# Manganese and Ferric Iron Effects on Photosynthesis

## Abstract:

Our group investigated the relationship between manganese and ferric iron vs. the leaf coverage rate in each transect for sites two, three and four. Our decision to learn more about the manganese and ferric iron relationships to photosynthesis was based on the biota surveys that the ESSRE 2003 group performed before we split up into smaller groups assigned with their own topics. The T-Tests that were performed between the biota surveys showed results that confirmed a strange pattern between the manganese and ferric iron relationships.

We hypothesized that the increasing leaf coverage rate would decrease the levels of manganese and ferric iron in an area. We performed the experiment by taking nine samples from the three sites. We also did the LaMotte© manganese and iron tests, and found the percentage of the leaf canopy and ground coverage. We compared results from each site through the analysis and thus proved our hypothesis to be correct.

Our results showed an increasing percentage rate of leaf coverage leading to a decreasing rate of manganese and ferric iron levels. For nearly every site, whenever the percentage rate increased, the manganese and ferric iron rates decreased. The formula we used for our analysis was r= Mn/Fe (Average coverage/ ground coverage), then r^2 for the final percentage. This percentage showed the chance it would be for someone else performing this experiment to get the same results as us. Our data further proved that a relationship existed and should be open for more investigations. There were many more

ways to verify our data more fully, but the little set of data we took was enough to verify our hypothesis.

## Introduction:

The research question our group investigated upon involved how the amount of leaf surface area changes the amount of ferric iron and manganese in the soil. Our previous knowledge based on the manganese and iron tests that were taken in the varied sites at the school led us to believe there was a pattern between the increasing manganese and ferric iron levels. We saw that as the manganese increased in each site, the ferric iron also did. According to our t-test results, we saw that iron and manganese for all three sites were statistically significant. To further research their possible relationship, we found that both manganese and iron were participants in the process of photosynthesis. We wanted to see if the leaf surface area covering above and below each site had an impact on the levels of manganese and ferric iron. Our research was to prove that as the leaf surface increased, the iron and manganese level decreased, due to the decreasing amounts of sunlight.

But first, let us give you a preview of all the necessary background information. Manganese is a necessary element in the enzyme system of plants. Manganese plays a role in reactions that affect germination, photosynthesis, and other vital aspects of plant development. Manganese is necessary for the process of photosynthesis and can prove to be very beneficial if found in the soil. In addition, the amount of manganese is influenced by soil pH, organic matter of content, moisture, and soil aeration (Kelling, 1999). Ferric iron is iron in the +3 valence state. In other words, valence is the “combining capacity of an atom expressed as the number of single bonds the atom can form or the number of electrons and element gives up or accepts when reacting to form a compound.

(Alacritude, 2003). Both ferric iron and manganese are elements of the redox components, or simply have a function in oxidation reduction in the soil.

The sites we researched had many important components. The diversity of the plants varied for all of the sites. In site two, as it is shown on our entire site data, the plant diversity consisted of 11 different types of plants with the English ivy most densely populating the area. In site three, as it is shown on our entire site data for site three, the plant diversity consisted of 9 different plants with the knotweed most dense. In site four, as it is shown on our entire site data for site four, the plant diversity consisted of 9 different plants with jewel weed most densely populating the area. We tested for the leaf plant density above and below the site (the canopy). We tested for the canopy of plants by using a densiometer that we created.

## Methods:

We chose three different sites that were marked off in the woods behind Roland Park Country School. The sites we tested have unique qualities that set them apart. Site two is a stream that is located at the base of a concrete dam. (Brock, 2002) This site has many fallen logs and is heavily populated with English ivy. (Brock, 2002) Site three is located at the top of a hillside. (Brock, 2002) It is near the mouth of the stream and is surrounded by rhododendron trees, ferns, English ivy and knotweed on both sides. (Brock, 2002) Finally, site four is a wet, flat, swampy area. (Brock, 2002) The stream spreads across this site and there are almost no trees. (Brock, 2002) The average global position in site two was 39.35791 going north and 72.1392325 going west. For site three, the average global position was 39.35796 North and 76.638385 West. The average global positioning for site four was 39.357835 North and 76.6882675 West.

For the first week and a half of our research seminar, we conducted biota surveys to gather the information that was needed. Using the results from the biota surveys, we found topics that were of interest to us. Our group realized that there was an interesting pattern between the manganese and ferric iron levels. So, in order to learn more about their relationship, we decided to perform an experiment to confirm their relationship.

