

The Effect of Sunlight on the Rate of Photosynthesis in *Trachelospermum Jasmenoides*

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Introduction

Different types of plant species, such as CAM plants, have adapted to sustain growth within their own particular set of environmental conditions. Yet regardless of a plant's environmental conditions, each species adapts to its environment with the aim of optimizing photosynthesis in order to sustain growth. For example CAM plants, which are mainly found in dry desert areas, close their stomata during the daytime and open them at night in order to prevent excessive water loss. This adaptation allows CAM plants to conserve water for photosynthesis, during which the plant utilizes water, sunlight and carbon dioxide in order to produce glucose with the byproducts of oxygen and water (Raven et al. 2005).

The process of photosynthesis, which is necessary for plant survival and growth, is affected by the environmental conditions in which a plant lives. For example one of its limiting factors includes the concentration of CO₂ or carbon dioxide in the atmosphere. Carbon dioxide, a necessary reactant in photosynthesis, enters the leaves of the plant through the stomata, which are found on the underside of plant leaves (Jones, 1973) . These pores not only control gas exchange, but also regulate the movement of water vapor in and out of plant leaves, as demonstrated by the behavior of CAM plants. In addition photosynthesis is a light dependent reaction, meaning that it is powered by light energy and is therefore directly impacted by the amount of light that strikes the leaves of a plant (Givnish, 1998). The chlorophyll and photosynthetic pigments of the thylakoid membrane capture the sun's energy in order to foster photosynthesis (Raven et al. 2005). Sunlight has also been found to open stomata and since transpiration, the evaporation of water from the stomata of a plant, increases as a plant's stomata open, transpiration has been found to be a light dependent reaction as well (Von Caemmerer and Farquhar, 1981). Therefore stomata are one of the main controls of both photosynthesis and transpiration in plants (Jones, 1998). As a dominant indicator of both the movement of water and carbon dioxide in and out of plant leaves, the density of stomata in the

leaves of plants in shaded areas versus plants in areas with more sunlight can be compared to determine which plants have a higher rate of photosynthesis.

In this study the *Trachelospermum Jasminoide* species, also known as the star jasmine, was observed in both a shaded region and a region with higher sun exposure, two areas the star jasmine is often found in. The star jasmine, which is a flowering angiosperm, has small white flowers with five petals, making it a dicot. We hypothesized that the *Trachelospermum Jasminoide* plants in sunny conditions would have higher rates of photosynthesis than those in the shaded region. In addition to higher photosynthetic rates, the plants in the sun would concurrently have greater stomatal density, a higher average temperature reading, and higher rates of transpiration.

Material and Methods

Two plants, one in the shade and one in an area with more sunlight, of the *Trachelospermum Jasminoides* were identified on Loyola Marymount's campus on the left and right sides of the chapel. Data was collected on October 14, 2014 around 2:00 pm from the plant species. Five leaf samples from each plant were used to collect five stomata impressions using nail polish and clear tape in order to measure stomatal density, diameter size and to count the number of open stomata. The same five leaves from the stomata impressions were then used to collect a total of five readings using the leaf porometer device, which measures stomatal conductance and transpiration rate. The same five leaves were also used to measure light exposure using the light meter, in order to measure and compare the amount of light striking the two groups of plants. Next the temperature of those five leaves from each plant along with five additional leaves from each plant, which were randomly selected, were recorded using the temperature gun for a total of ten temperature readings from each plant. In addition to the previous readings three soil samples were collected from the surrounding area of each plant and used to measure the pH and salinity of the soil using a pH probe and orbital shaker, which

consistently mixes the soil sample before the readings. The pH and salinity readings of the soil samples were then compared using a t-test and salinity was found to be a control for the experiment.

Results

Foremost the average number of stomata of each plant was graphed, as shown in Figure 1, and a t-test was performed in order to determine if the average means of the two groups are statistically different. Since the p-value of 0.005098 is below 0.05 it was concluded that the two averages of the sun plant and shade plant are statistically different.

