Stem Water Potential in Desert Willow Grown in Clinoptilolite Zeolite and In-situ Riparian Soil

ReNUWIt REU Participant: Kristina Macro
Mentor: Aldo R. Piñon-Villarreal, Faculty Advisor: Dr. A. Salim Bawazir

Revegetation efforts in the southwestern U.S. can be challenging because of insufficient and infrequent rainfall, fewer natural floods due to river channelization, competition against saltcedar *(Tamarix spp*.), and the high costs of irrigation (Dreesen et al., 2001). Clinoptilolite zeolite (CZ) could be used as a wicking material to raise sufficient moisture from shallow groundwater to sustain plant growth (Dung et al., 2011). Previous studies have shown that CZ can increase capillary rise in sandy soils, but no studies have explored the effects that CZ has on water stress in vegetation that has been established in CZ cores. This study focused on measuring stem water potential (SWP) as an indicator of water stress in the native shrub desert willow (*Chilopsis linearis*) as part of an ongoing riparian restoration study being conducted at an urban test bed near Sunland Park, NM. Determining if desert willows planted in CZ cores have lower levels of water stress than those planted in unamended in-situ riparian soil (RS) under similar groundwater and climactic conditions is the main research objective. The effects of different depths to groundwater (DGW) on water stress in desert willow planted in either CZ or sandy RS will also be explored. It is expected that shrubs planted in in-situ RS will experience higher water stress levels and that water stress will increase as DGW increases.

From June 7 to July 7, 2016, survivorship and health condition were monitored and SWP and leaf chlorophyll content (LCC) were measured for desert willow planted in two different DGW zones at the Sunland Park site. Measurements of DGW, soil volumetric moisture content (θ_v), and climatic data from a weather station at the site provided additional information to determine effects of groundwater, soil, and climate conditions on each plant's SWP and health. Depths to groundwater measured in February 2016 when the CZ boreholes were drilled in zones 1 and 2 were 1.4 and 2 m, respectively. Moisture content was measured in boreholes near three to four randomly selected plants for each substrate (CZ or RS) treatment within each DGW zone using time domain reflectometry. A HydroSense II sensor was inserted in each planting borehole at a depth of 30 cm and was used to measure θ_v. Health condition and survival were monitored using a scale that rated plants from dead to vigorous and assigned values between 1 and 5. A PMS 1000 pressure chamber was used to measure SWP for two or three leaflets per selected plant in the substrate treatments within each DGW zone. A Minolta Chlorophyll Meter was used to measure LCC for six leaves per selected plant.

Results from this study showed that plants grown in CZ in Zone 2 had consistently lower water stress levels than those grown in RS in the same zone (Figure 1). In Zone 2 plants grown in CZ also had a higher survival rate of 81% as compared to 56% for shrubs grown in RS. Stem water potential measurements for plants grown in RS in Zone 1 as well as for CZ treatments in both zones were all similar and not significantly different. This indicated that plants grown in CZ with a deeper DGW did not experience high water stresses like those grown in RS at Zone 2. This was due to high θ_v within the CZ boreholes from capillary rise that wicked shallow groundwater to the root zone. In Zone 1 desert willow plants grown in RS had slightly lower levels of water stress compared to shrubs in CZ boreholes (Figure 1) as well as a higher survival of 94% compared to 46% for the CZ treatment in Zone 1. The survival results in Zone 1 may not be as representative because of different quantities and seedling sizes used for planting in 2015 and 2016. Soil moisture content was negatively correlated with SWP, but this relationship was weaker for plants grown in CZ (Figure 2). Since plant roots were in contact with CZ media, variations in θ_v near the CZ borehole surface did not affect the SWP as it did for plants in RS boreholes. Most treatment θ_v and LCC values decreased over the study period while SWP increased. This was related to the increase in daily mean temperatures from 21 to 31 °C with daily maximum temperatures reaching as high as 41°C and low total rainfall depth of 5.3 mm during the study period.