Our experiment was composed of many steps. First, we created a densiometer. We used a tube that was approximately 4 cm in diameter and 7.5 cm long. Then, we attached two strings at perpendicular angles across the diameter of the top of the densiometer to form a crosshair or a “+” sign form. Then, we attached an 18 cm. piece of string with a metal nut hanging across the diameter by taping it.

On day one of our experiment, we used the densiometer five times on each transect of each site. We chose random spots on each transect and took the percentage of leaf coverage above to see the trees and below to see the shrubs, weeds and bushes. Then, we took 3 random samples with equal amounts of 15 cm. deep and 2 m. in diameter and put the samples into labeled bags. After we retrieved our soil samples, we started with the LaMotte Universal Extracting solution. Then, we performed the LaMotte Manganese tests and Ferric iron tests on all 9 samples. We repeated this procedure for days 3 and 4. Then, we analyzed our data and realized that we needed lower percentages for the leaf coverage rate. In order to achieve these lower coverage rates, we began to use transects of another area. The average global positioning of this area was 39.35787 North and

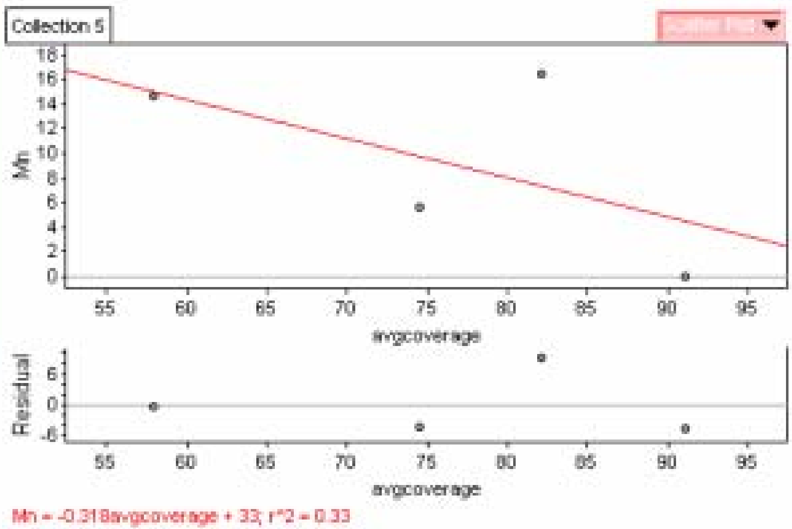
76.63925 West. We performed the same procedures for this new area for two more test trials.

## Results/ Discussion:

<u>The Average Manganese Levels vs. the Average Canopy</u>

Collection 5

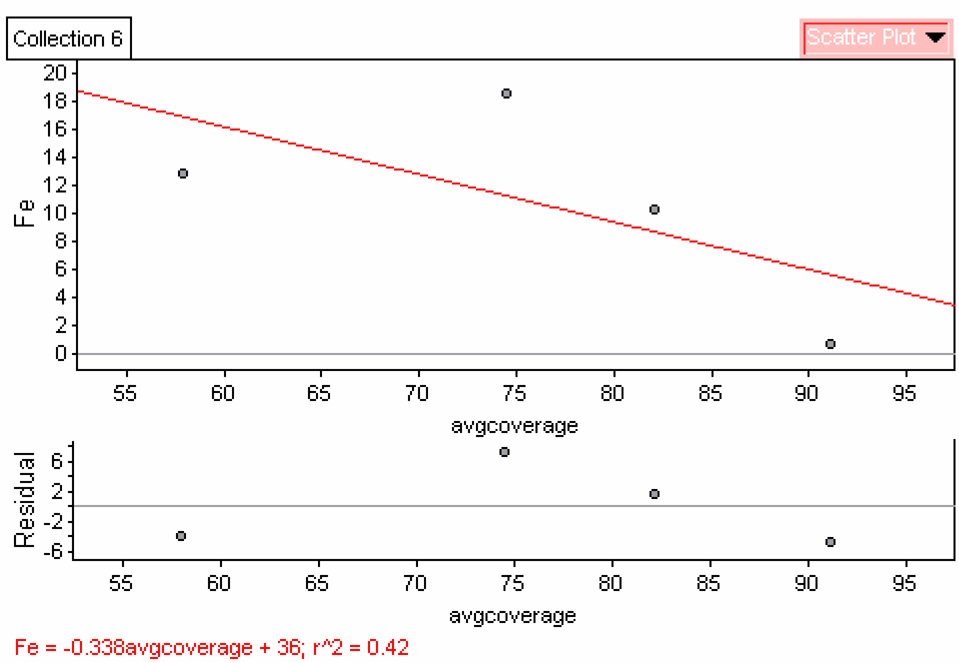
| | avgcove... | Mn | <new> |
|---|---|---|---|
| 1 | 91.13 | 0 | |
| 2 | 74.53 | 5.6 | |
| 3 | 82.1 | 16.5 | |
| 4 | 57.93 | 14.7 | |