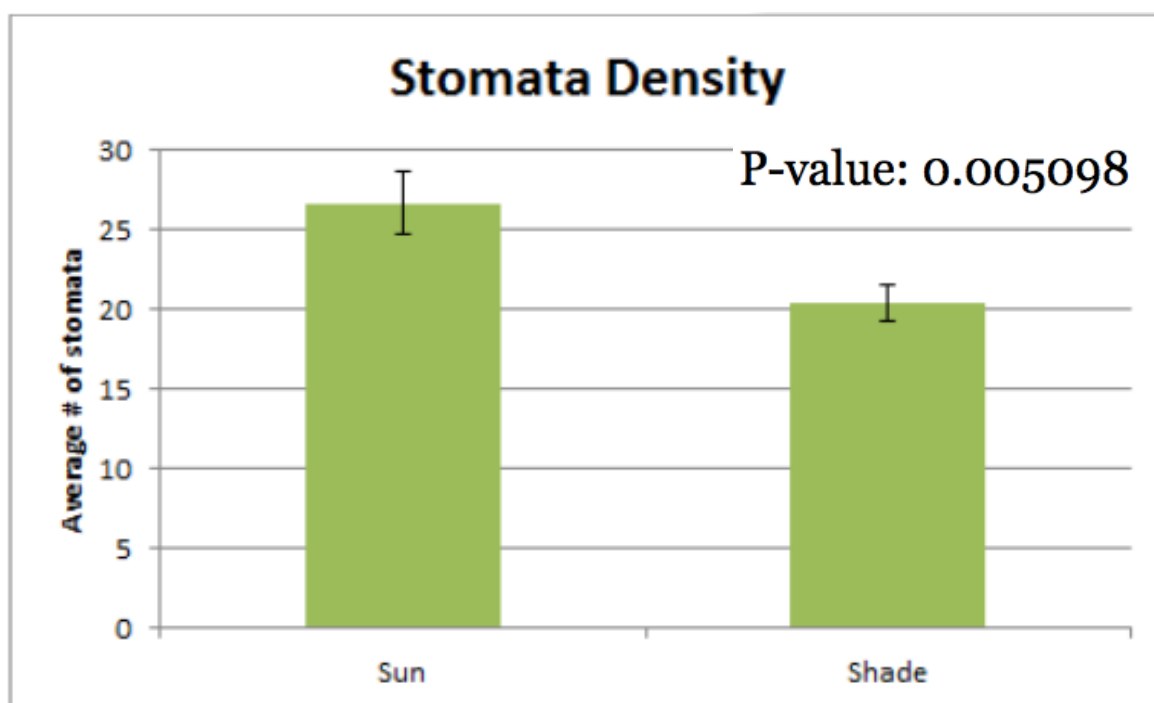


Figure 1. T-test with a p-value of 0.005098 showing the statistical difference between the average number of stomata of the sun plant and the shade plant. Green bars represent the average number of stomata for that plant. Black bars represent the error bars, which show the standard deviation.

Next the stomata impressions were used to measure the average stomatal diameters of the sun plant and shade plant in px in order to determine whether stomata diameter size could be used as a control. The average diameter measurements were then graphed, as shown in

Figure 2, and the error bars, which show standard deviation, were plotted in order to show the variation between the two averages. Since a low standard deviation was calculated, the diameter size of the stomata was concluded to be a control in the experiment.

