Soil Respiration under decomposing cacti in the Sonoran Desert

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Research Questions and Hypotheses:

How do the different nutritional and hydrologic characteristics of Prickly Pear and Buckhorn Cholla during decomposition impact microbial respiration rates?

We predict that respiration rates will vary based on the stage of decomposition, and that prickly pear will generally be more nutritious for soil microbes, leading to increased soil respiration.

Introduction:

- Some species of cacti are very well studied such as the Saguaro; however little is known about prickly pear and buckhorn cholla and their ecological roles in carbon and nutrient cycling.
- Decomposition studies (generally leaf litter) have been used to understand how nutrient cycling, energy flow in food webs, and soil formation are linked by the process of decay.
- Cacti are an important functional group in deserts due to their abundance, the nutrients of which are released into the desert soil, feeding decomposer communities.
- However, little is known about their decay dynamics and rates of carbon turnover. Our preliminary results show that carbon and nutrients are released at similar rates in the two species; however the initial quantity of carbon and water are greater in the Prickly Pear, so the soil beneath is expected to have corresponding respiration rates.

Methods:

- We located cactus segments in different stages of decomposition based on visible characteristics of decay.
- We used a Li-COR 8100 Infrared Gas Analyzer (IRGA) beneath decaying cactus segments to measure CO_2 flux from soil at 60 second intervals.
- We also measured soil moisture and temperature, which was compared to that of bare desert soil.
- Measurements were repeated once a week for six consecutive weeks from November 1st through December 6th.
- Data were analyzed using an ANCOVA to identify any significant effect of species, decay stage, moisture, and temperature on CO_2 flux.




Results:

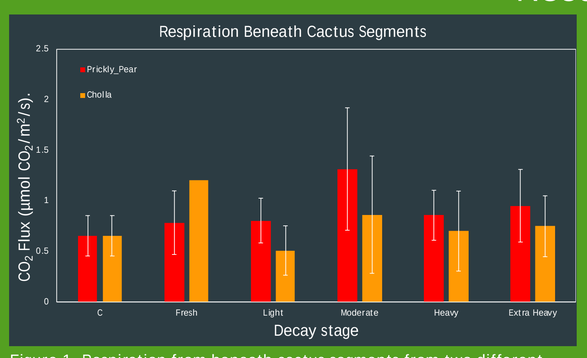


Figure 1. Respiration from beneath cactus segments from two different species across different decay stages.

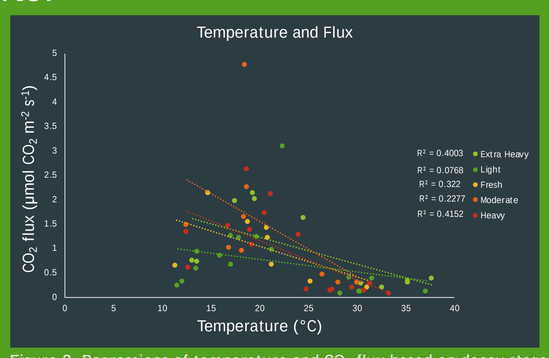


Figure 2. Regressions of temperature and CO_2 flux based on decay stage.

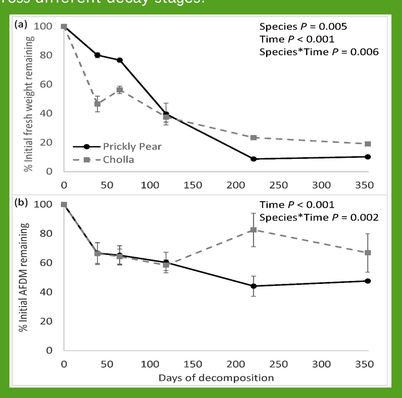


Figure 3. Mass loss from one year of decomposition in two species of cactus, expressed as fresh weight (including water) and ash-free dry mass (AFDM; excluding water).

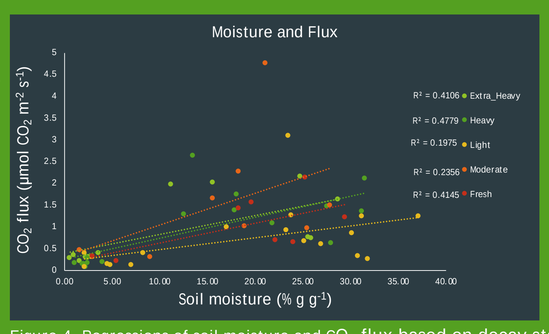
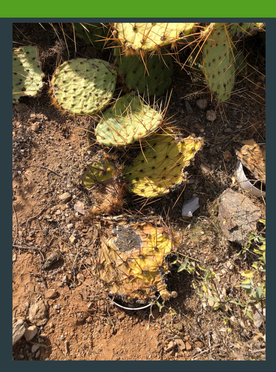
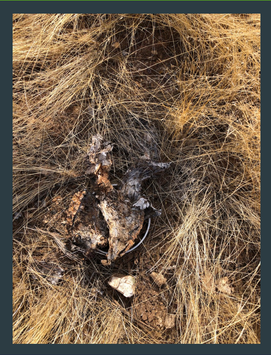


Figure 4. Regressions of soil moisture and CO_2 flux based on decay stage.

- The difference in species was not found to be significant in determining respiration rates beneath the cactus segments (P=0.145).
- Decay stage was determined to be marginally insignificant in determining C02 flux (P=0.051).
- Differences in moisture (P<0.001) and temperature (P<0.001) and their interactions (P<0.001) significantly influence CO_2 Flux.
- The interaction between the day and the CO_2 flux was also significant (P=0.003), where some days were warm and dry, and others were cool and moist.
- There was a trend of increasing CO_2 flux with decreasing temperature in both species.
- The rate at which these species release water, carbon and nutrients during decomposition varies with species and decay stage.

Discussion:

- Despite what we hypothesized, there was no significant difference between Prickly Pear and Cholla droppings. Rather, it is moisture, temperature, and the interaction between them that has the largest influence on soil respiration.
- With the data gathered, decay stage was determined not to be a significant source of variation in CO_2 flux. However, it may be determined that decay stage plays a more minor role in respiration rate with more research and data collection.
- Due to the rate at which fresh droppings lose water, heavily decayed stages of decomposition are more sensitive to changes in soil moisture.
- Moist conditions between 12 and 25°C were correlated with higher respiration rates. Respiration could be slowed with increased temperatures, leading to altered nutrient cycling due to a decrease in microbial activity.
- It would be interesting to see how this takes place over a year or more after dropping to investigate the ways the summer heat effects the respiration rate as well as the prolonged dry period preceding the monsoon rains.
- Wind made gathering usable data very difficult, but in future studies it would be useful to use cages or have more replicates of each decay stage and species to account for losses to wildlife.



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