The Correlation between Mycorrhizal Fungi and Available Potassium in Soil

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Abstract

During our ten-day experiment, we tested to see if there was a correlation between the level of fungi and the level of potassium in the soil surrounding maple and rhododendron trees in the E.S.S.R.E. research sites. To investigate this theory, we took 12 samples per day over the course of 3 days, 6 of these samples were taken next to a rhododendron tree, and the same number were taken from maple trees located near the rhododendron tree. All samples were tested for potassium levels (ppm) and mold density (#/cc). Our hypothesis was not supported.

Introduction

We already know that exomycorrhizal fungi forms mutual relationships with some plants, including maple trees and ferns, to help them intake phosphorus, nitrogen, potassium and water (Jenkins, 2005). Exomycorrhizal as well as ectomycorrhizal fungi are used by certain plants, such as Maple trees, to aid in the absorption of nutrients such as potassium. Available potassium refers to one of three types of potassium, the types being Unavailable, Slowly Available, and Readily Available Potassium. Up to 98% of all Potassium contained in soil is in the form of Unavailable Potassium, meaning that the form of the Potassium is mostly crystalline and not easily accessible for use by plants. Readily Available Potassium is exactly what one would assume it to be, the Potassium that plants are able to actually use. This 'Readily Available' Potassium is what our Potassium tests tested for.

Many plants are heavily reliant on the assistance of fungi to absorb what they need, such as water and nutrients. Nutrients such as potassium are known to be correlated with higher growth levels in plants, leading potassium to be a vital part of crop growth. This is made possible because the ectomycorrhizal fungi burrow into the roots of the plant and extend beyond the roots to create a sort of root extension, while exomycorrhizal fungi make something resembling a net surrounding the roots.

Methods

Twelve soil samples, taken to a depth of 15 cm with a width of 2 cm, were taken daily for three days for a total of 36 samples. One sample was taken from each of six separate Rhododendron bushes and one each from each of six separate Maple trees located in E.S.S.R.E. Sites 1 (N 39.35794; W 076.63977) and 3 (N 39.35797; W 076.63836) at the coordinates in Figure 1. Each sample was taken 30 cm from the trunk of the plant.

