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EXPLORING THE RELATIONSHIP BETWEEN ALTITUDE AND SOIL FERTILITY FOR OPTIMAL FAST PLANT GROWTH

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ABSTRACT

Soil composition plays a critical role in the growth and development of weeds. Weeds are defined as any plant growing where it is not desired, and their presence can cause significant economic and ecological damage. The composition of the soil affects weed growth in several ways, including nutrient availability, pH, and water-holding capacity. Nutrient availability, such as nitrogen, phosphorus, and potassium, is essential for plant growth, including weeds. Soils with higher nutrient levels, particularly nitrogen, tend to promote more weed growth. In contrast, low nutrient levels, particularly nitrogen, can slow down weed growth. Soil pH also affects weed growth; some weeds thrive in alkaline soils, while others prefer acidic soils. Water-holding capacity also influences weed growth, as weeds need adequate moisture to grow and develop. Thus, soil composition is a crucial factor in managing weed populations. Understanding how soil composition affects weed growth can help farmers, gardeners, and land managers design effective weed management strategies that target specific soil conditions to control weed growth.

Key words: Altitude, Brassica rapa*, Correlation, Nutrient Availability, Soil-Water Content*

INTRODUCTION

Huntingdon, Pennsylvania is found in the Allegheny mountains. As a small rural town with a large agricultural presence, we wonder how much thought is put into field placement on ones' property and how it can affect crop growth. Understanding that the soil's nutrient concentration plays a very large role in plant growth, the soil's water content is just as important of a focus. The water content starts the initial step of the plant growth process as it influences the nutrient uptake and movement by the plant (Datta, Taghvaeian, Stivers 2018). Too much water in the soil can cause the roots to rot or prevent the seed from germinating, whereas too little water prevents soil nutrients from traveling through the plant (Traunfeld 2020, Traunfeld 2023). The organism being studied, *Brassica rapa*, is a very hardy plant that grows well in a variety of soils allowing us to pay attention to the altitude and soil water content that these samples were taken from. With the background information we have collected, we expect the soil conditions of the midland environment to produce the fittest/tallest organisms and alternatively we predict the highland environment to produce the fittest/tallest organisms.

MATERIAL AND METHODS

First off, choose four test sites, one in each altitude category (highland, midland, lowland, and wetland). Using shovels we gathered two liters of soil from each location and stored them in two separate one liter containers. Next, 100 mL of soil is transferred to a smaller 100ml container and stored in a cool and dry room in order to obtain a dry weight. With approximately equal portions of soil in each container, the fast plant seeds (*Brassica rapa*) are deposited into a depression made within the soil, two seeds at the lowest level and two more seeds are added once the original depression is half filled. These plants were watered weekly with a liter which was equally distributed among the eight separate containers. Growth progression of the eight containers is measured weekly in millimeters, and carried out for a total of three weeks. Keep plants in the same location

throughout the course of the experiment to ensure that they receive the same amount of sunlight.

FIELD LOCATIONS

The Highland location is Han's overlook (40.4311860°, -78.0173412°) with an elevation of **240m** located on top of a local mountain. The Midland location is outside of the third floor biology wing of Brumbaugh Academic Center. (40.5017941°, -78.0187916°) which is a well kept area of the college's grassland with an elevation of **214m**. The Lowland sample is a valley located along Point Road at **186m** (40.439177°,-77.981832°) which has little human interaction but soil is constantly being changed by the river causing there to be little to no topsoil. The Wetland sample is from Old Crow Wetland (40.48841°, -78.03585°) which is a wetland full of tall grasses located at **192m**. All elevations of field locations were found using source, https://www.dcode.fr/earth-elevation.

RESULTS

Table 1. Summary of plant growth over the course of 4 weeks in soils from 4 different elevations. Growth measured in millimeters, represented with mean growth +/- standard deviation.

Environment (Elevation)	**Plant Growth**	**Variance**
Highland(240m)	74 +/- 50.91	High
Midland(214m)	46 +/- 12.73	High
Lowland(186m)	1 +/- 1.41	Low
Wetland(192m)	8.5 +/- 0.71	Low

