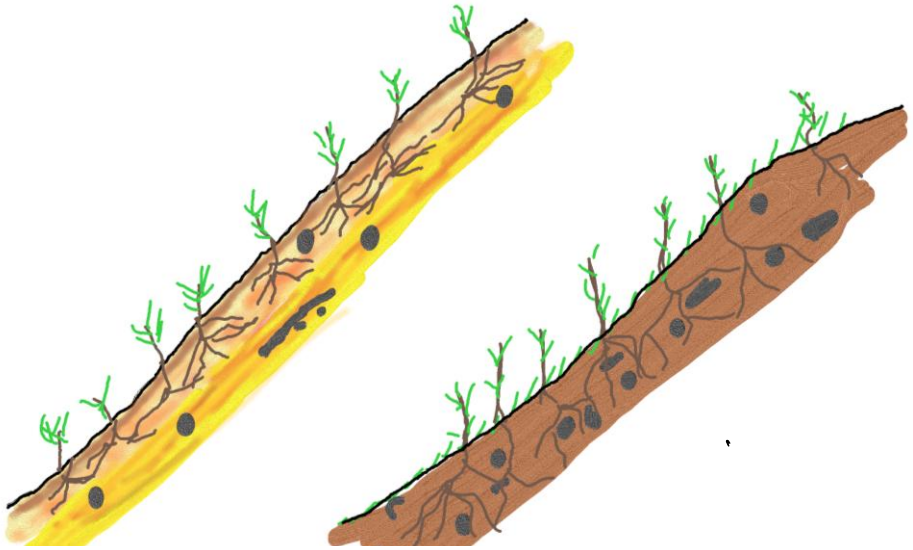
Project Introduction

- **Problem Statement: Investigating the metal uptake rate, phytoextraction and phytomining potential for willow species in the Rocky Mountains.**
- **Locations:**
  - Atlas Mill, Ouray, CO
  - Butte Metro Sewer, Butte, MT
  - Underground Mining Education Center (UMEC), Butte, MT

Background

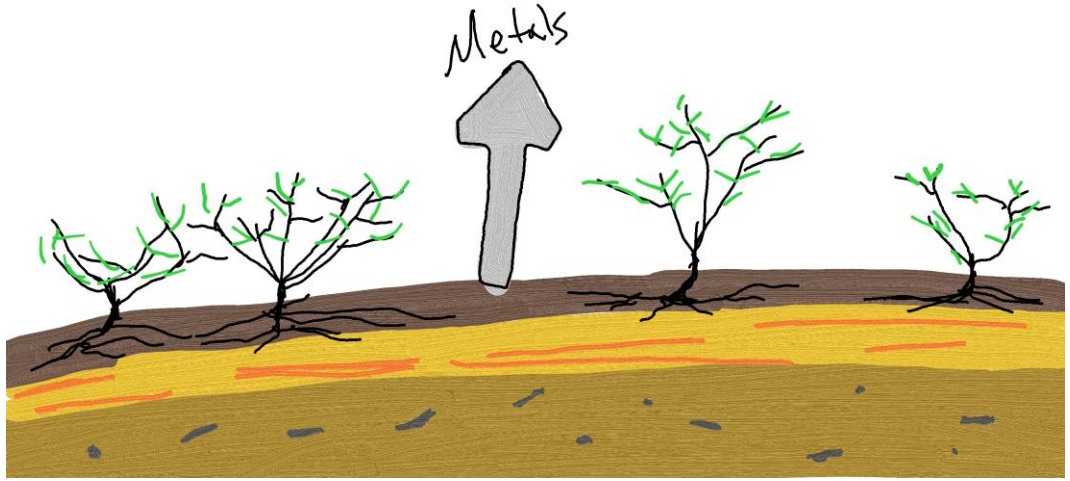
- **The Rocky Mountains have an extensive history of Mining**
- **Thousands of abandoned sites**
  - Human Health Risk
  - Environmental Health Risk
  - Lost Resources
- **Willows**
  - Common restoration species
  - Low cost, easy to install, hardy species

What is Phytoremediation?



- **Phytoremediation is the use of plants to aid in the remediation of a contaminated site.**

- **3 common forms of Phytoremediation:**
  - Phytostabilization
  - Phytovolitolization
  - Phytoextraction



Why Phytoremediation?

