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Effect of Fertilizer on Leaf Tensile Strength in Salvia Leucophylla

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ABSTRACT

This experiment sought to establish a connection between short term growth in *Salvia leucophylla* found in Southern California and nutrient availability in the soil. It was hypothesized that adding artificially produced nutrient mix *Miracle Grow©* would increase the strength of the leaves in the herb after one week of addition. Newer leaves were tested in the *Instron* device for tensile strength after one week, and after data analysis, it was concluded that there was no difference in tensile strength of leaves treated with fertilizer compared with leaves without fertilizer.

INTRODUCTION

The tradeoffs that plants face lead to differing amounts of energy allotted to strengthening leaves and other tissues. It is agreed upon that the tensile strength of leaves increases as more carbon is invested into the tissue (Cooley *et al.* 2004). However, literature considering the effect of nutrients in the soil on tensile strength was not available. In this protocol, the effects of soil fertilization on the tensile strength of purple sage (*Salvia leucophylla*) was investigated. It was hypothesized that fertilized plants would have more nutrients to allocate and thus would allocate more nutrients to the leaves than non-fertilized plants. This hypothesis was formulated with the inclination that nutrient content results in stronger leaves and therefore a larger modulus of rupture. It was accomplished using the Instron to perform a longitudinal break of purple sage leaves obtained on the Pepperdine University campus in both leaves treated with fertilizer and a control group in a nearby area which was left in its natural state. This experiment's results could potentially have implications on agriculture to show the effectiveness or ineffectiveness of fertilizers on plant growth, as well as provide information to coastal sage scrub groups about plant integrity.

MATERIALS AND METHODS

The subject of this project was the leaves of *Salvia leucophylla,* also known as purple sage, that grow on the hill behind the KSC center on Pepperdine University campus. 2 groups of *Salvia leucophylla* were randomly chosen from the same area and were labeled as "treatment" and "control." The treatment group was treated with a mixture of deionized water and a half scale of the full recommended dose of Miracle-Gro ©, and the control group was treated with the same amount of the deionized water that was used for the treatment group. 6 leaves (representing 6 different individuals) were collected from each plant group a week after they were treated with different types of water. The tensile strength of each leaf was measured by Instron, and the data points were plotted in graphs.

RESULTS

Figure 2 shows that the leaves of the treatment group had breaking points at tensile stress loads of 1.5 N/mm^2 (3 breaking points noted), 0.225 (2), 0.25 (2), 0.275 (2), and 0.3 (4). Figure 3 shows that the leaves of the control group had breaking points at tensile stress loads of 1.25 N/mm^2 (1 breaking points noted), 0.15 (4), 0.2 (1), 0.225 (1), and 0.3 (4). The highest amount of tensile stress required to break a leaf was the same for both the treatment and control groups. However, the other values for the treatment group were generally higher than the values for the control group; most of the breaking points for the treatment group are above 0.2 N/mm^2 while only roughly half of the breaking points for the control group are above 0.2 N/mm^2. Table 1 shows the mean Young's Moduli with standard deviation.

Figure 1- Study site on the Pepperdine campus: hill by the greenhouse and KSC.

