Effects of three landscape surface mulches on thermal processes in a drip-irrigated xeric landscape

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Introduction

Surface mulches are a common element of urban landscapes and are one of the seven principles of Xeriscape™. Most municipalities within the Phoenix metropolitan area have dust abatement ordinances that require applications of surface mulches to all bare landscape soil surfaces in public places. Inorganic mulches like decomposing granite are commonly used as landscape mulches in the desert southwest. Organic mulches are less common in the Phoenix metropolitan area, but the availability of organic mulch materials is increasing. Mulches applied to landscape surfaces can moderate soil temperatures by changing the surface heat energy balance and conserve soil water by reducing evaporation rates (Brady & Weil 2002, Pickering et al 1998). We characterized summertime thermal effects of three surface mulches, two organic and one inorganic, and bare soil applied at drip-irrigated landscape research plots, and at two overhead sprinkler-irrigated Bermuda grass turf plots.

Materials and Methods

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 research site in the following manner:

- Red Mountain Coral decomposing granite (DG), 1/4" minus screened, applied to four plots
- Composted ponderosa pine residue (PB), 3/4" minus screened, applied to four plots
- Chipped urban tree trimmings (TT), approximately 3/4" unscreened, applied to four plots
- Bare soil control (BS), 2 plots

Bermuda grass turf plots were located on the ASU East campus. Below ground soil temperatures were monitored every two hours for six months with Watch-Dog Model 100 data loggers (Spectrum Technologies) at depths of 5-10 cm and 30-35 cm. Temperatures at the mulch-soil interface were taken every 15 minutes for a 24-hr for each plot with copper-constantan thermocouples. Mulch surface temperatures were measured with an Oakton InfraPro Infrared Thermometer every four hours for a 24-hr for each plot. Campbell Scientific Q-7.1 net radiometers were used to measure the algebraic sum of incoming and outgoing all-wave radiation (short-wave and long-wave components - Watts/m²) on all surface mulches on relatively cloudless days for a 24 hr.

Results

- Below ground soil temperatures were more buffered by organic mulches than inorganic or bare soil treatments (Figure 1).
- Mulch-soil interface temperatures were lower under organic mulch than inorganic mulches (Figure 2, 630 – 600 HR, P = 0.0003, N = 4).
- Inorganic mulch daytime surface temperatures were lower than organic mulch surface temperatures (Figure 3, 1000-1800 HR, P = 0.0379, N = 36) and albedo was significantly higher (Figure 3, P < 0.0001) for the inorganic mulch and bare soil treatments.
- Nighttime net radiation values were less negative over organic mulches than inorganic mulches (Figure 4, 1800 – 600 HR, P = 0.0020, N = 4).

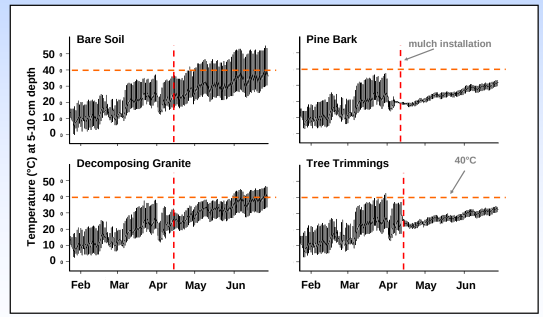


Figure 1. Below ground soil temperatures at depth of 5-10cm from January 2004 – June 2004.

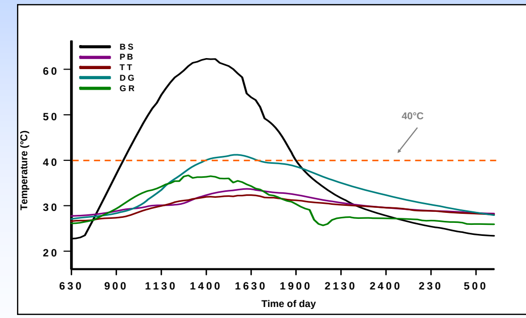
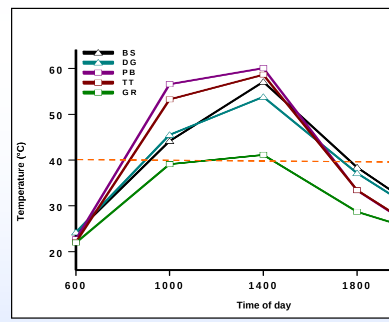


Figure 2. Daily mulch-soil interface temperatures in August 2004 (BS = bare soil, PB = pine bark, TT = tree trimmings, DG = decomposing granite, GR = turf grass).



mulch	albedo
DG	0.196
BS	0.182
YW	0.163
PB	0.156

Figure 3. August 2004 mulch surface temperatures and albedo values (BS = bare soil, PB = pine bark, TT = tree trimmings, DG = decomposing granite, GR = turf grass).

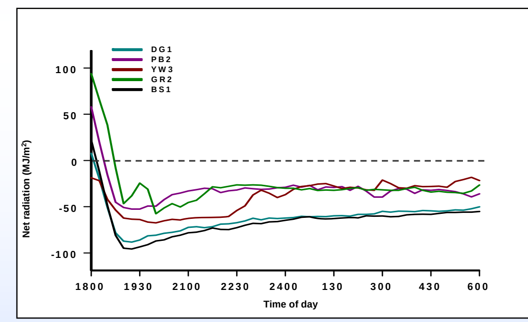


Figure 4. Nighttime net radiation values at canopy height over surface mulch treatments (BS =bare soil, PB = pine bark, TT = tree trimmings, DG = decomposing granite, GR = turf grass).

Conclusion

These results provide evidence to suggest that organic surface mulches have higher resistances to heat transfer than inorganic mulches. Use of organic mulches might improve summer landscape plant water and nutrient use efficiencies by lowering summer root zone temperature and soil moisture evaporative fluxes.

Ponderosa pine, decomposing granite and tree trimming surface mulch images captured by CK Singer, 2004

References

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