Connection Between Chlorosis in Illinois Birch Trees and Bioavailability of Iron In Adjacent Soil

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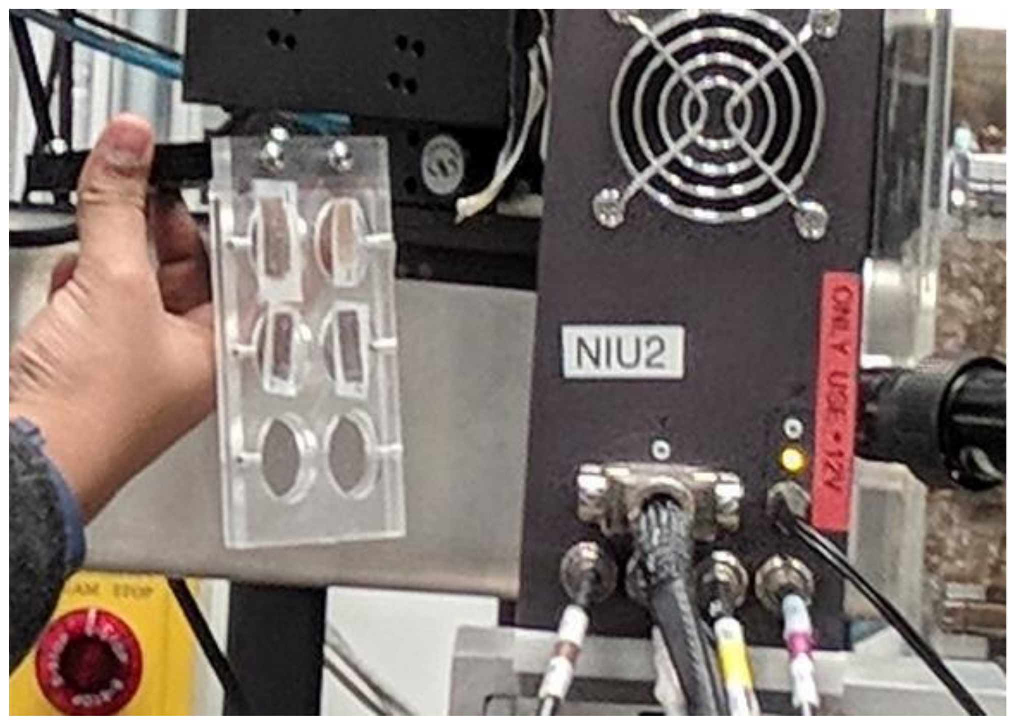
Introduction

Chlorosis, a botanical disorder characterized by insufficient chlorophyll production in leaves, is prevalent in northern Illinois birch trees. To understand the causes of chlorosis in *Betula nigra* and *Betula papyrifera*, soil and leaf tissue samples were examined using x-ray fluorescence spectroscopy to determine the relative presence of iron. Additionally, the acidity of soil samples was tested, as the Fe^{2+} iron ion is oxidized to the insoluble Fe^{3+} ion in high pH soils, making it unavailable for absorption by *Betula* species.

PROCEDURE

- Nine soil samples were collected at distances of 18-36 cm away from the bases of trees, and at depths of 22-38 cm. Additionally, leaf tissue samples were collected for x-ray spectroscopy.
- For each sample, 20 g of soil were mixed with 20 mL of deionized water and stirred. The resulting mixture was left to stand for 5 minutes. Afterward, the pH of the mixture was measured using an electronic pH meter.
- At the Advanced Photon Source at Argonne National Laboratory, soil and leaf samples were prepared and mounted to the bracket.
- The soil and leaf samples were tested for their elemental content using x-ray fluorescence spectroscopy at GeoSoilEnviroCARS (The University of Chicago, Sector 13).