Figure 2- Tensile Strength vs. Tensile Stress in the Treatment Group

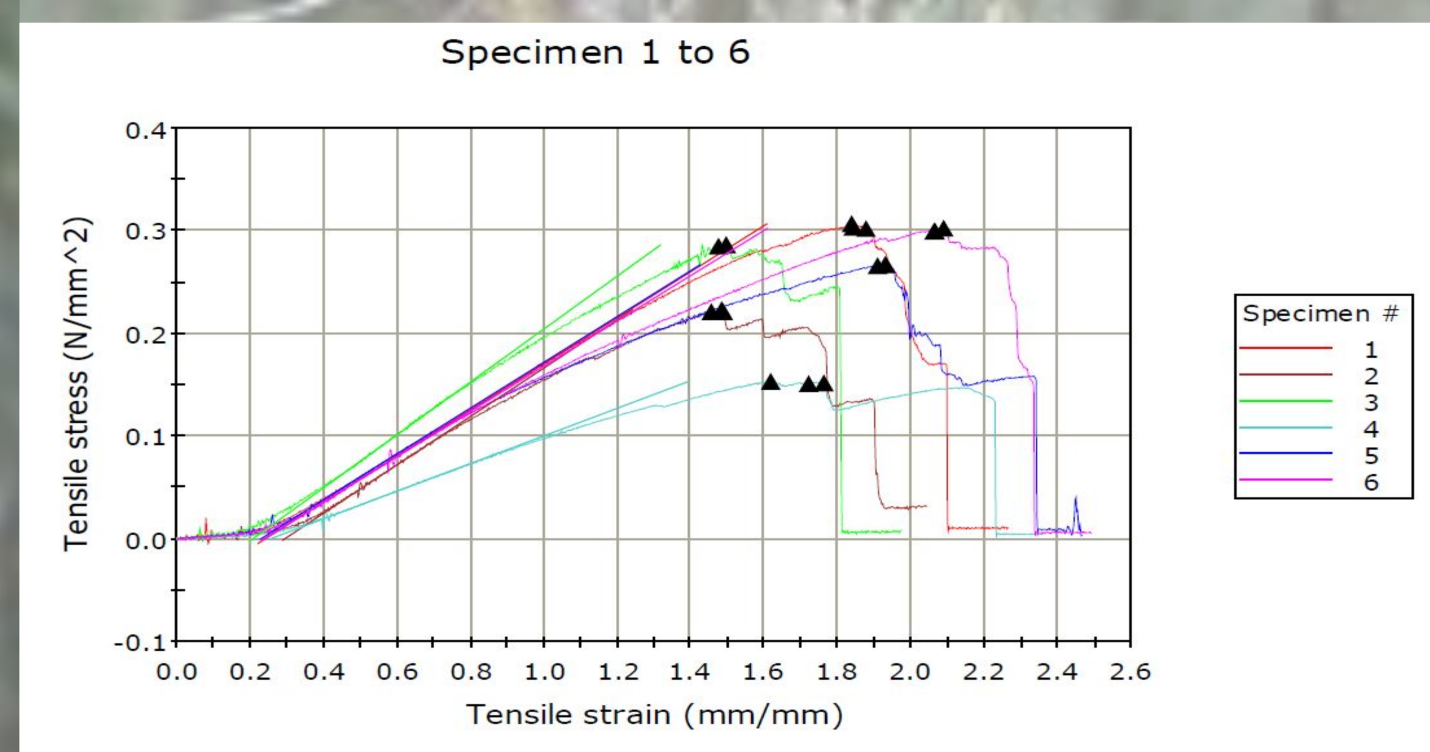

Figure 3- Tensile Strength vs. Tensile Stress in the Control Group

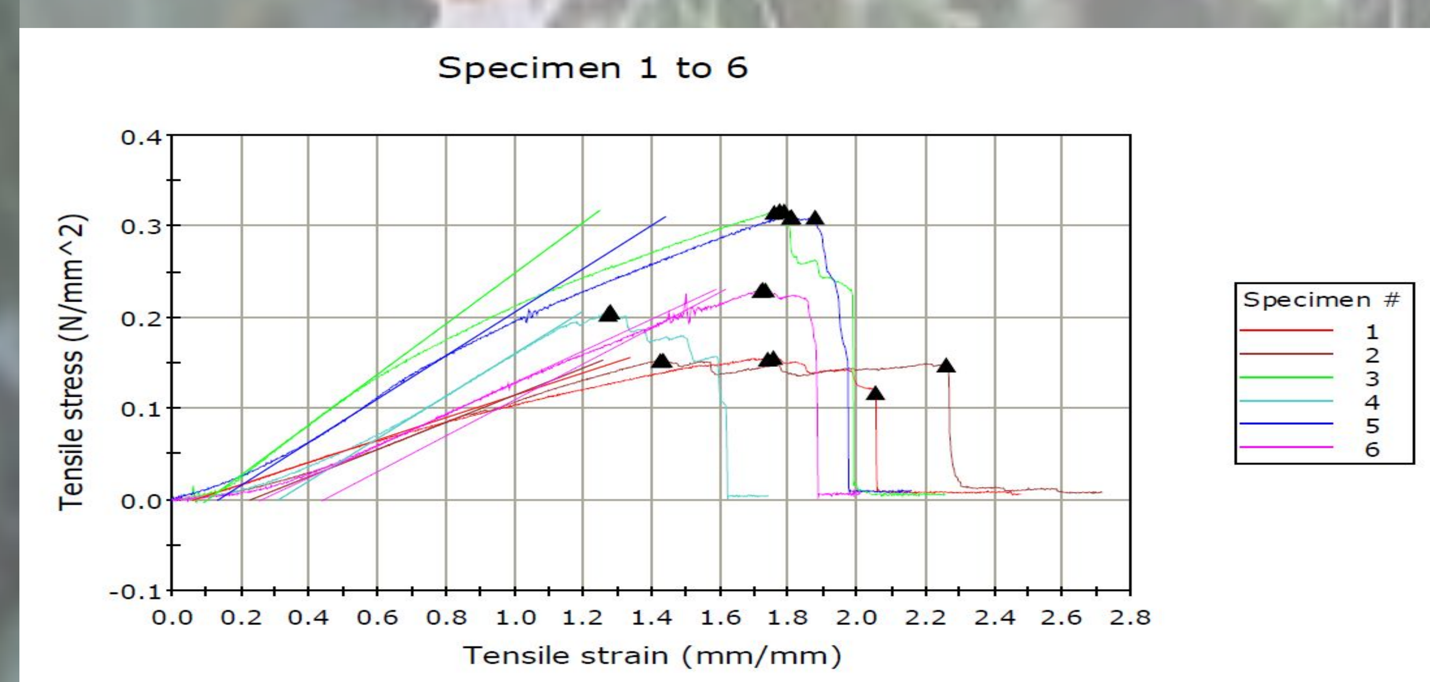

Table 1- Young's Modulus and Standard Deviation

	Young's modulus N/mm^2	Standard deviation
Control	0.20269	0.058
Treatment	0.21580	0.040

DISCUSSION

After performing this experiment, it was found that the results supported the null hypothesis, although this does not show the full effects of nutrients on plants. This was more than likely due to the lack of time available to treat the plants with fertilizer, and lack of time for the plants to assimilate the nutrients from the fertilizer into their leaves. Before the field study, growing treated pea plants in a controlled lab environment was attempted, which would have given the plants more time to assimilate the nutrients and would have a larger affect on the entire plant. However, a fungus in the temperature-controlled chamber continually killed the pea plants, so the plants were thrown out and the field study of *Salvia leucophylla* was adopted in its place. Another component of the experiment that could have been executed would be to test the Young's modulus of rupture of the stems, since perhaps the nutrients may have been assimilated into xylem fibers, showing increased mechanical strength in accordance with research already done (Jacobsen, 2005). However, this would have been hard due to instrumental limitations in the Instron device for measuring stems as small as those found in *Salvia leucophylla*. Also, the time constraint would have factored into this aspect of the test as well. The data from the experiment carried out showed promise before performing a statistical test, for there were four plants in the treatment that were above .25 (N/mm^2) of tensile stress, while the control only had two points of rupture above .25 (N/mm^2). After performing statistical analysis using a Man Whitney U, no significance was found. This could have been affected by the small values that were worked with. Also, this could