<u>The Average Ferric Levels vs. the Average Cover Canopy</u>

Collection 6

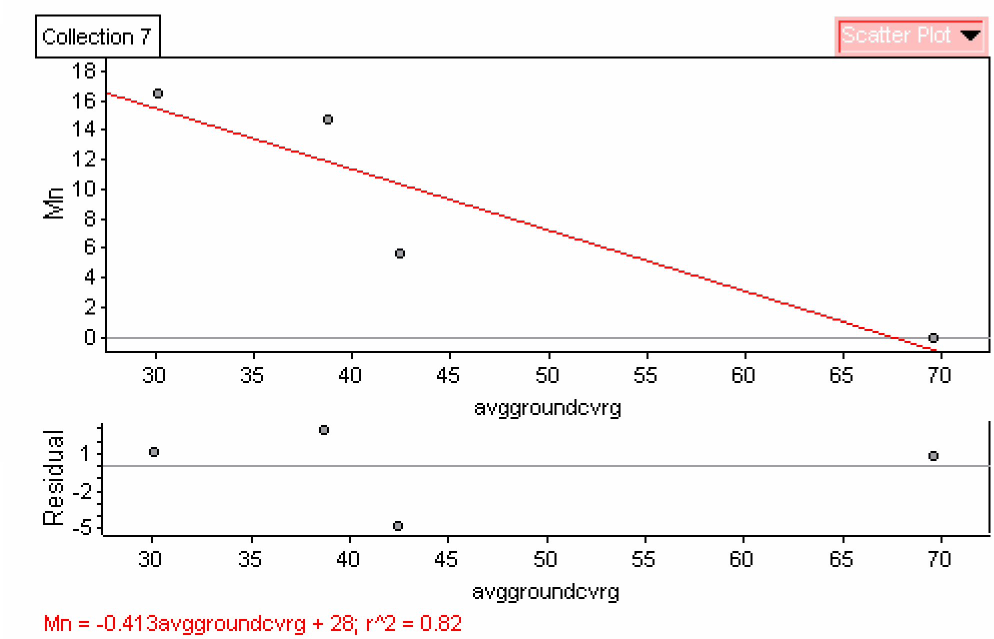
| | avgcove... | Fe | <new> |
|---|---|---|---|
| 1 | 91.13 | 0.83 | |
| 2 | 74.53 | 18.5 | |
| 3 | 82.1 | 10.3 | |
| 4 | 57.93 | 12.8 | |



## The Manganese Level vs. the Average Ground Cover

Collection 7

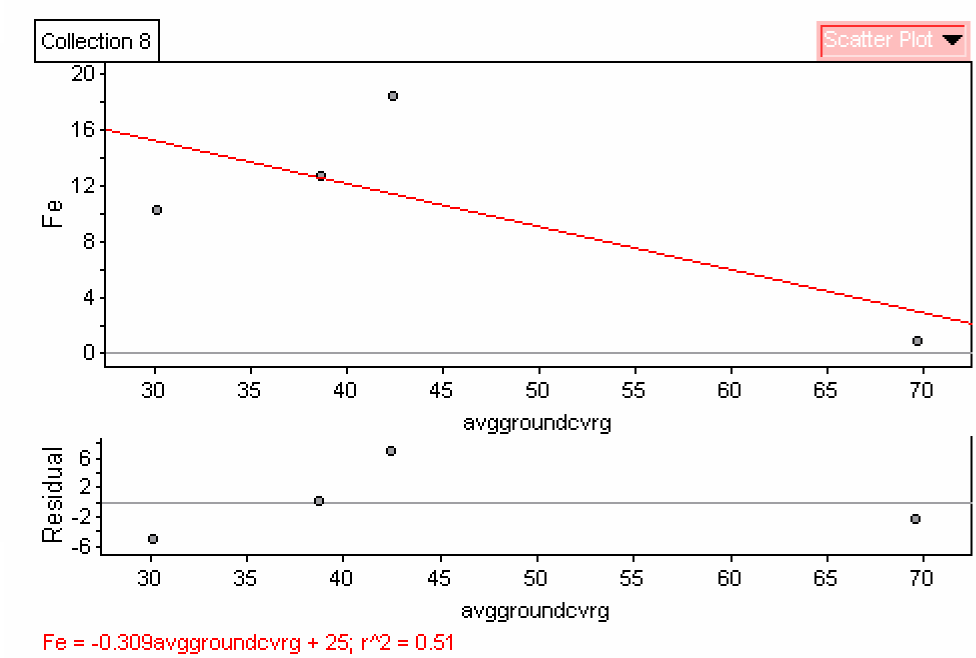
| | avggrou... | Mn | <new> |
|---|---|---|---|
| 1 | 69.6 | 0 | |
| 2 | 42.4 | 5.6 | |
| 3 | 30.1 | 16.5 | |
| 4 | 38.7 | 14.7 | |




