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Article #1

Effects of Caffeine and Vitamin E on Wisconsin Fast Plant

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BIO 3450-02: Concepts of Biology I for Early and Middle
Childhood Education

Fall 2014

Mr. Len Kenyon

Mr. Kenyon describes this assignment: Students conducted a semester-long research project using Wisconsin Fast Plants. Students selected two different organic substances to test against control plants. They recorded data on germination, growth and development, flowering, pollination, fertilization, and embryogenesis. The paper reflects students' understanding of scientific writing, statistical analyses, data collection, literature review, and clarity of thought for it all.

INTRODUCTION

We used the Wisconsin Fast Plant, also known as *Brassica rapa*. *Brassica rapa* is a crucifer and belongs to the family *Brassicaceae*. The University of Wisconsin bred this plant to have a very short growth cycle. It grows stems, leaves, roots, and flowers within approximately 14 days, and grows harvestable seeds about 40 days after being planted. Due to the short life cycle of Fast Plants, *rapa* is an optimal plant to use in an educational setting such as an elementary classroom. All it needs to grow is constant lighting and continuous watering through a capillary wick (Kanhathaisong et al., 2009). Studying plant growth is important because it can help find ways to increase the world's food source by improving the growth of crops. Studying plant growth can also allow people to improve the appearance of plants in their own personal gardens.

The goal of this experiment was to test the effects of green coffee bean, the caffeine source, and vitamin E on the Wisconsin Fast Plant. A study tested the effects of caffeine on a mung bean, *Phaseolus aureus*, by dipping the seedlings in solutions of 50, 100, 200, 500, and 1,000 μM of caffeine and distilled water. Caffeine appeared to have a negative effect on plant growth. Although caffeine is found naturally in many plant species and can be used on plants to manage pests such as slugs, snails, bacteria, and birds, this study concluded that caffeine stunts root development by reducing protein production (Batish et al., 2009). The green coffee bean will not improve plant growth. The caffeine in the green coffee bean will have a negative effect on plant growth because it will decrease the surface area of the roots, which will decrease the amount of water it can absorb.

Vitamin E is also known as tocopherol. To study the effects of tocopherol on plants, a scientific study was conducted in which plants that were tocopherol deficient were studied. The study showed that these seeds exhibited less seed longevity than plants that were not tocopherol deficient. When the seeds of the tocopherol-deficient plants and the control plants were stored over time, the tocopherol deficient plants had a much lower number of seeds that were still viable. This study showed that early seedling development was impacted by being deficient in tocopherol. The plants that were

tocopherol deficient had an inability to fully expand one or both of their cotyledons. They were also visibly smaller than the control plants (Sattler et al., 2004). The studied showed that vitamin E is essential to seedling development; therefore, applying extra vitamin E will improve the plant's development and overall growth.

MATERIALS AND METHODS

We put a strip of felt through each of the holes in the bottom of two quads. This would serve as a way for our plants to get water. We filled half of the quads with soil and placed two pellets of Osmocote, a fertilizer, in each of the sections. We then filled the quads with soil and planted two Fast Plant seeds in each section. There were a total of 16 Fast Plant seeds in the two quads. The plants were then watered and set under a lamp to germinate.

After the plants sprouted, we transplanted nine of the best plants into three pots, three plants in each pot. We placed two strips of felt through two of the holes in the bottom of each pot and filled them with soil. We then planted three Fast Plants in each pot. One pot would serve as the control which we labeled as such and set aside. We also labeled each plant 1, 2, or 3 in each of the three pots. In the next pot we squeezed the contents of one green coffee bean pill around the base of each of the three plants to infuse the plant with caffeine. We labeled this pot Experiment 1. In the last pot we emptied the contents of one vitamin E tablet into the soil and labeled this pot Experiment 2. We watered the soil of each pot and put the plants under a lamp inside the classroom.

Every Tuesday and Thursday for eight weeks we took measurements to monitor the growth of the plants. We measured the height of the plant from the soil to the apex in centimeters, the number of true leaves, the number of leaf hairs on the margin of each true leaf, and the number of pollinated flowers. We pollinated the flowers by taking a dead bee and rubbing its abdomen on the petals of each plant throughout the entire classroom. We counted the number of seeds by cutting open the seed pods and counting the seeds, and we counted the number of points on each of the true

leaves in order to assess growth. The data was recorded in a data table each day and the average was calculated for each pot daily. We watered the plants by putting water in the dishes that the pots were sitting in. The wicks that were in the bottom of each pot allowed the water to travel from the dish to the roots of the plants in the pot.

RESULTS

Table 1: Statistics of plant traits measured.