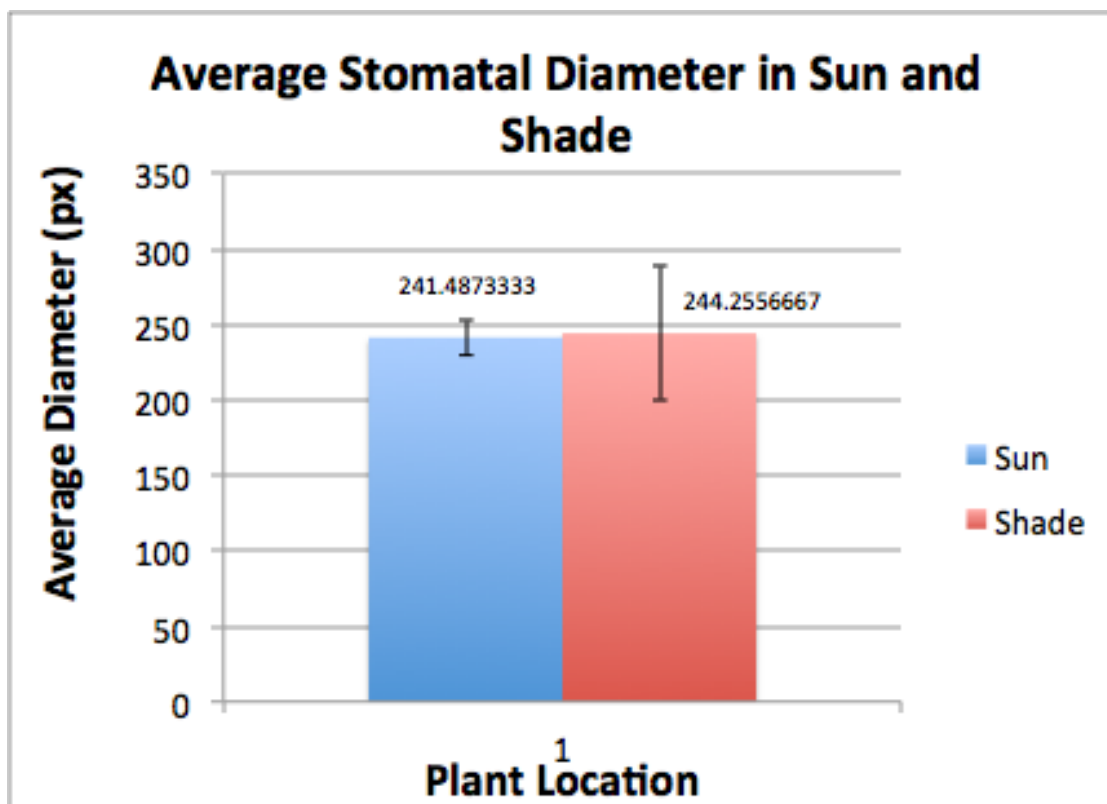


Figure 2. Bar graph displaying the average diameter measurements of the sun plant (blue) and shade plant (red). Black bars are the error bars, which show standard deviation.

Additionally the number of open stomata from the impressions of the sun plant and shade plant were counted and the average open stomata of each plant was calculated. The shade plant was found to have a higher number of open stomata compared to the sun plant.

Afterwards the light exposures of the leaves of the sun plant and leaves of the shade plant were recorded and the data was entered into a scatter plot for comparison. A t-test was then performed in order to determine if the average means of the two groups are statistically different. Since the p-value of 0.02270 is below 0.05 it was concluded that the two averages of

the sun plant and shade plant are statistically different. As seen in Figure 3, the sun plant contains a higher average light exposure than the shade plant.