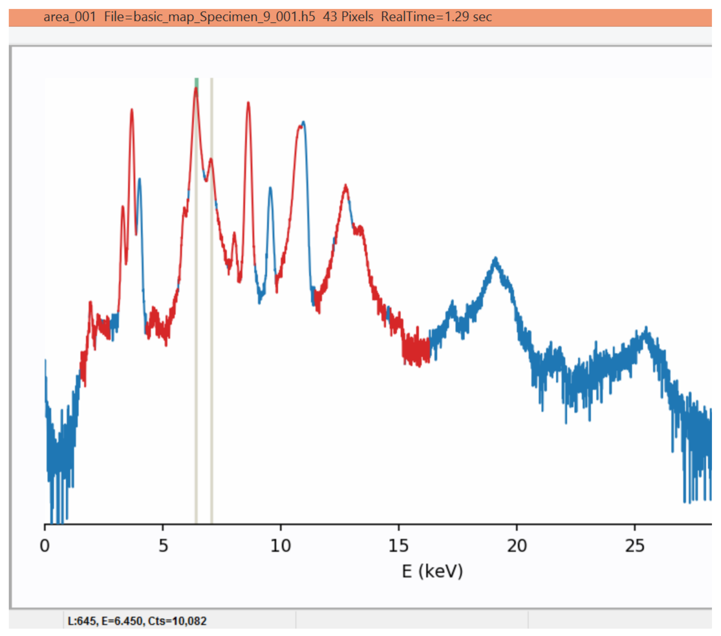


Bracket for mounting samples

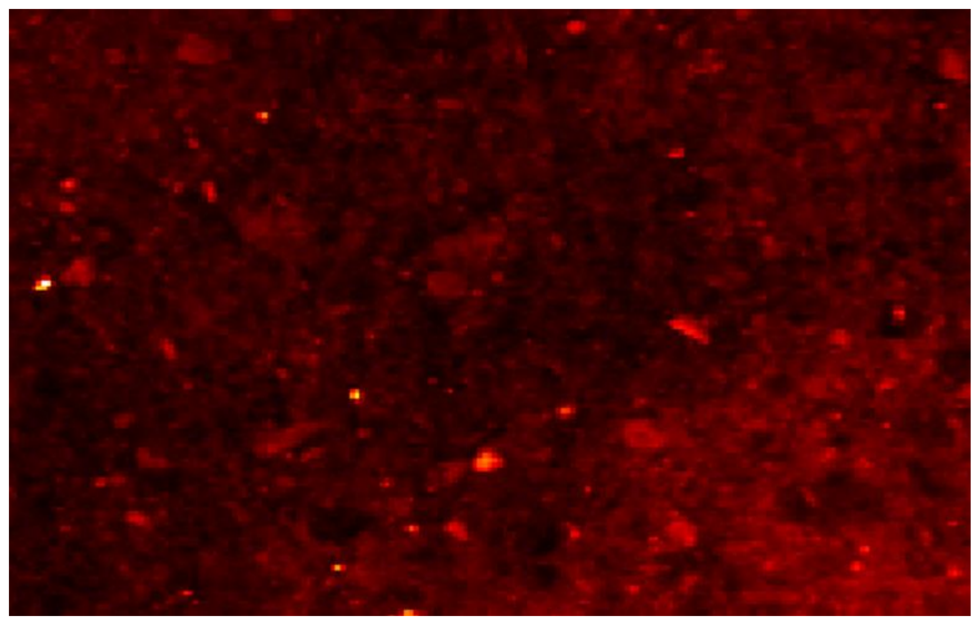
Collection of soil samples

RESULTS

- The samples that were tested had higher than optimal soil alkalinity, which makes the iron less soluble. There is no apparent trend in the abundance ratio relative to the pH of the soil.
- Due to differences in sample area and depth, a selected area on the x-ray spectra of either leaf tissues or soil samples was not comparable. To combat this problem, counts of iron atoms detected per pixel were used to compare leaf samples or soil samples. Although the iron in the samples could not be quantified, the relative quantities could be compared. Therefore, "Abundance Ratio" was calculated as a measure of how well iron was absorbed.
- The K-α peak in the spectrum showed the strongest iron signature centered at 6.405 keV.



Leaf sample x-ray spectrum



Leaf sample x-ray spectrum map

Sample Number	Iron Abundance in Leaf (Counts/Pixel)	Iron Abundance in Soil (Counts/Pixel)	Abundance Ratio (Counts in Leaf / Counts in Soil)	Soil (pH)
1 (Control)	359	3,333	0.108	7.81
2	298	2105	0.142	8.00
3	104	2044	0.0509	7.23
4	271	4055	0.0668	9.5

Conclusion

Since spectral data was only available for 4 samples, it was difficult to draw reliable conclusions based on the results. Although certain individual data points were consistent with the hypothesis, there was not a strong correlation between iron absorption and soil pH.

Samples 3 and 4 were consistent with the hypothesis that iron is present but unavailable due to high soil alkalinity causing chlorosis in *B.nigra* and *B.papyrifera*.

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