An Examination on the Relationship of Mold and Iron

By: Jenn Hearn, Lauren Pratt, and Patty Redfield

Abstract

Mycorrhizae are the intimate relationship between plant roots and mold. Within this relationship mold acts as a supplier of iron directly to plants. In the E.S.S.R.E. Microclimate Site 4, the indirect relationship between mold and iron was not observed in 2007. Mold levels were manipulated by placing different amounts of 35x35 cm 0.25 mm^2 wire screen canopies in E.S.S.R.E. Microclimate Site 4 to decrease the amount of sunlight in order to increase the amount of mold. Over a 4 day period, 3 15 cm by 2cm diameter soil samples were taken from each of the 5 plots and were tested for mold density and iron levels. The results demonstrated the indirect relationship between mold and iron, but difficulties with the procedure indicate that we should perform this experiment again in a location with greater amounts of sunlight.

Introduction

Basidiomycota are fungi that live underground in the soil (Campbell and Reece, 2007). These common molds live in a symbiotic relationship between the roots of plants that form a unique bond. These dependant relationships between the roots of a plant and the long filaments of the fungi in the soil are called Mycorrhizae. This term refers to the structures formed by both the root cells and the hyphae from the fungus (Campbell and Reece, 2002). This particular relationship between the plant's roots and the fungi is essential in natural ecosystems and agriculture (Campbell and Reece, 2002) because the filaments are key components to a plant's survival. Both the filaments of fungi and plants benefit from this interaction. The filaments of fungi are able to grow in smaller spaces of the soil, allowing for them to be able to descend deeper and into areas that plant roots may have difficulty getting to. The filaments then send back water and other various minerals to the plant (Nardi, 2003), and the plant reciprocates by sharing sugar energy created by photosynthesis from the sunlight (Nardi, 2003).

One essential element that fungi retrieve for plants is iron. Iron is one of the two essential elements for photosynthesis (Worms Way, 2007). Plants need iron in order to produce the chlorophyll that captures the light energy (Worms Way, 2007). Hence, it is critically important for the filaments of fungi to deliver the iron to the plant's roots so that they can be healthy (Worms Way, 2007). However, in the 2007 Environmental Science Summer Research Experience Biota Survey (E.S.S.R.E 2007), it was found that in Site 4, iron levels were extremely high while mold levels were extremely low. Additionally, the survey found few plants growing in the area. Based on this information, we suspect that the low levels of mold are preventing plant life in Site 4 from getting enough iron for

photosynthesis. We believe that if mold levels in Site 4 increased then the iron level in the soil would decrease. To test this hypothesis, we will be returning to site four and manipulating the mold levels in hopes to decrease the levels of iron.

Methods

In Quadrant 2 of E.S.S.R.E. Microclimate Site 4 (N 39.35733 W 76.6384), 5 35x35 cm plots were chosen in areas with adequate sunlight and near the same kinds of plants. Within each plot, 3 soil core samples 15 cm by 2 cm diameter were taken as the positive control. Each plot was then covered with their respective 35 cm by 35 cm 0.25 mm^2 wire screen canopies. Plot 1 received no canopy, to serve as the negative control. Plot 2 received a canopy with one layer of wire screen. Plot 3 received a canopy with two layers of wire screen. Plot 4 received a canopy with three layers of wire screen. The final plot received canopy with four layers of wire screen. Plots were held in place using 20 cm long wooden sticks with a 1 mm diameter wrapped in saran wrap. Plots were allowed to sit for 24 hours before 3 additional separate soil core samples were taken again from each plot. 3 separate samples were then taken 24 hours, 48 hours, and 72 hours later respectively.

Mold density for each soil sample was determined by performing serial dilutions to 10^{-2} with sterile water and plating 100 µl aliquots of each dilution onto a 3M Petrifilm™ Yeast and Mold Count plate that were allowed to grow for 48 hours. The most dilute plate that showed mold growth was chosen to determine density. At the same time the serial dilutions were performed, each soil sample was tested for iron levels in ppm using the Lamotte Kit STH-14.