## Average Ferric Iron Level vs. Average Ground Cover

Collection 8

| | avggrou... | Fe | <new> |
|---|---|---|---|
| 1 | 69.6 | 0.83 | |
| 2 | 42.4 | 18.5 | |
| 3 | 30.1 | 10.3 | |
| 4 | 38.7 | 12.8 | |



As shown on the average manganese levels vs. the average canopy coverage chart, the coverage rate for the sites in column one, two, three and four have increasing percentages, while the manganese rates are decreasing. The average canopy coverage rate was 33% possible that anyone else performing this test could get the same results. For the average ferric iron levels vs. the average canopy coverage chart, the coverage rate for the site in column one, two, and three have increasing percentage rates, while the ferric iron rates are decreasing. In the average canopy coverage rate, there is a 42% possibility that anyone else performing this test could get the same results. For the average manganese levels vs. the average ground cover chart, the sites for column one, three and four increases in percentage, while the manganese level decreases. The possibility of exact results was 82% for the averaged ground coverage rates. For the average ferric iron levels vs. the average ground cover chart, the sites for columns one, two and three increases in average ground coverage and decreases in ferric iron levels.

After reviewing our data, we have proved our hypothesis to be correct. To see if perhaps the manganese levels and iron levels were statistically different, we performed T-Tests between all of the averaged data. With a P value lower than .2, we discovered that the Manganese for sites two and three were statistically significant and that the ferric iron was statistically significant for sites one and two and one and three. The manganese levels for transects one, two and three were statistically significant for sites one and two. Ferric iron was statistically significant for transects one and two, one and three and two and three.

## Conclusion:

Our data proves that our hypothesis was correct. As the leaf coverage increased, the manganese and iron levels decreased, thus further proving that the manganese and ferric iron levels have a relationship with the leaf growth. There is a definite correlation between the ground coverage rates and the manganese and ferric iron levels. All four graphs prove a correlation exists between the percentage rates and the manganese and iron levels. The line of best fit that was graphed shows that the relationship is accurate and makes our hypothesis true.

If we could do our experiment another time, it would have been beneficial to have more trials. It would have also been beneficial to have more sites to work with. If we had had many varied sites with varied leaf coverage percentages, then our results may have been altered. It also would have been helpful if we had more data from the densiometer. Instead of five densiometer views per transect, we should have done 10 or 15. Also, we should have had more gridlines for our densiometer view. More gridlines would have helped the results to be more accurate in percentage.

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**Bibliography/ References:**


1. Alacritude, LLC. "Valence". [Online] Available http://www.encyclopedia.com/html/v1/valence.asp, 2003
2. Brock, David. “General Description of the ESSRE Survey Sites”. [Online] Available http://faculty.rpcs.org/brockda/ESSRE%20Locations.htm, 2002
3. E.E. Schulteand K.A. Kelling. "Soil and Applied Manganese". [Online] Available http://cf.uwex.edu/ces/pubs/pdf/A2526.PDF, 1999.
4. "Photosynthesis". Microsoft® Encarta® Online Encyclopedia 2003 [Online] Available http://encarta.msn.com/encnet/refpages/RefArticle.aspx?refid=761572911, 1997-2003 Microsoft Corporation.
5. Professor Neil Baker. "The Physiological Basis of Tolerance to Manganese Deficiency in Cereal Crops". [Online] Available http://www.essex.ac.uk/bs/pgrad/sships/mang.htm, 1998.
6. Tindall, Terry, Colt, Michael W., Barney, Danny L., and Fallahi, Esmaeil. "Controlling Iron Deficiency in Idaho Plants". [Online] Available http://info.ag.uidaho.edu/resources/PDFs/CIS1042.pdf, 2003.
7. The Globe Program [Online]Available http://archive.globe.gov/sda/tg/landcover/landcover.pdf, 2003