Effects of surface mulches on soil moisture content and leaf relative water content of *Atriplex canescens* L.

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Introduction

Principles of Xeriscape™, including use of landscape mulches and low water use plants, promote water conservation and can reduce plant water use by 60% (www.xeriscape.org). Organic mulches applied to landscape surfaces can increase soil moisture compared to bare soil controls (Pickering et al 1998). Within the CAP LTER area, decomposing granite is commonly used as an inorganic landscape surface mulch. However, in recent years, indigenous organic by-products such as composted pine residue from the Mogollon Rim and shredded urban tree trimmings are increasingly abundant resources. Research is needed to understand how these organic by-products might be used as surface mulches to conserve soil moisture and improve growth of native plants in Phoenix landscapes.

We conducted two experiments designed to compare the effects of three landscape surface mulch types (one inorganic and two organic) and bare soil on soil volumetric water content (VWC) and evaporative water loss, and on leaf relative water content (RWC) of *Atriplex canescens*.

Materials and Methods

Experiment 1. Surface mulches were installed at a minimum depth of 2 inches during April 2004 to 14 existing drip-irrigated landscape research plots at the CAP LTER Desert Botanical Gardens (DBG) research site in the following manner:

- Red Mountain Coral decomposing granite (DG), 1/4" minus screened, applied to four plots
- Composted ponderosa pine residue (PPR), 3/4" minus screened, applied to four plots
- Chipped urban tree trimmings (LTT), approximately 3/4" unscreened, applied to four plots
- Bare soil control (BS), two plots

Percent VWC soil moisture measurements were taken April 1, 2005 at the DBG research site with two time domain relfectrometry soil moisture probes (Fig. 3, Field Scout TDR 100 Soil Moisture System, Spectrum Technologies, Plainfield, IL) inserted vertically into the soil to a depth of 12 cm. Nine measurements were taken per plot in three north-south transects with three measurements per transect.

Two *A. canescens* shrubs were installed per plot during January 2004 at the DBG research site; within each plot, one shrub was irrigated and one was not. Percent leaf RWC analysis was performed April 16, 2005 on *A. canescens* shrubs. Three leaves were collected per plant at dawn. Leaves were then weighed as soon as possible for initial fresh weight after harvest (FW). Leaves were then soaked for 24 hours at room temperature in zippered baggies and weighed for fully turgid weight (SW) and dried at 65°C for a minimum of 72 hours and weighed for leaf dry mass (LW). Percent leaf RWC was calculated according to the formula (Jiang and Huang, 2001):

$$RWC = (FW-DW) / (SW-DW) \times 100.$$

Experiment 2. To measure cumulative evaporative water loss from soil beneath mulch treatments, 16 PVC cylinders (30-cm long x 15-cm diameter) were filled to a 25-cm depth with uniformly mixed, air dried, P horizon, Rillito gravelly loam soil sieved with a 5-mm screen (bulk density = 1.57 g/cm^3). 1.7 Kg distilled water (25°C) was added in small increments to each cylinder and allowed to percolate down through the soil profile. A 5-cm layer of each mulch was then placed on top of the soil in each cylinder, except for bare soil control cylinders, which were filled with soil only. Cylinders were then placed in 16 field plots (76-cm x 76-cm) in a randomized complete block design (Fig. 2). A cylinder was placed vertically into the ground at the center of each subplot and removed and weighed every 48 hours.

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Table 1. Mean soil percent volumetric water content (VWC) below mulch treatments. Means connected by the same letter are not significantly different by Tukey's HSD.

Mulch	VWC (%)
LTT	16 a
PPR	15 a
DG	15 a
BS	10 b
Mulch	P = 0.005

Figure 3. Field Scout TDR 100 Soil Moisture System, Spectrum Technologies (Plainfield, IL). Image captured by Catherine Singer during June 2005.

Table 2. Mean percent leaf relative water content (RWC) of *A. canescens* by mulch and irrigation treatments. Means connected by the same letter are not significantly different by Tukey's HSD.

Mulch	Irrigation	RWC (%)
LTT	Y	79.37 a
LTT	N	76.64 ab
PPR	Y	76.31 ab
PPR	N	77.49 ab
DG	Y	67.35 c
DG	N	74.58 ab
BS	Y	75.90 ab
BS	N	70.95 bc
Mulch		P < 0.001
Irrigation		P = 0.877
Mulch [Irrigation]		P < 0.001

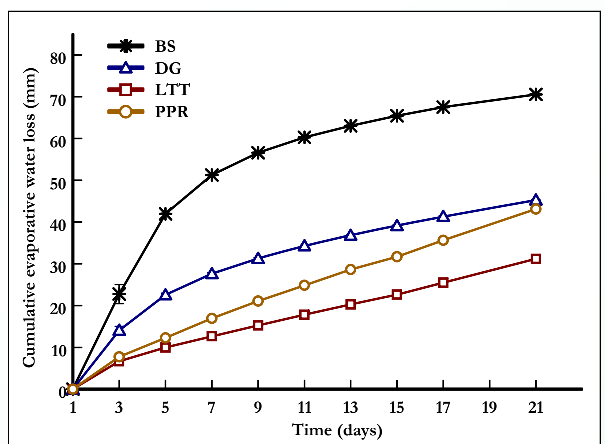

Figure 1. Cumulative cylinder evaporative water loss (mm) by treatment during May 31 to June 21, 2005.

Results

- Soil moisture content was higher (P = 0.005) under mulched landscapes, both inorganic and organic, than bare soil, and soil moisture content was highest under shredded urban tree trimmings (Table 1).
- Leaf RWC of *A. canescens* was significantly higher (P < 0.001) in shrubs grown in organic mulch (Table 2).
- Leaf RWC was not affected by irrigation (P = 0.877, Table 2)
- However, leaf RWC was affected by irrigation when nested within mulch type (P< 0.001, Table 2).
- Cumulative evaporative water loss was greatest (P < 0.001) from bare soil or soil mulched with decomposing granite and was least from soil mulched with either composted pine residue or shredded urban tree trimming (Fig. 1).

Conclusion

These results show that organic surface mulches can improve internal water status of *Atriplex canescens* by reducing evaporative soil water loss in a desert environment. Future studies should be conducted to determine the effects of organic surface mulches on other commonly used native landscape plants.

Figure 4. *Atriplex canescens* growing in ponderosa pine residue mulch. Image captured by Catherine Singer during December 2005.

References

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Figure 2. Research site for soil evaporative water loss experiment. Image captured by Catherine Singer during June 2005.