Results

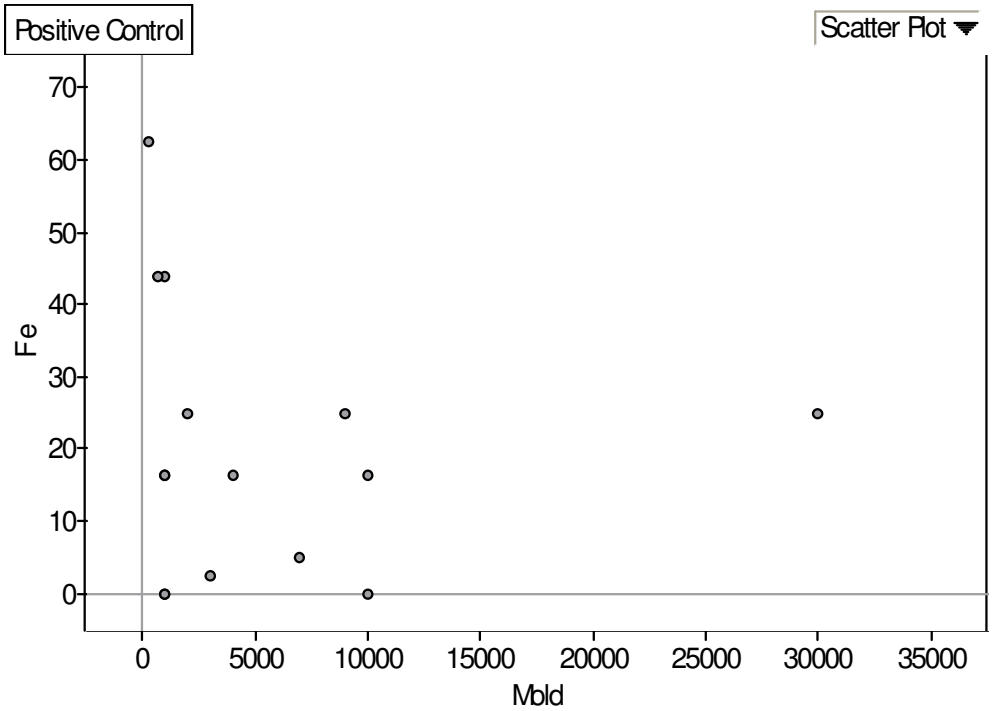

Figure 1: shows the relationship between iron and mold for Positive Control

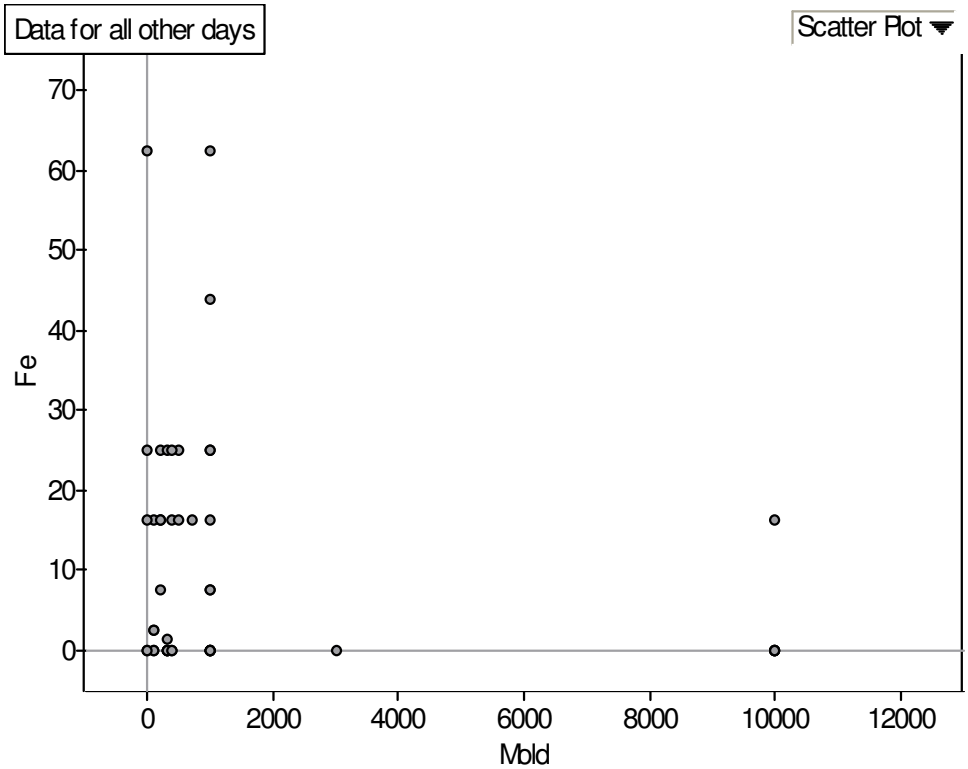