- **Cost effective**
- **Natural**
- **Simple**
- **Easy to understand**
- **Low emission**

Metals

- **Target metals:**
  - Mn, As, Cu, Zn, Mg, Cd
- **Critical Metals**
- **Dependent on orebody of wastes**

2024 Summer Work

- **Literature Review**
- **Conducted background site work in Colorado and Butte**
- **Adjusted Project and developed Growth plan**
- **Began Processing data**

Background Site Parameters

- **Metals content:**
  - Willows
    - Roots, Shoots, Leaves
    - ICP OES analysis
  - Soils
    - ICP OES, XRF, Nutrient testing
  - Water
    - Surface water, groundwater
    - ICP OES

Atlas Mill, Ouray, Colorado

- **Abandoned Mill in the San Juan Mountains**
- **Good Samaritan Project conducted by Trout Unlimited in conjuncture with USFS**
- **Clean-up objective: Remove waste product from 100-year floodplain of Sneffels Creek**

Work conducted at Atlas Mill

- **Met with Trout Unlimited Representative**
- **Installed 18-1.5” monitoring Wells**
- **Established 13 Surface water monitoring locations**
- **Collected soil samples**
- **Collected willow samples**
- **Collected Groundwater and surface water samples**


Atlas Mill Campground

Atlas Mill Parameters

- **Water Quality:**
  - Surface Water
  - Groundwater
- **Soil Characteristics**
  - Soil Sampling
  - Nutrient testing
  - Metals testing
- **Willow Sampling**
  - ICP Analysis for metals

Water Quality

- **Monitoring wells**
  - PH
  - Conductivity
  - Temperature
- **Surface water**
  - PH
  - Conductivity
  - Temperature

Willow Sampling

- **Willows**
  - Roots
  - Shoots
  - Leaves
  - Height

Butte Metro Sewer

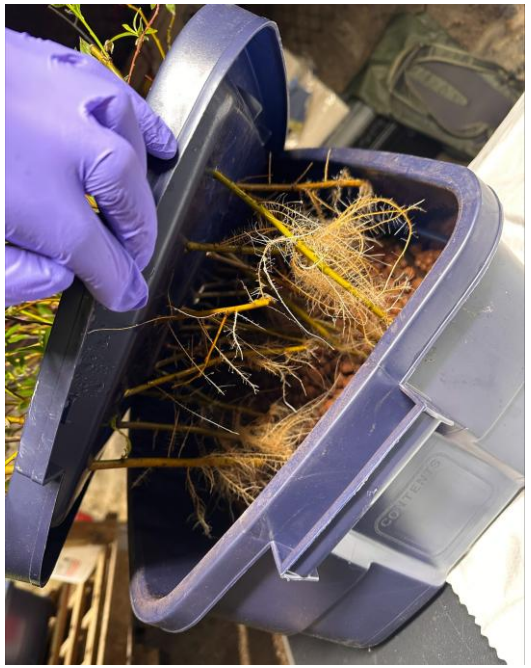
- **Located in Butte, MT**
- **Existing population of willows**
- **Groundwater contamination present**

Sampling at BMS

- **Samples:**
  - **Surface Water:**
    - **Upgradient**
    - **Downgradient**
  - **Soil Samples**
    - **0"-6"**
    - **6"-12"**
    - **12"-18"**
  - **Willows:**
    - **Roots, Shoots, Leaves**

Growing Willows

- **2 growth settings**
  - Underground Greenhouse
  - UMEC surface
- **4 growth conditions**
  - “Mine Rock Clean Water”
  - “Mine Rock Orphan Boy Water”
  - “Clay Bead Clean Water”
  - “Clay Bead Clean Clean Water”
- **30 shoots per basin**



