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# The Effects of Leaf Hydration on Light Reflectance in Salvia leucophylla and S. mellifera

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# The effects of leaf hydration on light reflectance in Salvia leucophylla and S. mellifera

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## Introduction

One of the fundamental goals of the biological sciences is to understand how form meets function. Plant systems have been crucial in bridging the gap between the different sectors of biology, and the study of plants is increasingly important in the burgeoning environmental crisis. Many plants have structural extensions called trichomes. These tiny filaments play a crucial role in water trapping and light reflectance; it is also proposed that trichomes are critical in protection against several different stressors including pathogen infection, excessive light, and temperature.

While the presence and general function of trichomes has been well established, the variation of trichome benefits in different environments has not been investigated. Specifically, the relationship between hydration level and light reflectance is to be explored as it directly correlates to a plant's ability to use light productively; perhaps the excess trapping of water encourages a greater reflectance of light. This is the hypothesis on which this experiment is built. The more water trapped by the trichomes, the higher the level of light reflectance, and the drier the plant, the less reflectance.

## Experimental

The Unispec Spectral Analysis System was used to determine the NDVI and experimental index of individual leaves of *Salvia leucophylla* and *Salvia mellifera*. Once six plants of each species had been tagged, all within the same populations, branches and leaves sampled and tested were paired to avoid unnecessary variation. One set of branches was kept as a control, and was tested immediately for NDVI and experimental index under a "normal" condition. Alternatively, leaves from another branch were sprayed with water and allowed four minutes prior to testing. The other set of branches was set to dry under a fan for 24 hours (Fig. 5); relative dryness was tested as a measure of water potential using the Scholander Hammel pressure chamber. Comparison of NDVI and experimental index was subsequently examined, as was the *Salvia leucophylla* and *Salvia mellifera* comparison.

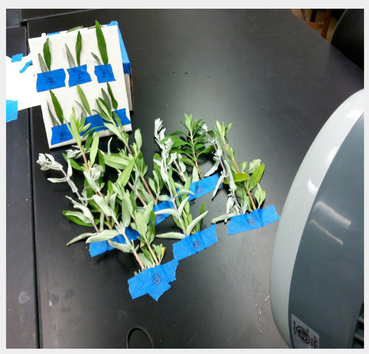

Fig.5 Experimental set up for drying. Plant type/species paired in location so that air flow was consistent through all six trials.

## Abstract

The presence of trichomes on a plant affect the plant's ability to retain water; this, in turn, must affect light propagation and reflectance. It was hypothesized that a plant with a higher trichome density (*Salvia leucophylla*) would have a greater change in reflectance when exposed to a more aired or hydrated environment than a species with a lower trichome density (*S. mellifera*). Results obtained using a Unispec suggest that Salvia mellifera is more resistant to change in NDVI in response to drying and wetting. Water potential data suggest this may be related to the plant's resistance to actual drying and wetting in the first place.

## Results

Fig. 1

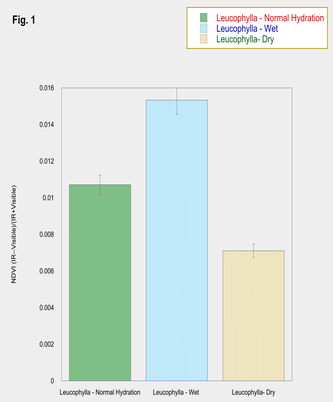


Fig 1. Shows the relative NDVI for S. leucophylla for the normal, wet, and dry conditions. (P<.05)

Fig. 2

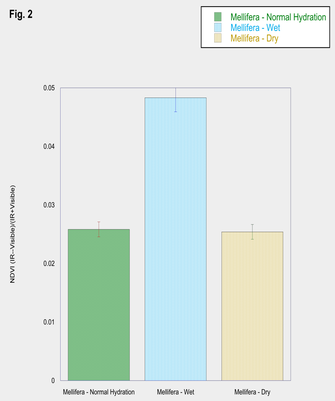


Fig 2. Shows the relative NDVI for S. mellifera for the normal, wet, and dry conditions. (P>.05 Wet-Dry)

Fig. 5

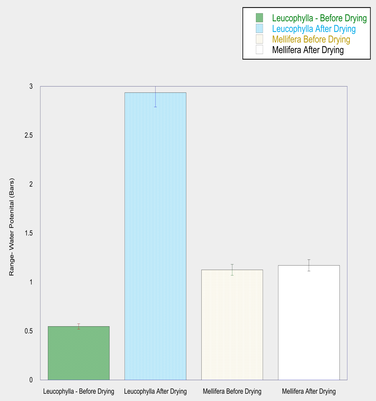


Fig 5. Shows water potential as a means to assess dryness.