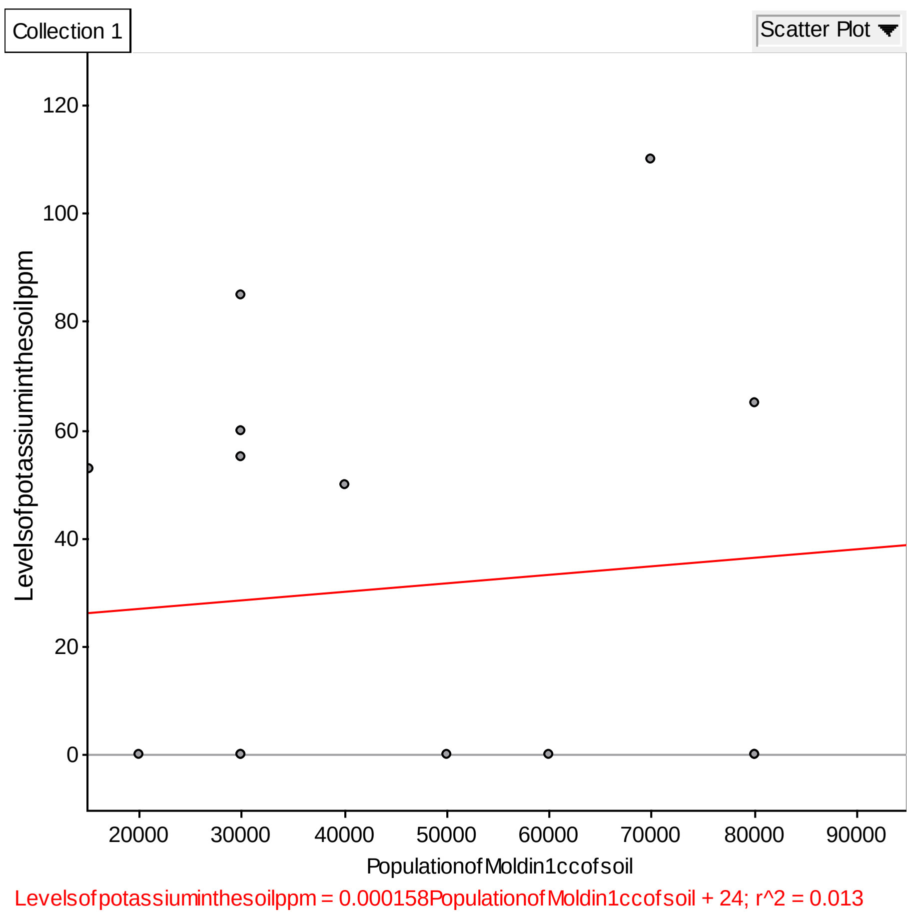
Figure 1

Plant	Maple Tree	Rhododendron
1	N 39.35810 W 76.638673	N 39.35811 W 76.63874
2	N 39.358009 W 76.638672	N 39.35913 W 76.63863
3	N 39.35814 W 76.63863	N 39.358009 W 76.638672
4	N 37.35789 W 76.63956	N 49.35812 W 76.63930
5	N 39.35824 W 76.63679	N 39.35789 W 39.35010
6	N 39.35802 W 76.63982	N 39.357917 W 39.35013

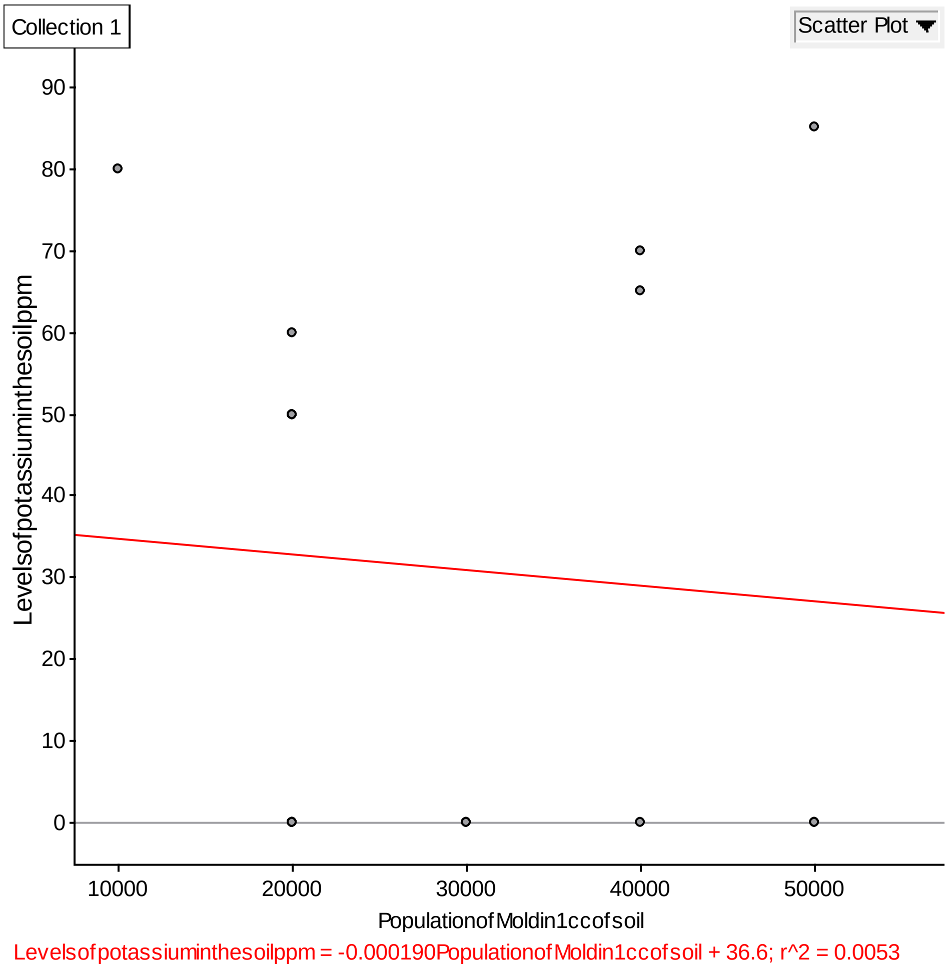
All 36 samples were tested for potassium (ppm) using a LaMotte Test Kit Combination Soil, Model STH-14 (Code 5010-01). Simultaneously, serial dilutions were performed on each sample to the 10^{-2} dilution using sterile water. 100 µL of the 10^{0}, 10^{-1}, and 10^{-2} dilutions were plated on their own individual 3M Petrifilm™ Yeast and Mold Count Plate and were allowed to grow for 72 hours. The number of mold/cc of soil was then calculated using the most dilute sample with at least one mold growing on the plate.