N: number of plants, X: mean, S: standard deviation, R: range

Plant Trait Measured	Control				Exp. 1				Exp. 2			
	N	X	S	R	N	X	S	R	N	X	S	R
Height (cm)	3	3.976	1.043	3.1	4	4.5035	0.949	2.875	3	3.5347	0.817	2.53
# Leaves	3	2.659	0.579	1.73	4	3.345	1.003	3.05	3	2.9	0.916	3
# Hairs	3	27.899	8.878	32.67	4	19.625	4.921	15.5	3	30.122	7.958	25.73
# Flowers	3	1.368	1.789	3.67	4	2.275	1.831	4.5	3	1.829	1.488	3.66
# Seeds	3	0	0	0	4	0.2	0.632	2	3	0	0	0
# Points on True Leaves	3	20.349	6.174	22.34	4	27.375	6.461	23.25	3	26.625	9.314	29.67

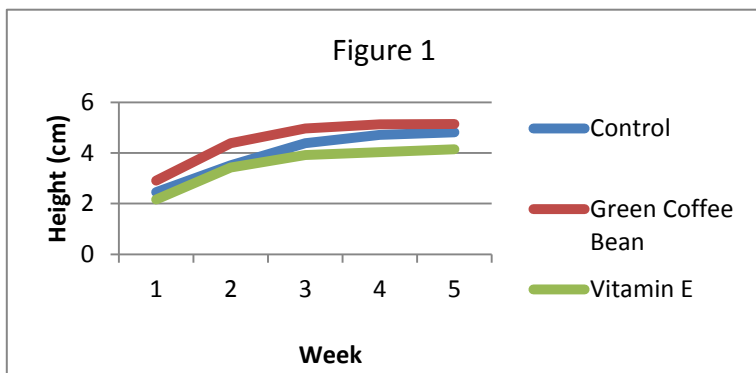


Figure 1: Average height of the three plants per week for 5 weeks.

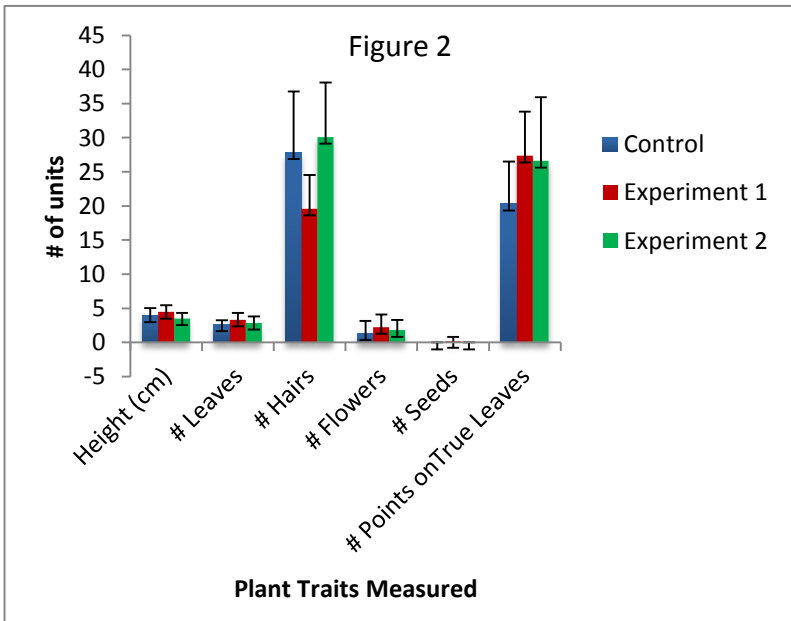


Figure 2: Overall averages for each plant trait measured.

Experiment 1 had four plants rather than three (Table 1). The green coffee bean group consistently had the highest average height over the course of five weeks followed by the control then the vitamin E group (Figure 1). The vitamin E and the control groups were very close in their average weekly plant height until about the middle of the second week (Figure 1). The green coffee bean group had the largest total average for every trait we measured other than the number of hairs (Figure 2). The green coffee bean was the only pot that yielded seeds (Table 1). Both the number of points on the true leaves and the number of hairs had a greater amount of deviation from the mean (Figure 2). The growth for all three plants was fairly steep at first and then became flatter (Figure 1).

CONCLUSION

The green coffee bean excelled in all but one of the traits that we measured compared to the other two plants. This suggests that the caffeine in the green coffee bean actually improved plant growth. This is contrary to our original hypothesis which stated that the caffeine would impair plant growth because it would stunt root development by reducing protein production. An article that tested the effects of caffeine on watermelon plant growth had results that support our original hypothesis (Montes-Zavala 2013). The plants that were given the caffeine concentration of 9 μM yielded fewer fruits than the control. The study mentioned that there have been several studies that have investigated the effects of caffeine on plant growth, and many of them have had contradictory results. The authors stated that this could have happened due to different concentrations of caffeine, different types of plants, and different types of measurements (Montes-Zavala 2013). It is interesting to note that Experiment 1 was superior in plant growth and seed yield despite the fact that it had four plants rather than three. We would have thought that this would have caused Experiment 1 results to be the lowest because having an extra plant means that there was more competition for space, water, and nutrients.

The vitamin E tablet had the lowest weekly average plant height and overall average plant height which suggests that tocopherol (vitamin E) negatively affects plant growth. This is also contrary to our original hypothesis which was that tocopherol was essential to seedling development, adding extra tocopherol would enhance the plant's growth. We could not find any other studies that tested the effects of adding tocopherol to plants. It is possible that since plants produce tocopherol on their own, so adding extra tocopherol could have been too much for them to handle.

It is likely that standard deviations for the number of points on the true leaves and the number of hairs on the true leaves were high due to human error. It was difficult to count the number of hairs because they were so small that we had to use a magnifying glass. It was also difficult to count them because sometimes they were clumped together and it was difficult to count how many were there.

The number of points on the true leaves varied so much because when the true leaves were just appearing they had a lot of points, and when the leaves got bigger the points rounded out and there were fewer of them. For future studies we would recommend measuring the plant's height from the base to the top rather than from the soil to the apex to reduce error by eliminating confusion about where the apex is located.

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References

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