Fig. 3

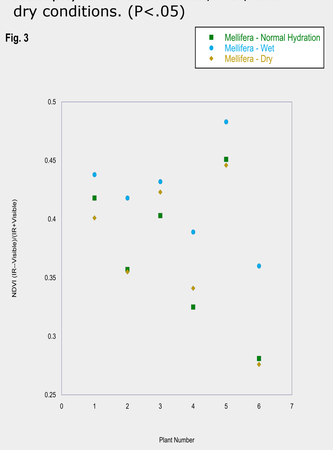


Fig. 4

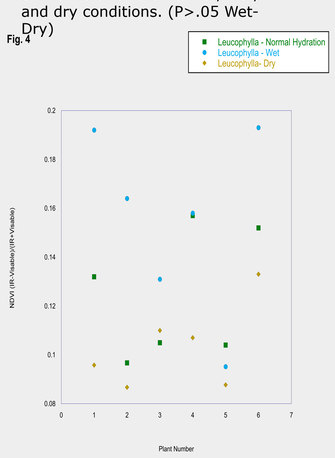


Fig 3. Fig 4. Shows the relative change in NDVI in S. mellifera for each plant in the wet, dry, and normal conditions.

Fig 4. Shows the relative change in NDVI in S. leucophylla for each plant in the wet, dry, and normal conditions.

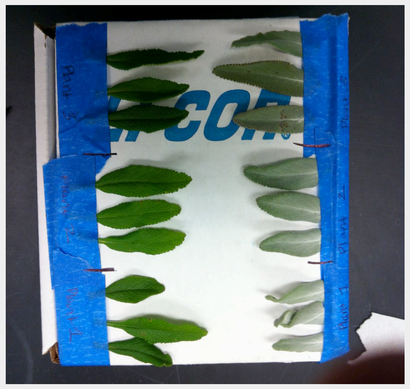

Fig. 6 Paired trials of leaves from the different plants. *Salvia leucophylla* pictured on top with *Salvia mellifera* on bottom.

From left to right, Kolina Mah-Ginn, Logan Schmitz, and Hayley Presthus.

## Discussion

We found that on average for the six plants selected of both *Salvia leucophylla* and *Salvia mellifera*, the former had a lower water potential. We suspect that this is true because of the greater presence of trichomes on *Salvia leucophylla*, making the overall plant hydration less important since the trichomes can function to maintain water in the leaf. *Salvia mellifera* has fewer trichomes however, and therefore a higher water potential is needed in order to keep the leaf from desiccating.

Our spectrophotometer readings demonstrate that *Salvia mellifera* was less susceptible to drying and wetting. In comparing Figures 3 and 4, a greater difference can be seen in the light reflectance values of the dry versus the wet *Salvia leucophylla* than in that of the dry versus the wet *Salvia mellifera*. *Salvia leucophylla* that were dry can be seen to have a lot lower reflectance in comparison to the *Salvia mellifera* because the trichomes present trap water and can possibly facilitate light reflectance. Greater reflectance is likely a result of trichomes that create a boundary layer of water over the leaf. When the *Salvia mellifera* are wet, however, a smaller affect is observed due to the smaller density of trichomes resulting in less water retention and a more minor change in light reflectance. The layer of water created by the small amount of trichomes in *Salvia mellifera* is likely not as thick maybe only partially covering the surface of the leaf. This is our rational for the greater reflectance results seen for *Salvia leucophylla.*

While the functions of trichomes have been studied, every biological system has its tradeoffs. Similar to C4 plants that are able to fix oxygen at the price of a higher metabolic overhead, we speculated that the function of trichomes to trap water would have an effect on their ability to reflect light. The manner in which they best function could have a huge impact on their ability to be treated in order to maximize the function of plants in the future.

From a humanistic perspective, it is valuable to research the properties of trichomes to better their role in crop protection as well as pharmaceuticals. Glandular trichomes play a role in resisting insects for example by secreting a resinous substance that coats the plants surface, functioning as a natural insect repellant (Peter 2008). Limiting the movement of insects and parasites on a plant's surface helps crops to flourish, playing a large role in our economy today. From our experiment, however, it might be discovered that the function of trichomes to protect the plant from one factor could lead to the cost of protection from another. Therefore, this study has an influence on the quality of crops in the future. Pharmaceuticals are another large industry that the knowledge of trichomes can expand upon. Research utilizing recombinant DNA technology has already allowed industries using cigarettes, liqueurs, and perfumes for example to be greatly prôgressed.

However, will their usage in these fields continue to be prominent in a world where global changes are taking place on a large and unpredictable scale? The world is heating up and climate is no longer a stable factor. Sunlight and moisture, both of which we are studying in this experiment, are vital to consider due to the way in which trichomes could be impacted and therefore their use in the crop and pharmaceutical industry restricted. With a growing population, the ability for the crop industry to flourish is something that relates to everyone and our dependence on the functioning of plants is phenomenal. Therefore, while this experiment only tests two factors that influence trichomes, the results obtained from this experiment could have large impacts that could lead to broader future studies as well as insight into how our society could function in the future.

## Conclusion

It is concluded that S. mellifera was less resistant to wetting and drying, and therefore greater retained NDVI in those situations.

- S. leukophylla has lower water potential.
- S. mellifera shows a greater overall NDVI and a greater resistance to change in hydration.

## References

1 Peter, A. J., Shanower, T. G. 2008. Plant glandular trichomes: chemical factories with many potential uses. Resonance.

## Acknowledgements

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