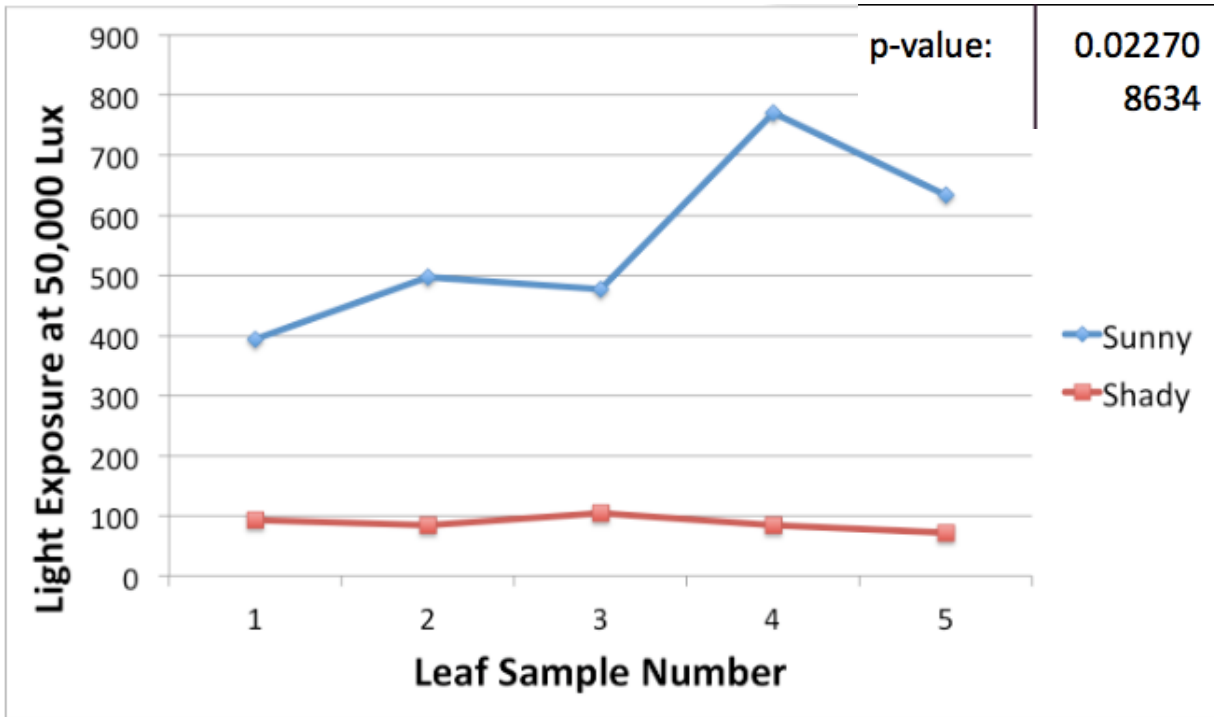


Figure 3. Scatter plot displaying the light exposure readings of both the sun plant (blue) and shade plant (red) with t-test showing the statistical difference between the averages with p-value of 0.02270.

Next it was concluded that the sun plant had a higher average temperature of 21.8 degrees Celsius while the shade plant had a lower average temperature.

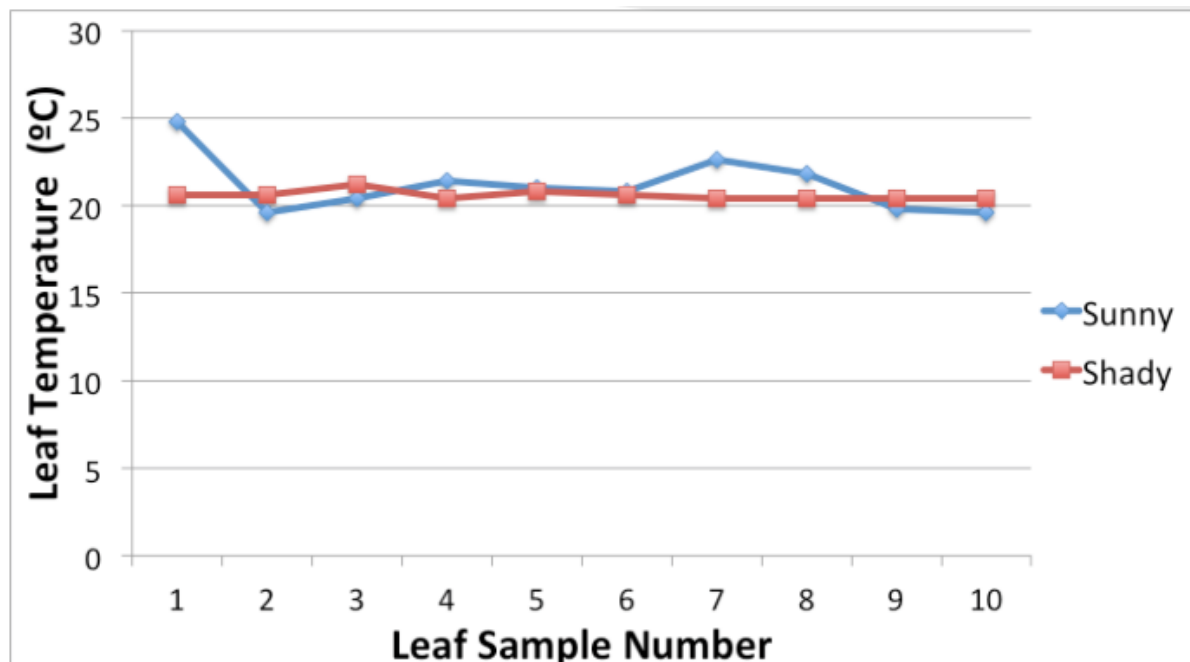


Figure 4. Scatter plot of temperature reading of sun plant (blue) and shade plant (red). Shows higher average temperature reading of 21.18 degrees Celsius for sun plant compared to lower average temperature of the shade plant.

After the the transpiration rates of the leaves were measured and entered into a scatter plot for comparison. A t-test was then performed showing a statistical difference in the transpiration rate averages of the sun plant and shade plant since the p-value was calculated to be 0.022708634, which is lower than 0.05.

