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Abstract

In our experiment we studied the respiratory qualities of green bark ceanothus (*Ceanothus spinosus*). Plants are generally thought to undergo respiration during the night, building up carbon dioxide stores that are released in response to light. In resprouts with large root crowns, such as *C. spinosus*, we expected to see large amounts of carbon dioxide released right after dawn. This can be shown with the use of a portable gas exchange system. In *C. spinosus*, we compared normal respiration rates, based on carbon dioxide expulsion, to values obtained at predawn. We were able to show that there is significant carbon dioxide expulsion that occurs in response to predawn sunlight. We predict this may be related to very high metabolic rates of the roots as the plant resprouts.

Introduction

Floral ecology and physiology in the Santa Monica Mountains' unique post-fire Mediterranean climate has been subject of the novel research proposals of students attending Pepperdine University for many years. Few places on earth offer the post-fire research opportunities concerning Chaparral shrubs more so than just inland of the southern California coastline. Green Bark Ceanothus (*Ceanothus spinosus*), native to the Santa Monica Mountains and well-represented on Pepperdine University's Malibu campus, is a 6-18ft tall shrub discernable from other members of the Rhamnacae family due to its green bark and spiny branches. Because *Ceanothus spinosus* is a plant thriving in a climate characterized by its semi-aridity, its investment of energy, uptake of CO_2 during the day and its subsequent efflux of CO_2 just before dawn is vitally important to understanding the significance of resprout energy allocation and efficiency in a recovering post-fire ecosystem (1). We hypothesize that the predawn efflux of carbon dioxide generated from the root crown and the level of negative photosynthesis that occurs in *Ceanothus spinosus* will be different than levels due to normal respiration when exposed to full or partial sunlight throughout the day. According to Joauin Azcon-Bieto and Barry C. Osmond, carbon dioxide efflux after photosynthesis is possibly linked to time of day and temperature (2). Accordingly, measurements (photosynthesis, CO_2 concentration etc.) were taken predawn before the plant was exposed to significant levels of light, at mid-day when light levels were at their highest, and at late afternoon when partial sunlight allowed for normal levels of respiration.

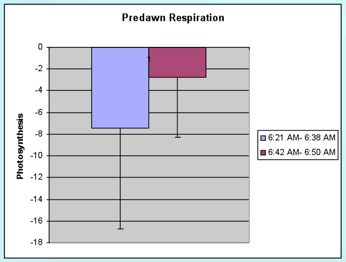
Study Site

Photo (left)- *Ceanothus spinosus* resprout at burn site on Pepperdine University's Malibu campus.

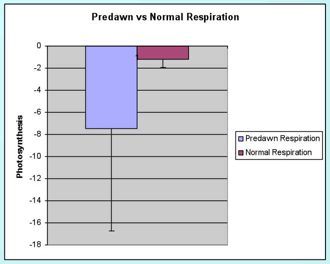
Materials and Methods

The experiment was conducted at the Burn site here on Pepperdine campus using *Ceanothus spinosus*. To measure the photorespiration rates of the plant three different *C. spinosus* plants. One plant was kept as a control and the other two as test groups. The two test groups were completely covered by a purple felt tarp to minimize sunlight exposure and the control was kept in natural sunlight. For the Negative photosynthetic rates, predawn measurements were taken using a LI-6400 gas exchange system. The machine was carefully calibrated. A sample leaf from one of the plants was chosen and cleaned with a Kim wipe. The cuvette was then clamped to the leaf. To strictly measure plant respiration the light in the cuvette was kept off. The data was recorded and the procedure was repeated for each plant multiple times. (The test plants remained under the tarp during measurements). For the Normal respiration rates the same procedure was used with the exception that our test plants were completely uncovered during readings and data was taken in the middle of the day.

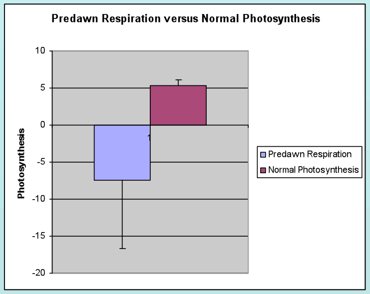
Data



In just a predawn 30 minute interval respiration rate severely declines in response to increasing sunlight.



Predawn rates of respiration are abnormally higher than average respiration rates while the plant is actively carrying out photosynthesis.



The average photosynthesis rate of C. spinosus is much lower than the average predawn respiration rate.

Conclusions

In conclusion we found that there are indeed excessive amounts of carbon dioxide efflux in response to predawn sunlight. Through predawn readings, we were able to measure negative photosynthesis beyond normal respiration rates and thus through our statistical analyses we were able to accept or hypothesis. Normal respiration rates for *C. spinosus* are usually around -2 or -3 μmol CO_2 m-2 s-1, in our predawn readings we measured negative photosynthesis below -19 μmol CO_2 m-2 s-1. This reveals there must be some sort of activity within the plant beyond normal respiration. We speculate that this excess CO_2 comes from the root crown, undergoing respiration, aiding the resprouting process. After fires the root crown of *C. spinosus* remains alive and active; this is where the plant sustains itself in order to resprout. Our data offers insight into this fascinating process these plants undergo in response to fire. The activity of the root crown is just beginning to be more fully understood and this data greatly contributes to that understanding. The CO_2 release not only indicates the activity of the root crown itself, but also the mechanisms of carbon transport within the xylem water and the plants' ability to respond to light. Also this ability to produce large quantities of CO_2 might aid *C. spinosus* in metabolic processes during times of water stress, allowing the plant to avoid photorespiration, keeping the CO_2- concentration high inside the leaves even when the stomata are closed. Our data reveals a novel activity of the root crown and through further research the beneficial aspects of this adaptation could be elucidated.

Literature Cited

1) Saveyn, An et al. 24 October 2007. Stem Respiration and carbon dioxide efflux of young Populus deltoides trees in relation to temperature and xylem carbon dioxide concentration. Ecophysiology-Original Paper. Volume 154, Number 4. 637-649.

2) Azcon-Bieto, Joaquin and Osmond, Barry C. 21 June 1982. The effect of carbohydrate status on the rate of CO_2 production by respiration in darkened and illuminated wheat leaves. Plant Physiology. Volume 71. 574-581

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