To better assess the water stress in plants established by using CZ, SWP measurements need to continue throughout at least one complete growing season. These results can be used to determine the appropriate groundwater conditions where the CZ should be used as a wicking material for future revegetation projects in other urban riparian zones.

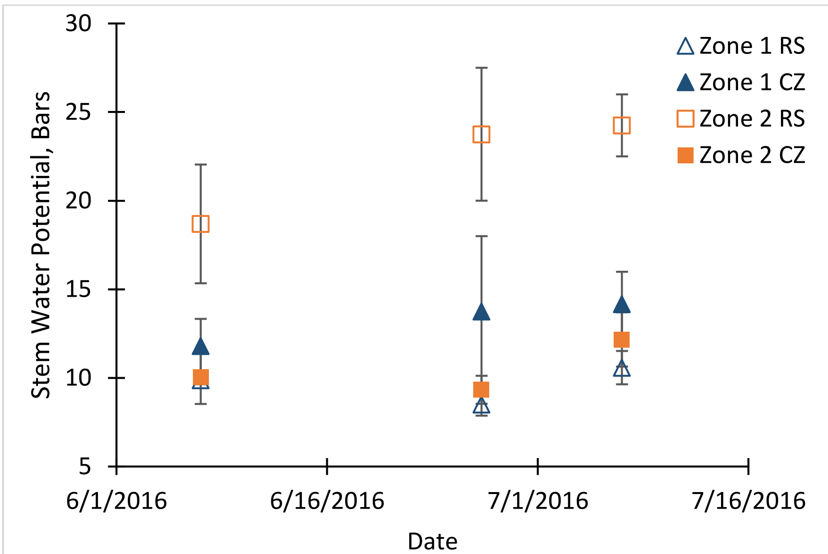

Figure 1. Stem water potential results for both zones 1 and 2

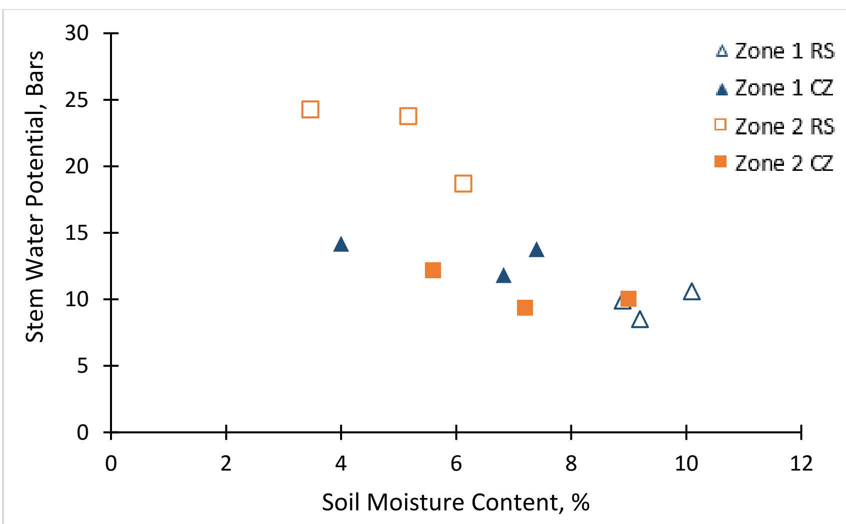

Figure 2. Stem water potential vs. volumetric moisture content for both zones 1 and 2

References

Dung, T. T., Bawazir, A. S., Shukla, M. K., & Bandini, P. (2011). Some hydraulic and wicking properties of St. Cloud zeolite and zeolite-soil mixtures. *Applied Engineering in* Agriculture, 27(6).

Dreesen, D., Harrington, J., Subirge, T., Stewart, P., & Fenchel, G. (2001). Riparian Restoration in the Southwest – Species Selection, Propagation, Planting Methods, and Case Studies.