Impacts of Drought Conditioning on Loblolly Pine

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Introduction

The average annual temperatures in the southeastern United States has been steadily increasing.

Warmer temperatures are expected to impact different aspects of the ecosystem.

- Intensity of wildfires
- Emergence of forest pests and pathogens
- Loss of land
- **Increase in the frequency of drought events**

Drought Conditioning

Forest nurseries commonly use the practice of drought conditioning seedlings to reduce the adverse effects of moisture stress and improve the tolerance of seedlings to arid conditions after being planted.

Drought hardening involves reducing or withholding irrigation so that plants are adapted and primed for subsequent dry conditions.

Drought and Xylem Embolisms

What is a xylem embolism?
-the disconnection of above ground plant tissue from the root system due to xylem conduits being filled with air and water vapor.

Drought conditioning can damage the hydraulic system of seedlings through xylem embolisms by decreasing the water conducting capacity.

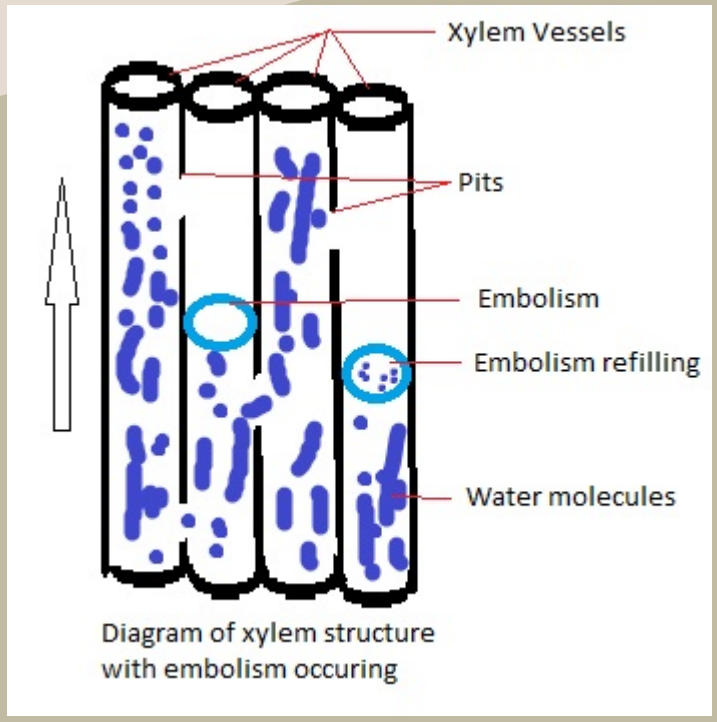
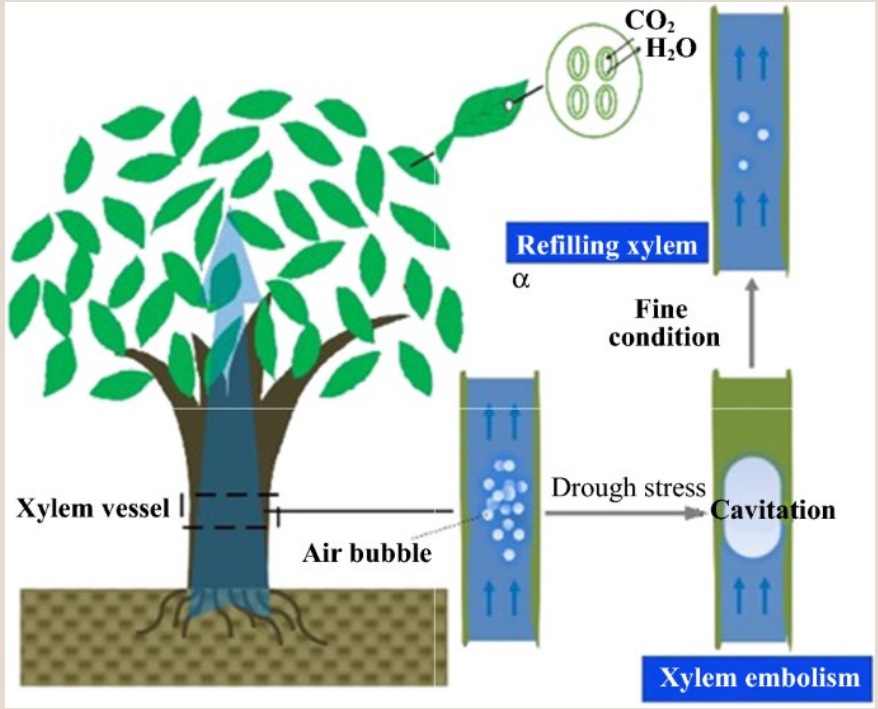