Results

Graph #1 represents the increase in mold population in the soil surrounding the rhododendron trees in conjunction with the increasing potassium levels. Graph #2 demonstrates the inverse relation between mold and potassium in the soil surrounding maple trees; as mold increased, potassium decreased.

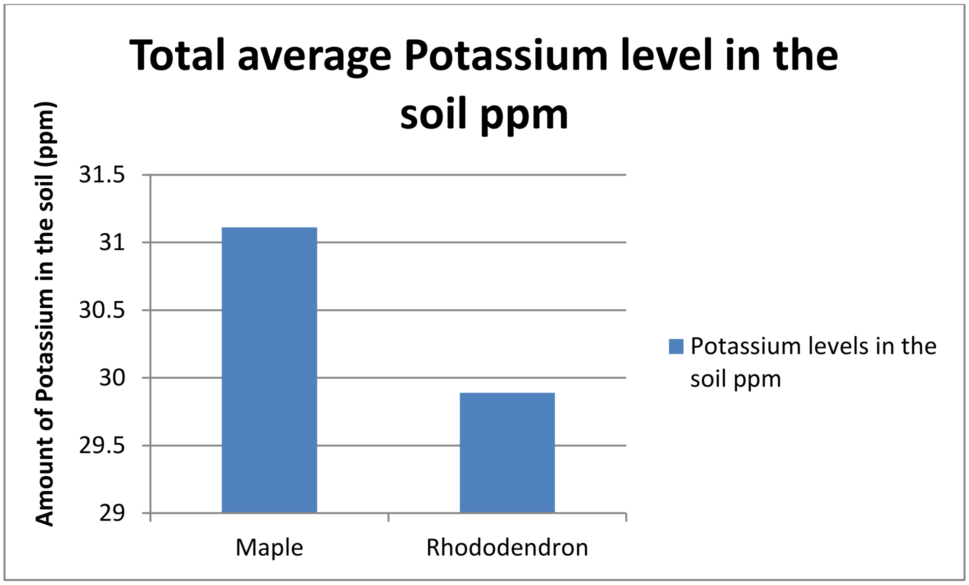


(Graph #1; rhododendron trees population of mold and potassium relationship)

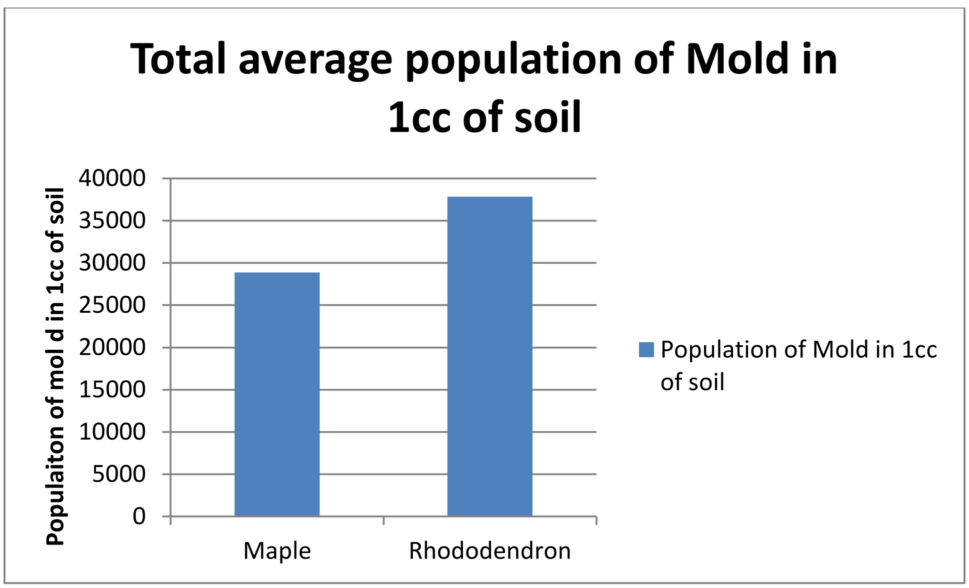


(Graph #2; maple trees population of mold and potassium relationship)