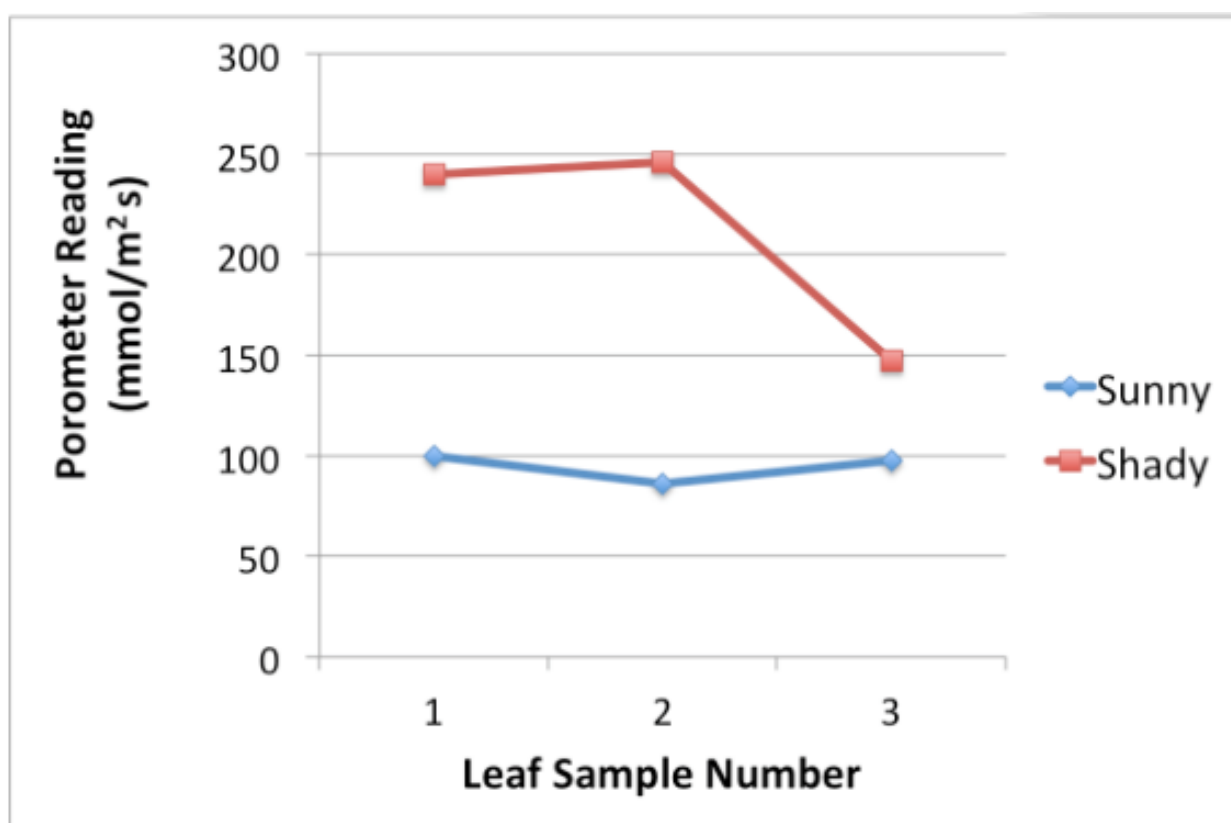


Figure 5. Scatter plot of transpiration rate readings of the sun plant (blue) and shade plant (red). Shows higher average transpiration rate for shade plant compared to lower average transpiration rate for sun plant

Finally the salinity of the soil of the two different plants was measured using a pH probe and the average salinity was entered into a bar graph, as shown in Figure 5, in order to determine if salinity could be used as a control. A t-test was then performed in order to

determine if the average means of the two groups are statistically different. Since the p-value of 0.655036919 is higher than 0.05 it was concluded that the two averages of the sun plant and shade plant are not statistically different. For this reason salinity was determined to be a control in the experiment.

