Stayin’ Alive!:
Examining the Winter Adaptation of Chlorophyll in the Bark of Quaking Aspen Trees

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Abstract

The Quaking Aspen (*Populus tremuloides*) grows all across North America. It is easily noted by its white bark and twirling leaves. The Aspen is able to live at various climates and elevations. The Aspen has many adaptations such as a shared root system, ability to clone itself, twirling leaves and chlorophyll in its bark. It was the objective of this study to examine the relationship between the amounts of chlorophyll in the bark of Aspen trees with different diameters at breast height (DBH). The study showed no statistically significant relationship between the amounts of chlorophyll in the bark in relation to DBH.

**Keywords:** Photosynthesis, Winter Survival, Chlorophyll, Aspen

Introduction

The Quaking Aspen tree is the most widespread growing tree in North America (Pearson & Lawrence, 1958). In Minnesota, Wisconsin and Utah, Aspen stands are more common than any other forest type. An Aspen stand located in Utah is considered the largest single organism on earth with a weight estimated at 6,000 tons. Aspens are of importance to ecosystems, forage production and biodiversity (Kurzel, et al., 2007). Forests dominated by Aspens often contain twice the number of species per unit area as found in conifer forests (Binkley, 2008).

Aspen stands are a vital part to many ecosystems, especially in the western United States. The western United States battles forest fires every summer. As a fire burns through a forest, Aspens drop a crown fire to the ground because of the small amount of flammable material (U.S. Department of Agriculture, 2003). A fire will benefit an Aspen by removing other trees competing for nutrients and sunlight and also can produce vegetative reproduction of the tree
CHLOROPHYLL IN THE BARK OF ASPEN TREES (Kurzel et al., 2007). The Aspens may be able to form new stands and use the nutrient rich soil provided by the fire to thrive. Also, Aspens play a key role in new growth and succession after a fire disturbance. As a new Aspen stand grows after a fire, there is more available habitat for animals to occupy. Finally, Aspens help prevent soil erosion and can also be used in restoration of riparian habitats (U.S. Department of Agriculture, 2003).

The Aspen has one very important adaptation that allows it to be such a common tree in North America. The bark of the Quaking Aspen contains chlorophyll and therefore is capable of photosynthesis (Pearson & Lawrence, 1958). It has been estimated that the bark provides up to 15% of the photosynthetic surface of quaking aspen trees (Covington, 1975). Also, leaves are present for only three to four months, but the bark provides a year-round photosynthetic surface (Covington, 1975). This allows the Aspen to continue to produce food for itself during the winter and enables it to survive in climates and locations other trees cannot.

The ability to photosynthesize in its bark may prove to be a critical winter adaptation of the Aspen as climate change produces longer and colder winters in some areas. As climate change continues there may be a change in which Aspen stands can tolerate harsh winter conditions. If there is more chlorophyll in the bark of trees of different sizes it may show which trees can better survive the winter. It was the objective of this study to determine if there is a statistically significant relationship between the amount of chlorophyll in the bark and the diameter of Quaking Aspen trees. It was hypothesized that aspens with a larger diameter have more chlorophyll in their bark because a larger tree has more nutrient needs for survival and chlorophyll is a necessary agent in photosynthesis. This question is of importance because it may produce results that allow ecologists to determine how...
Materials and Methods

A total of six samples were taken from the Aspen grove at Spring Mountain Ranch in McCall, Idaho. McCall is located in the central mountains of Idaho, part of the Rocky Mountains. The elevation is 5,023, annual precipitation is 26.28 inches, average maximum temperature is 54°F and average minimum temperature is 27°F (Western Regional Climate Center, 2011).

I measured the six trees for their circumference at breast height. From the circumference measurements, I then calculated the diameter at breast height (DBH). At the height of five feet, a knife was used to harvest a one-inch by one-inch section of the bark, from the North aspect of the tree, penetrating to the top part of the cortex.

In the laboratory, samples were resized into 1cm x 1cm x 2mm (length x width x depth) and cut into smaller pieces (< 0.5 mm x 0.5 mm). I then placed samples in into 10ml of aqueous 80% acetone solution, sealed the container and stored samples overnight in a dark place.

The next day, I measured absorbency at 646nm and 663nm with a spectrophotometer (SpectroVis Plus, Vernier, Oregon, USA). I calculated the chlorophyll content using the following formula:

\[ \text{Chlorophyll Content} = \frac{7.18 \times A_{663} + 17.32 \times A_{646}}{\text{area of sample}} \]

Results and discussion

The chlorophyll content data received from the above formula in addition to the DBH data was used to run a Linear Regression through R Software (R Development Core Team, 2011).
My results showed that there was no statistically significant relationship (R-squared= 0.00016, p-value= 0.9809) between DBH and the chlorophyll content of aspen bark (Table 1).

The hypothesis that aspens with a larger diameter have more chlorophyll in their bark because a larger tree has will more nutrient needs for survival and chlorophyll is a necessary agent in photosynthesis was not supported. There is no statistically significant relationship between the amount of chlorophyll in the bark and the DBH. However, it should be noted that the study does support prior research that there is indeed some chlorophyll located in the bark of Quaking Aspen trees as can be seen by the output of the spectrophotometer (Table 2) with results of the absorbency at 646nm and 663nm above zero. The ability to photosynthesize through its bark will allow Aspen trees to continue to thrive even if climate change continues.

As climate change affects different regions, there is the possibility of colder, more intense winters. Ecologists are interested in the Aspen because of its ability to withstand cold conditions (Barr & Potter, 1974). If colder winters become more common it is likely that other plants and trees will not be able to survive the winter. Because of the Aspen’s ability to photosynthesize in its bark it has an advantage over these other trees. It has been shown that photosynthesis occurs in Aspen tree bark even at air temperatures below freezing (Covington, 1975). The ability to photosynthesize in its bark will get the Aspen an advantage over other trees if climate change produces longer, colder winters.

Conclusion

The results of this study show there is no statistically significant relationship between the amount of chlorophyll in the bark and the DBH of aspens trees. The presence of chlorophyll in the bark of Aspen trees allows them to photosynthesize year-round. With climate change, the
possibility of more fires or colder temperatures may allow the Quaking Aspen to continue its stronghold on North American forests while other trees may struggle to survive. Although there is no relationship between DBH and amount of chlorophyll in the bark of Aspens, the adaptation of photosynthesizing bark is then a very important factor in the life of a Quaking Aspen and its importance will only increase with time as climate change become more apparent.

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References


Tables

Table 1. Data output from R Commander

<p>| | |</p>
<table>
<thead>
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<tr>
<td>Residual standard error</td>
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<tr>
<td>Multiple R-squared</td>
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<tr>
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<td>F-statistic</td>
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<tr>
<td>p-value</td>
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Table 2. Harvested Aspen bark sample data and absorption (at 646nm and 663nm) results from the spectrophotometer.

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<tr>
<th>Sample Number</th>
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Fig. 1. The relationship between Chlorophyll content and DBH of Quaking Aspen Trees.