In graph #3, the levels of potassium in the soil surrounding both maple and rhododendron trees were nearly the same, but the graph of the soil from the maple tree shows that there were 1.22 parts per million more of potassium than in the soil around the rhododendron trees. Graph #4 shows that the soil surrounding the rhododendron trees had a total average of 8,944.44/cc more mold per 1 cubic centimeter of soil compared to the soil near the maple trees.

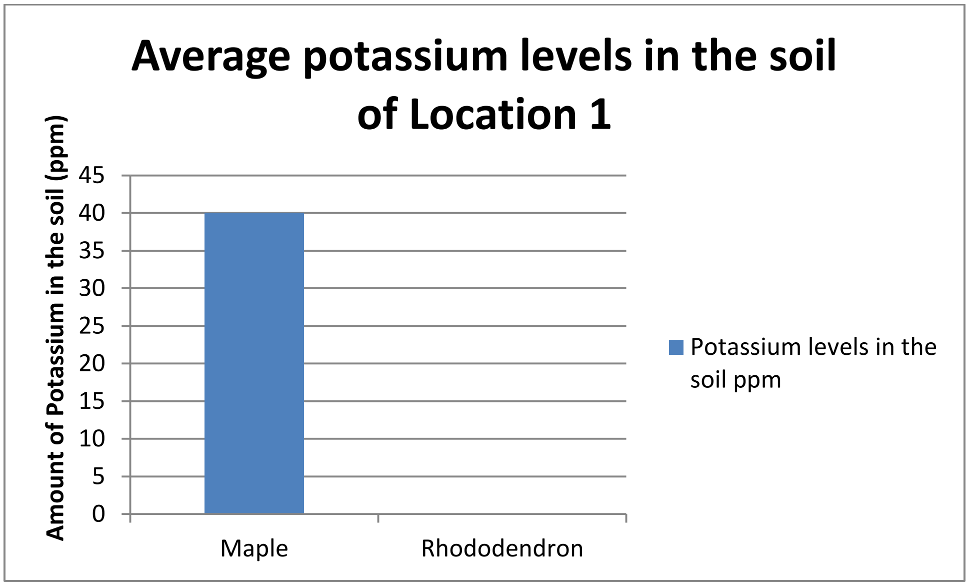


(Graph #3; total average population of potassium (ppm))

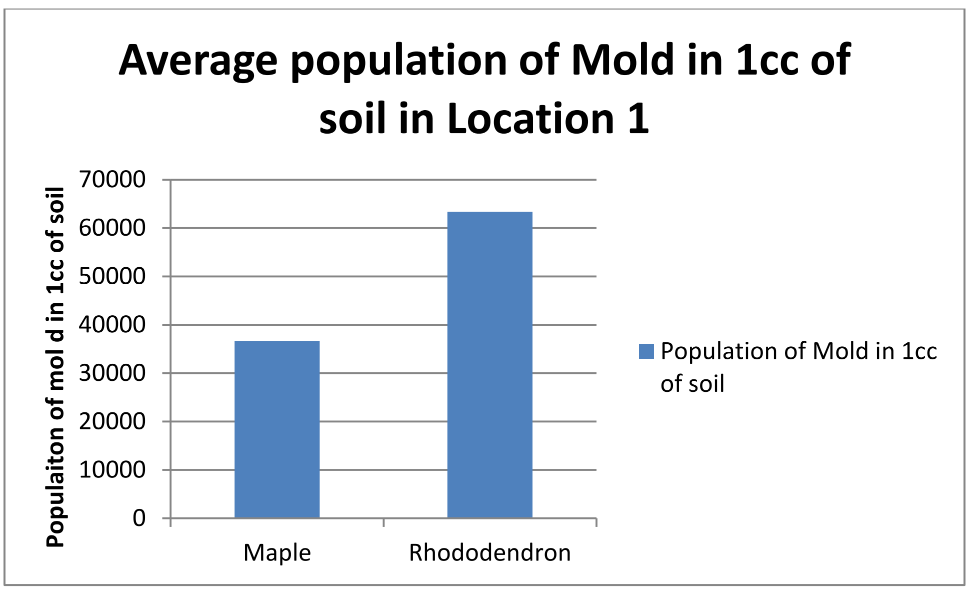


(Graph #4; total average population of mold per 1 cc of soil)