Figure 2: shows the relationship between iron and mold throughout the days of the week.

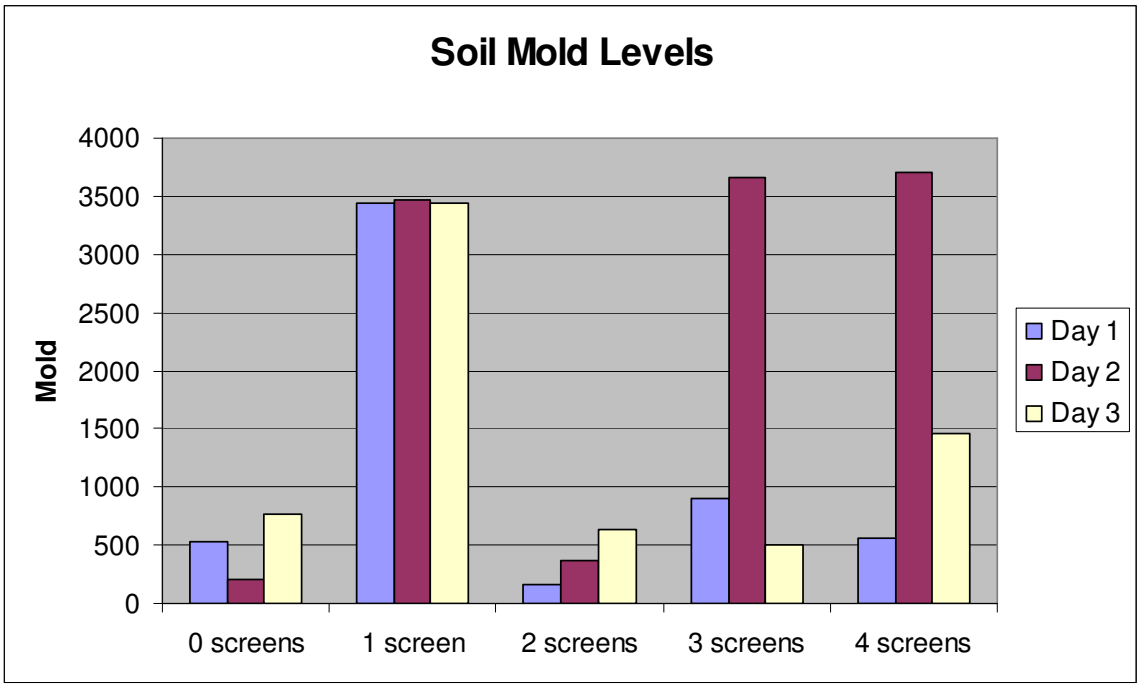

Figure 3: illustrates the mold levels within each screen throughout a 3 day cycle.