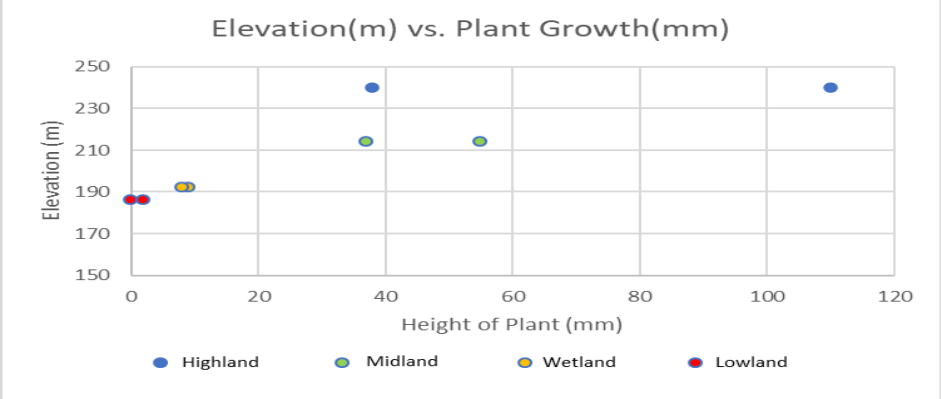

Figure 1. Comparison of elevation in meters between four different locations versus the height of plant growth in millimeters. From largest to smallest growth in a four week period, the results show that the highland environment had the most growth followed by midland, wetland, and then lowland. A total of n=8 samples, 2 from each field location, were analyzed using correlational statistics which identify r = 0.841 and p = 0.0088.

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Table 2. Calculations of a soil's water content, reflected as a percentage, acquired through dry mass calculations and description of the soil's main composition.

	Highland	Midland	Wetland	Lowland
% water	11.3%	2.9%	10.77%	18.6%
Main comp.	topsoil	topsoil	clay	clay

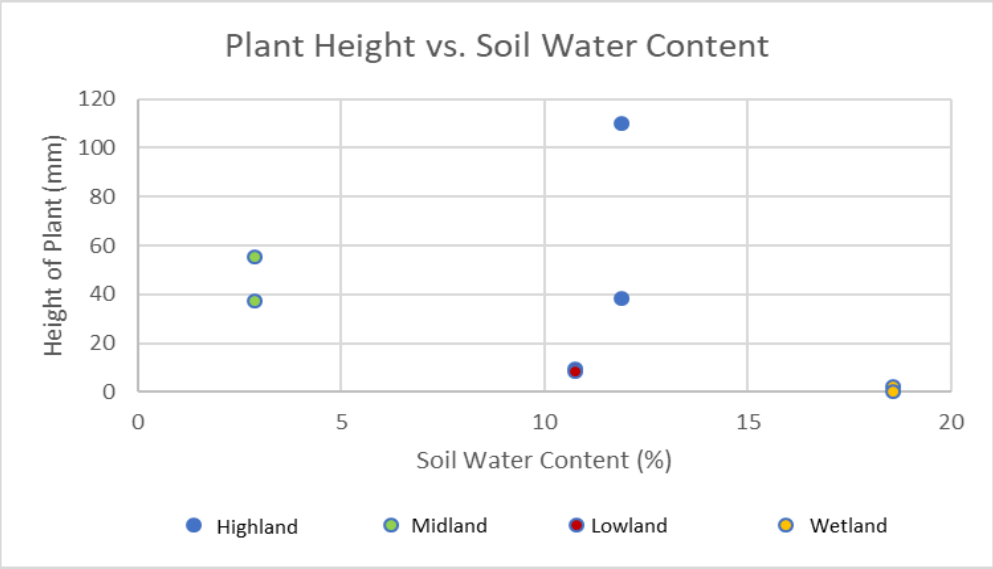

Figure 2. Comparison of plant height grown in soils of four different locations over the course of 4 weeks, measured in millimeters, versus the water content of said corresponding soils, measured as a percent through dry mass calculations. A total of n=8 samples, 2 from each field location were analyzed to identify r = -0.394 and a p-value wasn't able to be identified.

DISCUSSION

Optimal soil conditions can vary due to a variety of factors. This experiment focused on the elevation that a soil sample was taken from and the height of the plant that was able to emerge from it. Figure 1, shows the comparison between these two variables and was analyzed using the Pearson's Product-Moment Correlation test as the data follows a normal distribution. This test produced an r-value of 0.841 which provides a positive linear association, meaning as the values of one variable gets higher, as does the other. The two-tailed t-test of this r value produced a p-value of 0.0088 meaning that at a 5% level of significance we have sufficient evidence to reject the null hypothesis that soil conditions don't matter in affecting the growth and survivability of plants. While the results do support our alternate hypothesis that the highland environment would produce the fittest/tallest organism, this is somewhat unexpected as we were focusing the experiment on the water content found in this soil. Figure 2 shows the comparison of plant height from the 4 different field locations to the percent water-content that is listed in Table 2. Performing correlational statistics on this data proved unsuccessful as the r-value reported and the trend of the data did not produce any type of association between the two variables. A possible explanation of why the value did follow the

hypothesized trend is, as stated in table 2, that the soil samples of the highland and midland regions were mainly topsoil whereas the wetland and lowland regions had a more clay-like substance. This difference in composition could have prevented the wetland and lowland samples from obtaining much, if any, growth. Future research to expand on this topic could have more samples to measure plant growth to improve the variability factor, such as how in table 1 the highland and midland environments had high variability. Also, researchers should perform analysis on the nutrient composition of the soils as well as the water content in order to gain a better understanding of which factor plays a larger role in the growth of a plant.

ACKNOWLEDGEMENTS

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