Our research shows that potassium levels in location 1 around the rhododendron trees were nonexistent. In graph #5, it shows that there was an average of 40 ppm of potassium around the soil of the maple tree in location 1 (graph #5). In graph #6, it shows that there were on aver 26,666.66/cc more mold per 1 cc of soil around the rhododendron trees. These graphs disprove our hypothesis because the data in both graph #5 and #6 shows that when there is a small amount of mold in the soil it assists the rhododendron trees take in a greater amount of the potassium from the soil. It also shows that when there is a large amount of mold in the soil around the maple trees, it does not help the maple trees intake potassium.

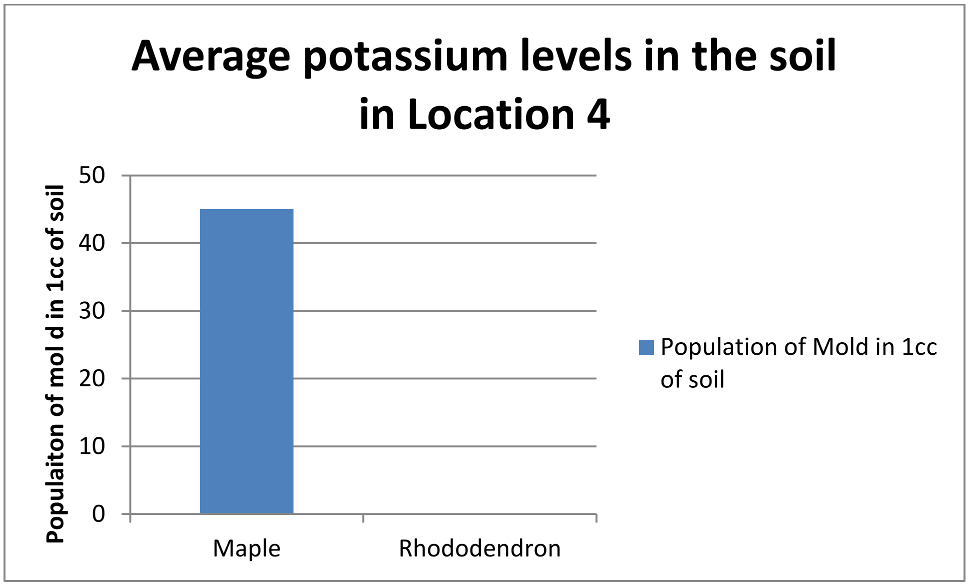


(Graph #5; average potassium levels in location 1 of rhododendron and, maple tree)

