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EFFECT OF SOIL NITRATES, PH, AND ORGANIC CONTENT ON *ACER SACCHARUM* SEEDLING DISTRIBUTION

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ABSTRACT

I examined the relationship between distributions of sugar maple (*Acer saccharum)* seedlings and soil characteristics at Juniata College's Raystown Field Station. I compared soil pH, nitrate and percent organic content in three areas of high seedling density to three areas of low seedling density. I found no significant differences in pH, nitrate, or percent organic content between soil collected from areas of high sugar maple seedling density and areas of low density.

INTRODUCTION

The sugar maple (*Acer saccharum*) is a common tree inhabiting moist valley soils of Central Pennsylvania. It's optimal environment consists of well drained loamy soil abundant in organic matter, with a pH ranging from strongly acidic (pH 3.7) to slightly alkaline (pH 7.3) (Burns, 1990). They do not grow well in dry, shallow soils. Sugar maple's leaf litter tends to modify the pH and nutrient status of soil to conditions optimal for seedling establishment, and plant growth (Burns, 1990). Leaching by rain and runoff however removes nutrients from the soil, and such leaching may inhibit establishment of maple seedlings (Bennett et al., 1988).

To produce optimal growth, all essential plant nutrients must be present in adequate quantities within the soil. Nitrogen is the most common element to be deficient from the soil (Bennett et al., 1988). Nitrogen is used in relatively large quantities by plants to produce amino acids, protein, and chlorophyll (Bennett et al., 1988).

I observed that there were distinct areas at the Raystown Field Station in which sugar maple seedlings grew in large dense patches. Surrounding these areas of dense seedlings few, if any sugar maple seedlings grew. Because soil nutrients can vary enormously over relatively short distances (Perry, 1994) I hypothesized that soils differed in nutrients and composition between the high density and low density patches therefore resulting in the patchy distribution of maple seedlings.

METHODS AND MATERIALS

I conducted this experiment in the maple grove adjacent to Lake Raystown at Juniata College's Raystown Field Station, Entriken quadrangle Huntingdon County Pennsylvania (North 40° 21'29", West 78° 09'01"). The maple grove is approximately fifty years old, with an over story dominated by sugar maples, with red maples (*Acer rubrum*), and white oaks (*Quercus alba*) mixed in.

I randomly established 3 plots among areas of high sugar maple seedling density (>50 seedlings/m^2), and 3 plots among areas of low maple seedling density (<10 seedlings/m^2). I randomly

selected three 1 m^2 subplots within each plot and counted all the living sugar maple seedlings and took a soil sample within each of these subplots.

I measured percent organic content of the soil by drying about 30 grams in an oven to constant weight to remove any moisture. A known weight of each soil sample was placed in a crucible in a 600° C furnace until all organic material contained in the sample was burned away. I then calculated percent organic content for each sample based on the original sample weight and the weight after burning.

To extract nitrogen from the soil, I first calculated the amount of moist soil needed to obtain 10 g of dry soil, based on my previous calculations. To this soil I added 0.10 g calcium sulfate, and 20 ml deionized water. I removed water from the soil by vacuum filtration. I then analyzed the water for nitrate content using a cadmium reduction method (HACH, 1992).

I determined the pH of the soil by taking10 g of each soil sample and adding 20 ml of deionized water to it. It shook it and let it settle three separate times. After the third time the soil was removed from the water by vacuum filtration, and the water was tested for pH concentration using a pH meter.

To compare the percent organic matter, pH, and the nitrate concentration of soil collected from high density areas to those collected in low density areas, I used a two sample T-test (Ambrose et al., 1995). I used an α level of 0.05 and considered differences to be significantly if $p<0.05$.

RESULTS

Mean percent organic matter did not significantly differ between high density plots (9.48%) and low density seedling plots (8.69%) (t=0.85, df=14, p=0.41). Similarly the mean soil nitrate did not significantly differ between high density plots (0.0357 g/ 10 g soil) and low density plots (0.0318 g/10 g soil) (t=0.3, df=15, p=0.76). The same was true of the pH content of the soil, the mean soil pH of high density plots (3.85) and that of low density plots (4.16) did not significantly differ (t=-1.42, df=15, p=0.17).

DISCUSSION

I found no significant differences between the mean percent organic matter, pH, or nitrate content of the soils of high and low seedling density. These factors are not causing the patchy distribution of sugar maple seedlings, which I observed at the Raystown Field Station.

If I were to continue investigating the relationship between the differences in sugar maple seedlings at the field station I would test for a variety of different factors. The density differences might be a result of different light intensities coming through the canopy. It may be the result of seed distribution. Or possibly the difference between the areas where seedlings are growing where they are not is related to some other soil factor that I did not test for. It is possible that an essential nutrient, other than nitrogen, is the limiting factor. There is something which is limiting the distribution of sugar maple seedlings in the maple grove, but it may take a lot of trial and error before the cause is determined.

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