have been due to the lack of time for the plant to assimilate the fertilizers, or since the nutrients were not carbon based but other non-carbonaceous nutrients, the plant's tensile strength may be unaffected by an influx of nutrients such as those found in fertilizers. The original rationale was that an increase of non-carbonaceous nutrients would allow the plant to more efficiently process carbon dioxide in the reactions needed to produce it in the leaf, and therefore more sugars, cellulose, etc. would be produced and allocated to the xylem fibers, as well as structural support of the plant. The fact that more tensile strength was required to break the leaves of the fertilized plants does suggest that a longer trial may have greater effects, even though this test did not have statistically significant results. Although this protocol did not show a difference between the treatment and control groups, a longer study in both the lab and the field with more individuals sampled could further pursue this hypothesis.

CONCLUSIONS

The lab component of this experiment was unsuccessful due to unforeseen factors beyond control, and the field portion showed no statistically significant difference between the treated and control populations. Therefore, following this data the null hypothesis is accepted. Consideration must be made that since the typical coastal sage scrub plant invests a lot of energy into the prevention of tissue dehydration, it must take longer than a week to grow (Kolb and Davis, 1994). Because of this, it is nearly impossible to measure newly grown leaves affected by the treatment within a week. Future research could perform this experiment both in the field and in a controlled lab setting. It also provided some valuable insight into the scientific method and how the data could show a hypothesis to be false which prompts reformulating the hypothesis and redesigning the experiment. Studies taking into account the barriers that came up during this experiment could provide more insight in this area.

LITERATURE CITED

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