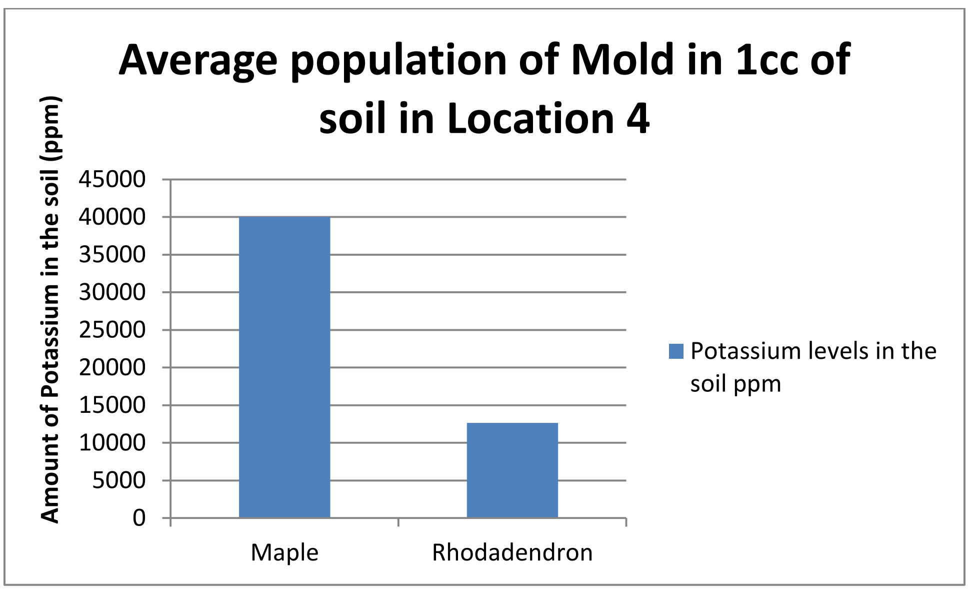


(Graph #6; average population of mold per 1 cc of soil in location 1 of maple and rhododendron trees)

The average potassium level in the soil from location 4 (Graph #7), was 45 ppm for the soil surrounding maple trees, whereas the average for surrounding rhododendron trees was 0 ppm. The average population of molds per 1 cc of soil around the maple tree in the fourth location had 27,333.33/cc more mold compared to the soil nearby the rhododendron tree in the fourth location.



(Graph #7; average potassium levels in the soil on location 4)



(Graph #8; average population of mold in 1cc of soil in location 4)

This data does not support our hypothesis. Our hypothesis was that rhododendron trees were not absorbing potassium as well as maple trees (which have a positive relationship with Mycorrhizal fungi). This data shows that there is another factor to explain why rhododendron trees were not absorbing potassium as well as maple trees.

Discussion

Based on the work of Larry Englander (1980), we originally hypothesized that perhaps the Rhodedendra there were missing their Mycorrhizal fungi due to recent disturbances there, and that as a consequence, the Rhododendra were not absorbing all the available potassium (hence the statistically greater potassium observed there in this year's biota survey). We decided that by examining the density of fungi around the roots of maple trees as a positive control against examining the density of fungi around the roots of Rhododendra, we should be able to support or deny our hypothesis. We chose Maple trees because they are known to have a positive relationship with Mycorrhizal fungi.

As graphs 1 & 2 show, it would appear that our hypothesis, that the Rhododendra were not absorbing potassium as well as Maple trees, is correct. However, after further statistical analysis of the data, we realized our hypothesis was actually false, since the r^2 values of both graphs were so low (r^2=.013, r^2= .0053).

What we did discover is the data in fact proved something else entirely. As graphs 3 & 4 show, the expected relationship between the population of mold and potassium levels for both groups of plants was fairly normal, and we actually observed that the Rhododendra had more mold (37000/cc soil) surrounding them than surrounding the maples (29000/cc soil), which was the opposite of what we expected (P=0.2022).

More importantly though, we found that the levels of potassium in the soils around the two kinds of plants were nearly identical (P=0.9175). Hence, our data overall indicates that in almost all of our test sites, the mold in the soil was in fact not responsible for a corresponding potassium level.

After analyzing the individual sites further, for a possible explanation for this lack of correlation, we found that plants located in E.S.S.R.E Site 3, where native plants dominate, there was a high density of mold (62000 /1 cc) associated with a low quantity of potassium (0 ppm) around the Rhododendron. The maple had lower populations of mold (36000/ 1 cc) and higher levels of potassium (40 ppm). Without enough mold to absorb the potassium, the potassium levels grew. The natural variances between the two plants were proven by (P=0.09) in the mold population and (P=0.194) in the potassium levels.

The plants in the fourth location had the most irregular behavior of all the areas that were tested. An issue with this site was the high density of invasive species. When a maple displayed irregular behavior displaying not only high levels of mold (40000 in 1 cc), but high levels of potassium (45 ppm), we theorized that this was because it was an invasive species of Maple, but unfortunately did not get the chance to test this. In the case of the Rhododendron, there was a low number of mold (17500in 1 cc), yet no potassium at all (0 ppm), suggesting the mold was working well here. We now wonder why the Mycorrhizal fungi in this area worked so efficiently with the Rhododendra, yet so badly with the Maple trees. This question could be explored in further research, perhaps involving invasive species.

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