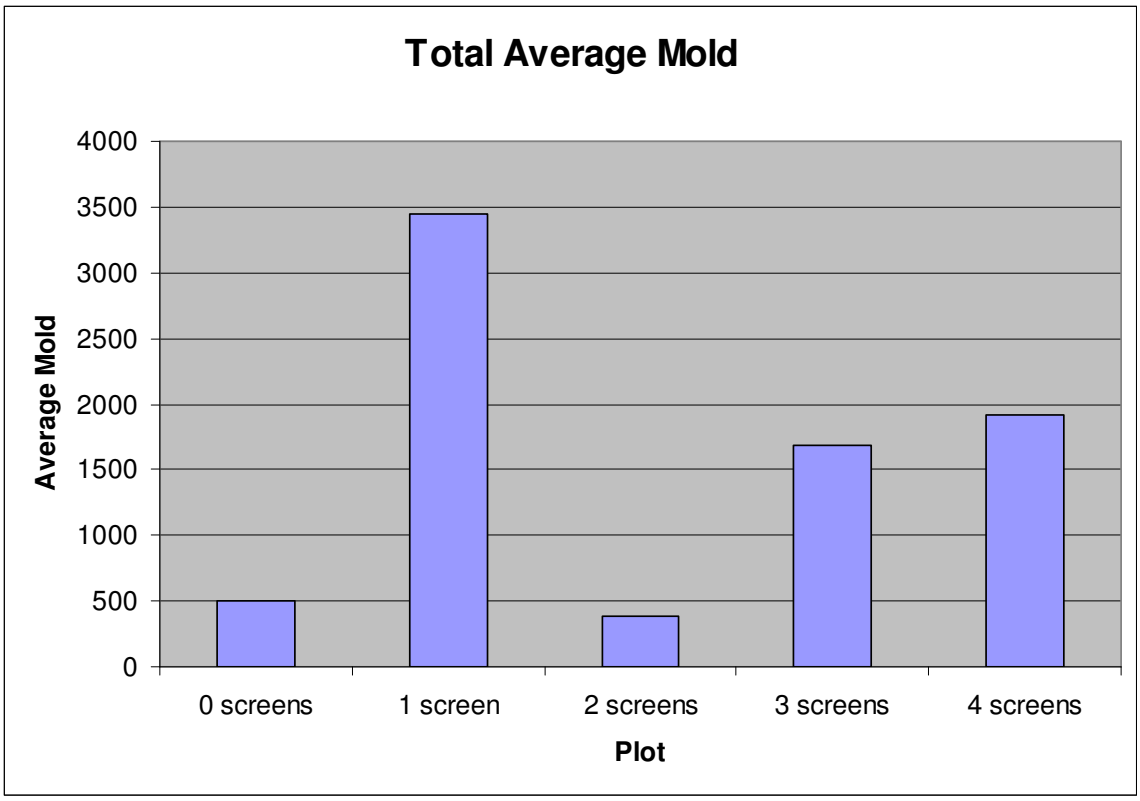

Figure 4: confirms the average mold level within each screen.