Underground Mine Education Center

MONTANA
TECHNOLOGICAL UNIVERSITY

UMEC Greenhouse

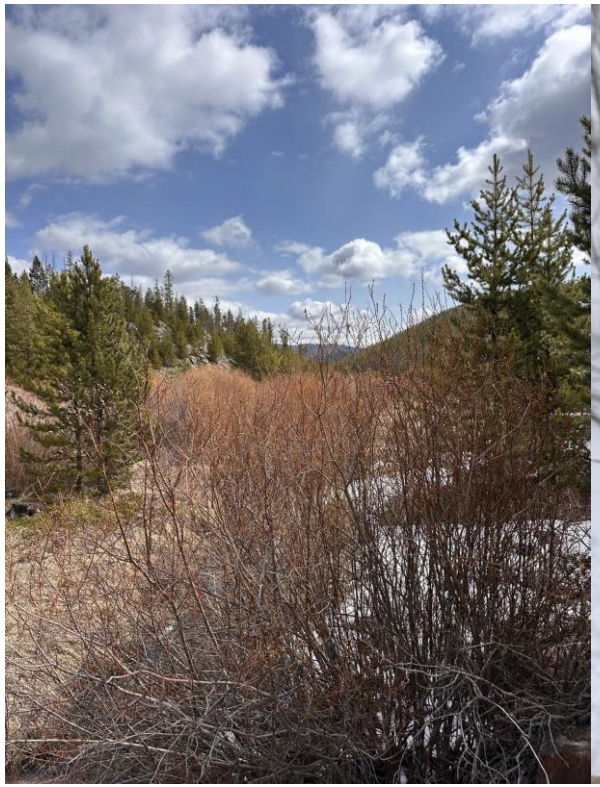
- **Located in Underground Mine Education Center**
- **Controlled Environment:**
  - **65-75% humidity**
  - **9.5-11 C**

UMEC Surface

- West of Campus
- Access water sources
- Access to power
- Exposed to natural conditions 05/23/25 - 07/25/25

Willow Source

- **Willows**
  - 50 Live Shoots collected February 19th, April 22nd
    - Less than 6" tall
    - Shoot Diameter: ½"-1"
  - Source: Blacktail Creek

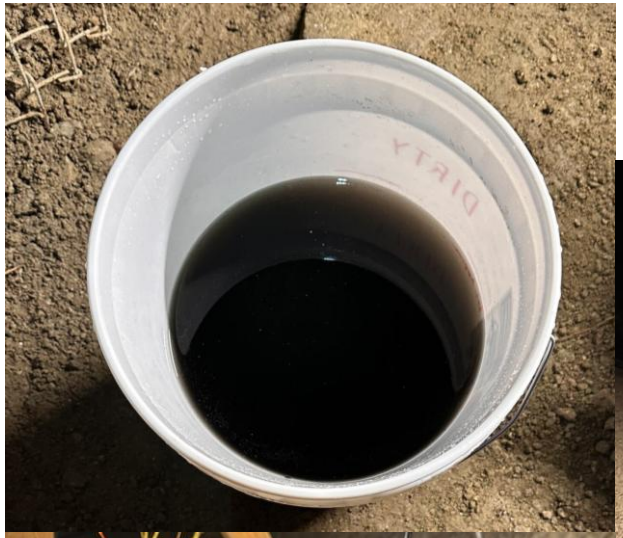


Willow methods

- **Willows Processed Further**
  - **Shoot length: 6-10"**
  - **Shoot diameter: 1/8"-¼"**
  - **120 Shoots**
    - **30 shoots/growth basin**

Water Sources

- **Two water sources:**
  - Orphan Boy Water
  - Tap/Dehumidifier water



Growth Basins

Planting

- **120 shoots planted 03/13/25**
- **120 shoots planted 05/23/25**

Sampling and monitoring

- **Samples of influent water and effluent water collected every other rotation**
- **Monitoring:**
  - pH
  - Conductivity (mS)
  - Temperature (C)