Diagram of xylem structure with embolism occuring

Drought and Xylem Embolisms



Some species have shown the ability to rapidly repair embolized xylem conduits

Several recent studies, especially with conifers, have shown a lack of a mechanism to refill embolized xylem conduits.

OBJECTIVE 1

Determine the physiological effects of varying levels of drought conditioning on one-year-old containerized loblolly pine seedlings

OBJECTIVE 2

Determine the effects of embolized xylem on survival and growth during a drought after out planting

OBJECTIVE 3

Examine growth and recovery after rewatering

Phases of the Study

Drought Conditioning (greenhouse)	Control-treatment were watered every other day and soil was kept saturated. DCWP-three sequential cycles of drought conditioning targets defined by predawn water potential measurements. DCCW-three sequential cycles of withholding water based on defined container weight targets
Drought After Outplanting (stress facility)	All seedlings were well-watered for 3 weeks after outplanting to facilitate establishment. Early and late season droughts of 1 month where water was withheld. Randomized complete block design with 4 replications of 3 treatments (3 genetic families)
Recovery After Drought (stress facility)	Normal watering regimen after each drought

Timeline

OCTOBER 2021
Seedlings received and treatment phase began

MARCH 2022
Seedlings planted in stress facility until established

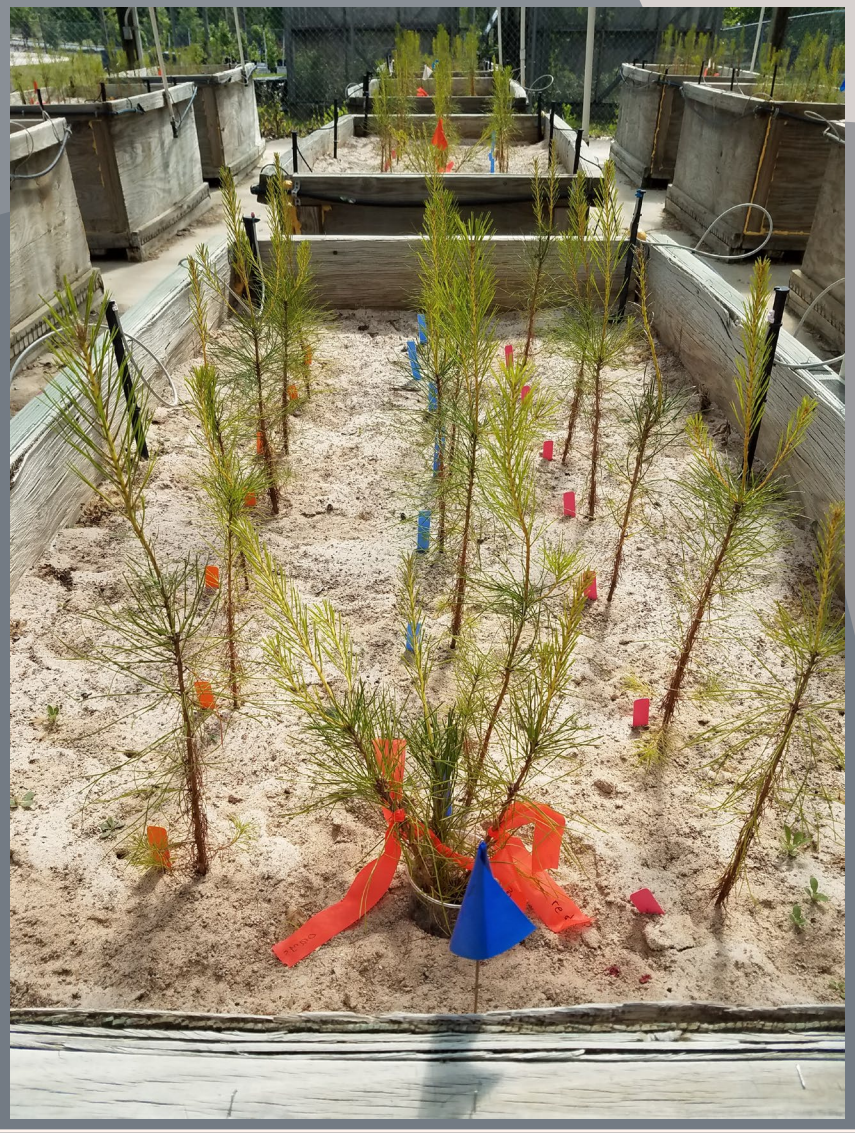
APRIL 2022
Beginning of drought phase. Water withheld for one month to impose early season drought