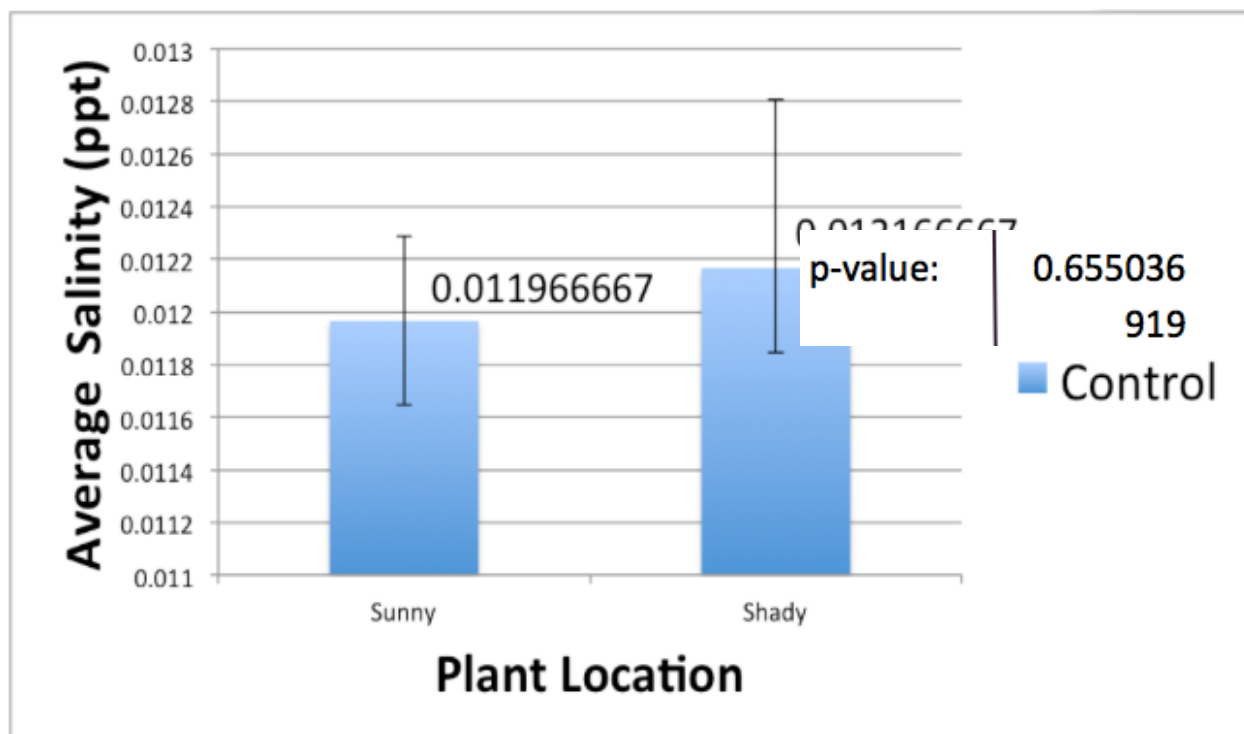


Figure 6. Bar graph displays the average salinity measurements of the sun plant and shade plant. T-test with p-value of 0.655036919 shows no statistical difference between the averages of the two groups.

Discussion

After analyzing the results it was concluded that while some of the data showed clear statistical variation, our hypothesis was neither supported nor disproved since some of the data was inconclusive. For example while the sun plant was found to have a higher average stomata density than the shade plant (Figure 1), the shade plant was found to have more open stomata than the sun plant. This data explains the statistics from Figure 5, which displays a higher average transpiration rate for the shade plant. This data is important since previous studies

show that as the stomata of a plant open, the transpiration increases and as sunlight strikes the leaves of a plant stomata tend to open (Von Caemmerer and Farquhar, 1981). Yet, despite these findings our data rejects the correlation between more sunlight, which causes more stomata to open, and higher transpiration rates, which are controlled by the number of open stomata, since the shade plant, which had a lower average light exposure when compared to the sun plant (Figure 3) happened to have more open stomata and therefore a higher transpiration rate (Figure 5). Although the part of our hypothesis, which states that the plant in sunny condition would have a higher rate of transpiration, was disproved by our results, our statement that a higher number of open stomata correlates with a higher transpiration rate was supported, as shown by the higher transpiration of the shade plant with more open stomata. Additionally our prediction that higher rates of photosynthesis correlate with higher temperature readings was rejected, since the shade plant was found to have a lower average temperature (Figure 4), but a higher rate of transpiration due to increased numbers of open stomata when compared to the sun plant (Figure 3). This finding may correlate with the ability of plants to close their stomata in hotter drier, climates, as CAM plants do, in order to retain water and minimize loss by decreasing rates of transpiration (Raven et al. 2005). Therefore further research must be conducted to explore the correlation between higher rates of photosynthesis and higher rates of transpiration, while taking into account water loss as a disadvantage to photosynthesis.

References Cited

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