UMEC Growth 03/13-05/15

03/13/25

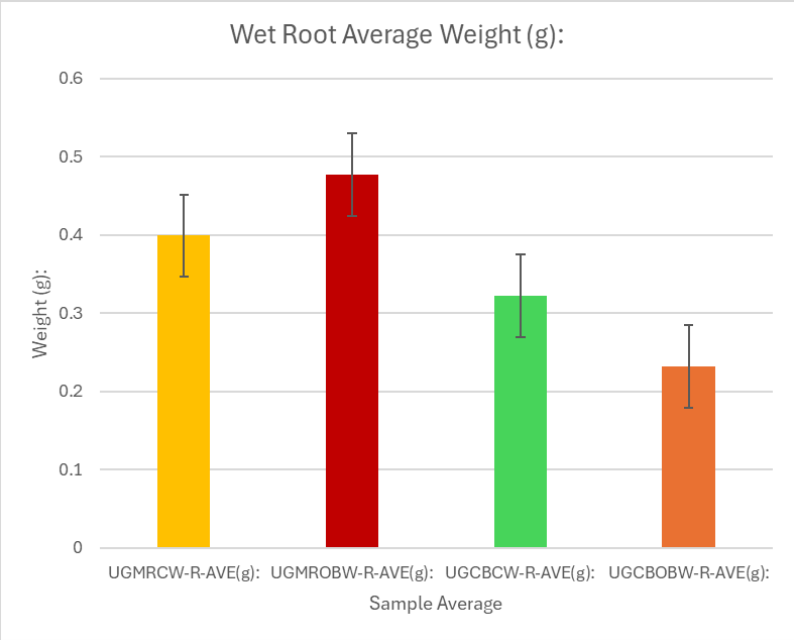
04/01/25

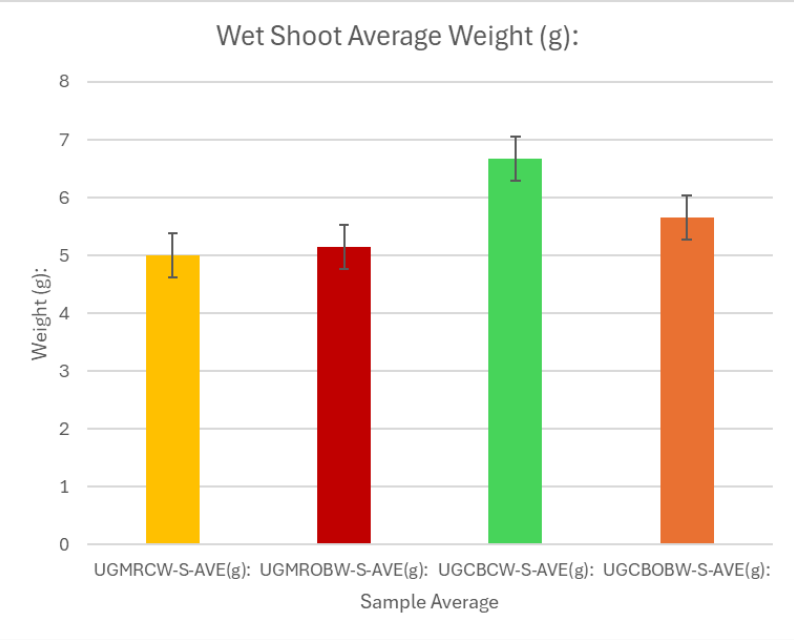
05/15/25

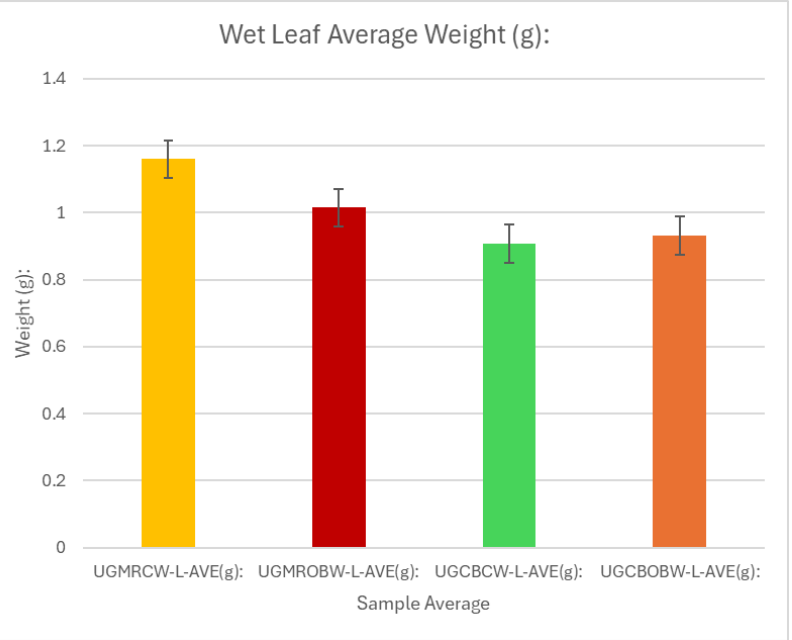
UMEC Growth Collection

- **Basins drained**
- **Plants removed**
- **Plants rinsed, dried, separated, weighed, bagged**

Average Wet Mass Data







Growth Analytes

- **Willows**
  - Roots, Shoots, Leaves
  - ICP OES
- **Growth media**
  - XRF
  - ICP OES Validation
- **Water**
  - ICP OES

Acknowledgements

Thank you to Robin Bullock, Carl Leitert, Halle Cogley, Gavin Rahl, My Committee, and Montana Tech

Special Thanks to the Army Research Labs for funding my Project


Questions?