MAY 2022
Watering of seedlings resumed to monitor recovery

AUGUST 2022
Second experimental drought initiated.

Seedlings immersed in safranin O dye in stress box.

Layout of treatments in stress facility

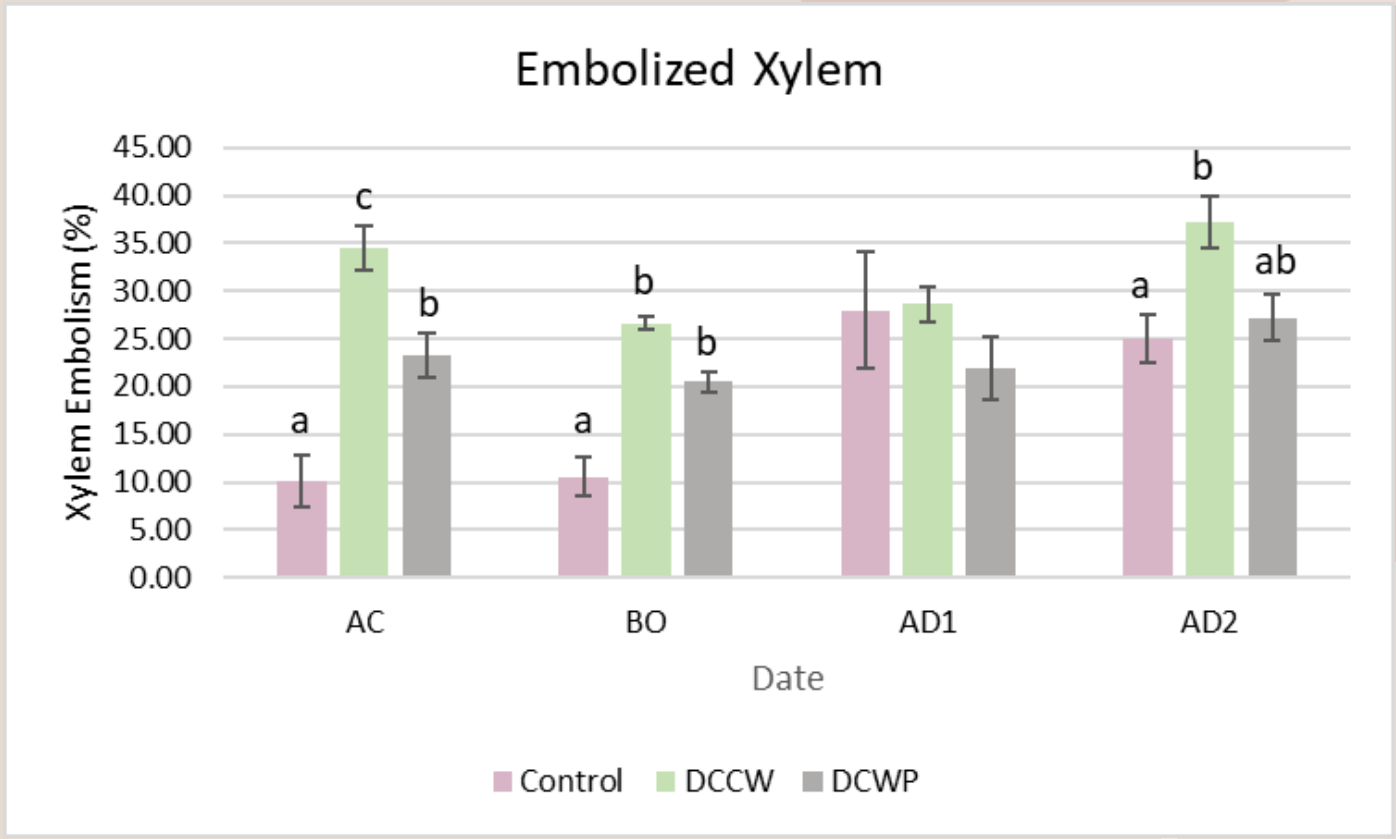


Container weight measurements

Embolized Xylem

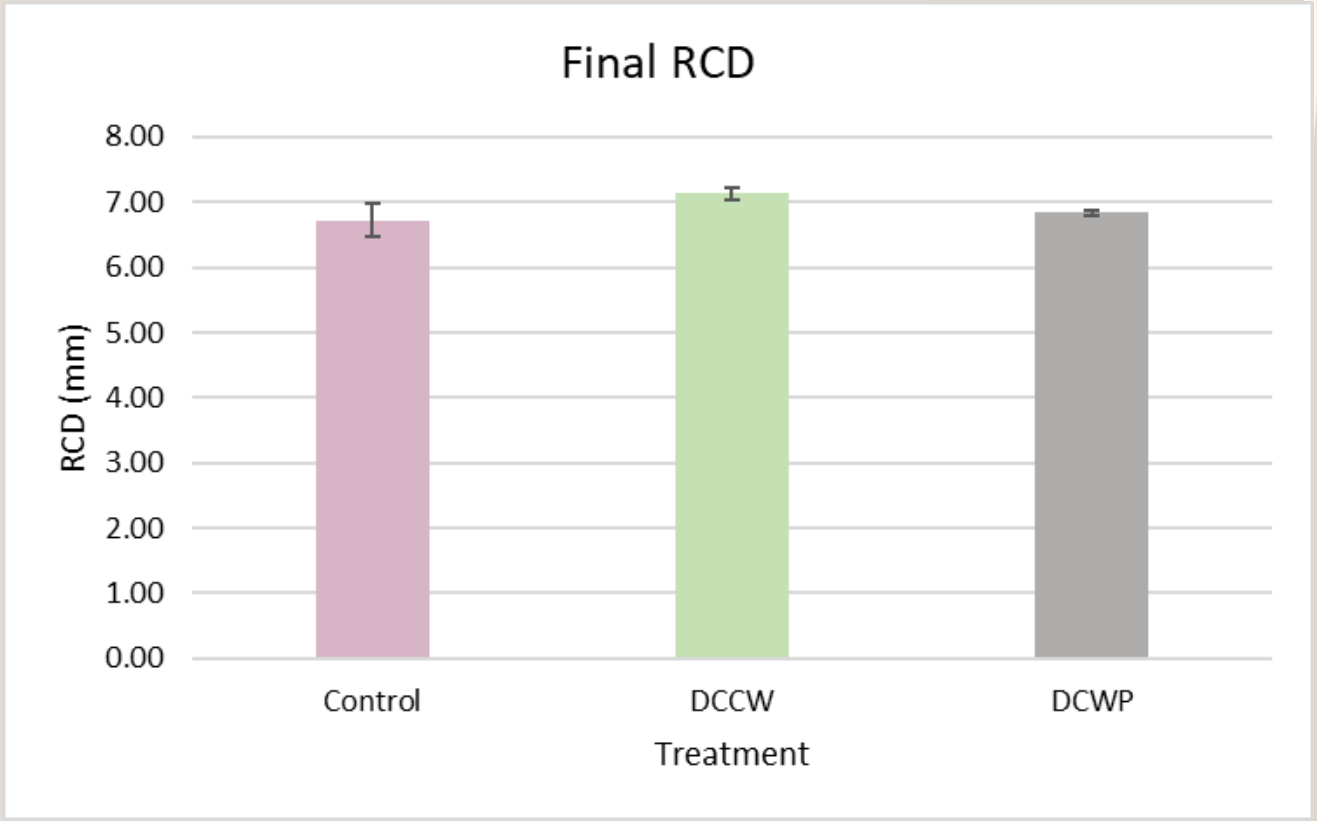
Patterns of embolism in stems shown by dye staining with safranin O.