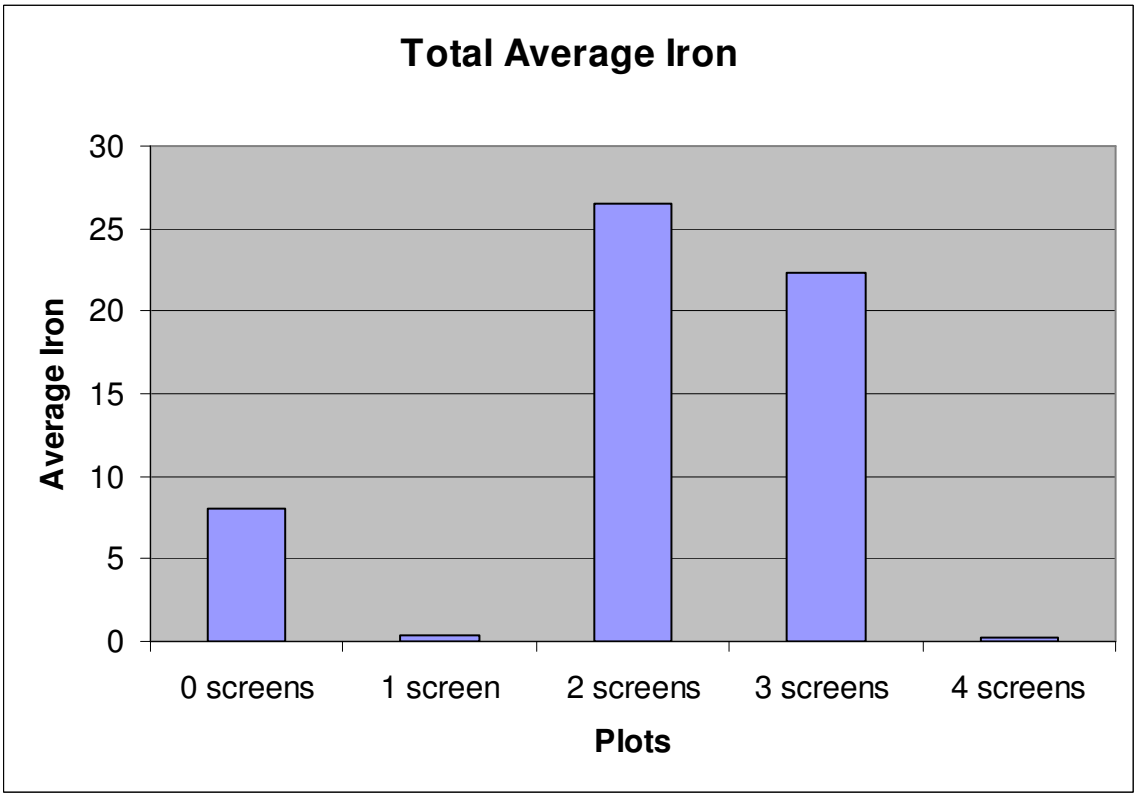

Figure 5: shows the average iron level within each screen.

Discussion

Based on the symbiotic relationship between mold and plants, we hypothesized that the lack of plant life in Site 4 was due to an inadequate supply of iron because there was an insufficient number of the necessary symbiotic molds. Following our attempt to manipulate mold density to see if that, in fact, accounted for the iron levels observed during the original Biota Survey (E.S.S.R.E. 2007) , we realized that our experimental protocol actually failed. As can be seen in Figure 3, there does not appear to be any consistent relationship between the number of screens used and the amount of mold found in the soil. Instead, soil mold levels fluctuated inconsistently from plot to plot. However, when comparing the linear regression of the positive control data (Figure 1) with the linear regression of the experimental data (Figure 2), we found that indeed something we did successfully manipulated the mold levels somehow (as evidence by the higher r^2 value, $0.036818 > 0.0087081$). Since Figure 4 and Figure 5 show that mold and iron are indirectly proportional, our larger supposition that the low mold levels could account for the unusual iron levels found in the original Biota Survey is supported.

Based on what we found, we manipulated the number of mold in the soil but not by the amount of screens. Possible reasons could be the placement of the screens and the amount of sunlight reaching each screen. The screens were placed near a tree but screen 0 was placed the furthest away from the tree and screen 4 was placed closest to the tree. The placement of the screens could have been a major factor causing the mold levels shown in Figure 4. Also, when looking at Figure 4 and Figure 5, the relationship between mold and iron seem accurate except for screen 1. This could be because of its location: a root underneath it, the amount of sunlight, or the amount of moisture in the

soil. In order to successfully perform this experiment, be sure to place the screens in areas with areas with direct and evenly spread sunlight. This way each screen is receiving the same amount of sunlight. In addition, another research team in E.S.S.R.E. 2007 found that iron levels could be changed by leeching. Hence, we may also want to look at how the amount of water in Microclimate Site 4 is affecting the iron levels. And finally, another research team in E.S.S.R.E. 2007 found that the nitrogen cycle was not functioning properly in Microclimate Site 4 which could also be the cause of the lack of plant life. Therefore when performing this experiment again, the appropriate nutrients involved in the nitrogen cycle should also be tested for at the same time as iron.

References

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Acknowledgements

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