Xylem area not stained was embolized.

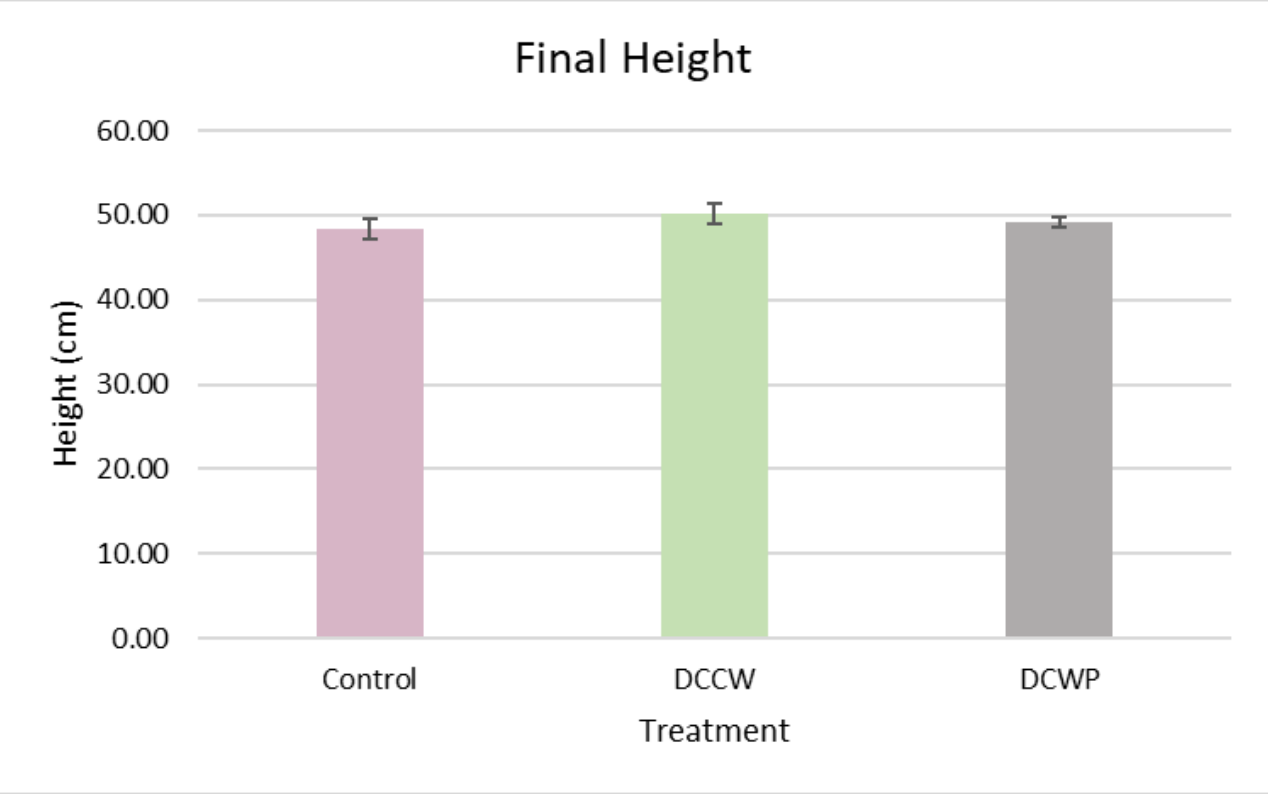


AC = After drought conditioning trt
BO = Before outplanting
AD1 = After first drought
AD2 = After second drought

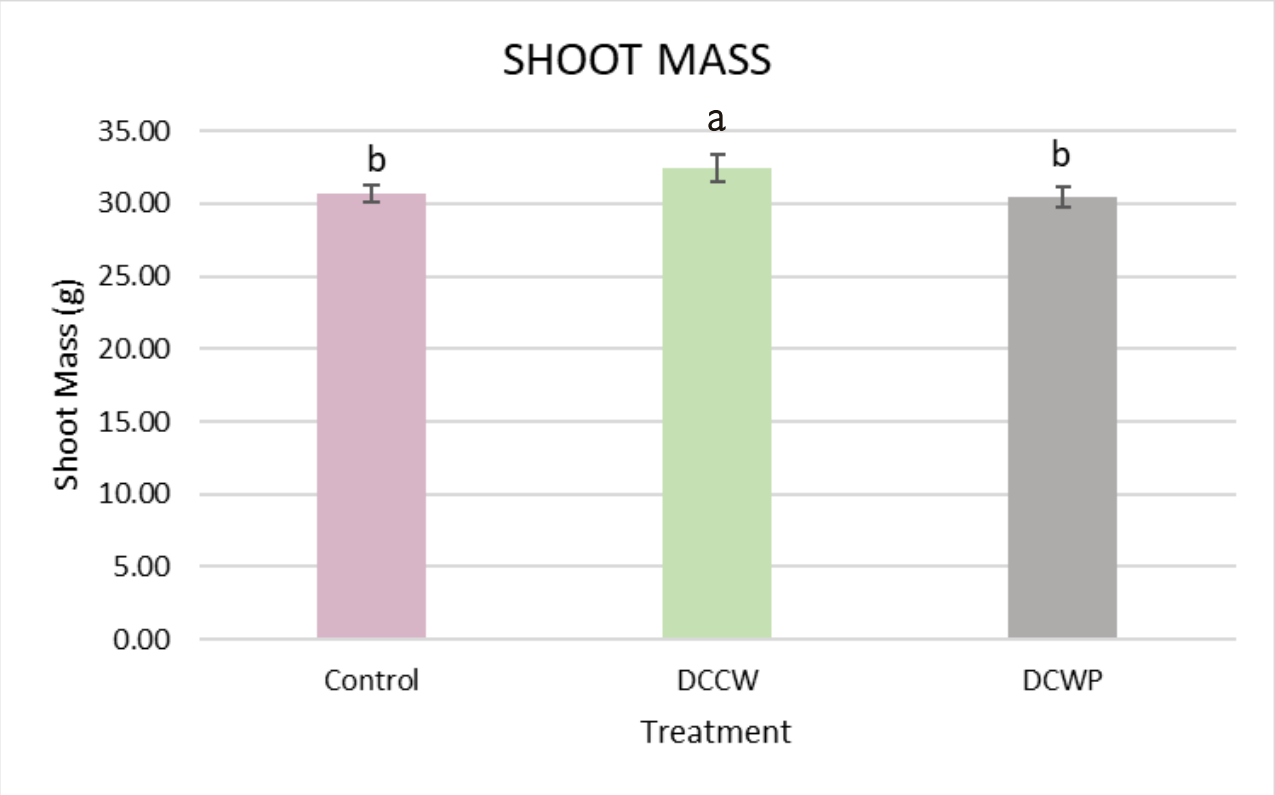
Effect on Root Collar Diameter



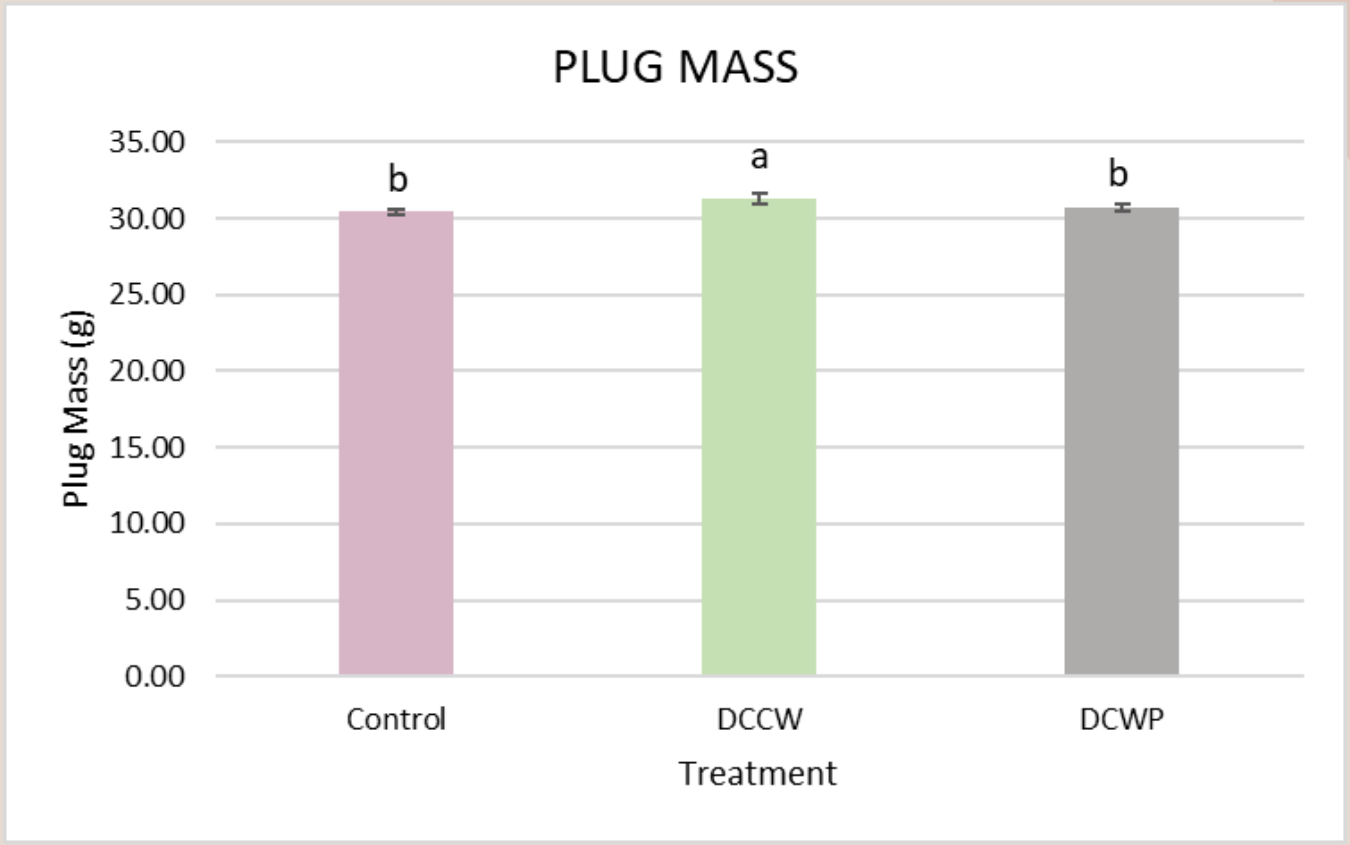
Effect on Height



Effect on Shoot Mass



Effect on Plug Mass



Conclusions

1. Embolisms did occur in the more stressed treatment, but growth was not really affected.

2. There is no evidence of benefits

Management Implications

- The container weight (CW) treatment did have more embolisms and given that climate is changing, a more impactful drought could cause mortality.
- Drought conditioning MAY be beneficial, but it is critical to quantify.
- This may be a moving target as winters get warmer.

Drought Study Team

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Thank you

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