THE SEARCH FOR THE MISSING PLANTS

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ABSTRACT

"Why don't plants seem to grow under black walnut trees (*Juglans nigra)*, but seem to grow under American elm trees *(Ulmus americana)*?" is the experimental question. This project was done because there were not so many plants growing under black walnut trees. This research is important because this could be a way to help walnut farmers better use the land under their walnut trees and be able to produce a second crop. The hypothesis is the soil under black walnut trees will have a lower pH (more acidic) than soil under American elm trees. This study was conducted by testing the pH of soil from one meter and two meters away from black walnut trees and American elm trees using the GLOBE Program protocol for soil pH testing. The results were very confusing because the difference in pH between black walnut trees and American elm trees was statistically insignificant, indicating the results did not support my hypothesis. Therefore, there must be another variable which accounts for the seemingly lack of plants growing under black walnut trees compared to American elm trees. Even though the data does not support the hypothesis, pH should be able to be eliminated as a potential factor in determining plant growth under these two plant species. As a consequence, other factors such as water use, toxins, or possible symbiotic relationships should be considered for further study.

PURPOSE

The reason to do this project is because I noticed not many plants were growing under black walnut trees where we go to look for gold along the Clear Fork River. Also, people at the Bug Zoo at the Ohio Agricultural Research and Development Center in Wooster, Ohio said plants would not grow under black walnut trees when I asked, but didn't really explain why. I remained confused and curious. Therefore, I decided to test this out. I looked on the GLOBE website to find a soil protocol and there was one on how to test for soil pH!

I really want to find out if it is possible to grow more than one crop on land for walnut tree farms. We need to find ways to be better stewards of our land. Best practices such as crop rotation, horizontal crop rows on a hillside, and wind breaks are some proven ways we have been using to conserve our soil resources. Since there is so much land between trees, I would like to find a way to use this soil better.

RESEARCH QUESTION

The research question is: Why aren't there many plants growing under black walnut trees? How can the soil between black walnut tree farms be better utilized?

Research shows farmers rotate their crops. Before this practice, farmers would plant the same crop year after year until the nutrients were taken out of the soil and that crop would fail. Farmers would then go to the next land, clear it out and plant until the soil became exhausted. Farmers now, for example, plant corn one year then soy beans the next around me. Although I am only eleven years old, I have never seen the farm fields around me not planted.

Farmers now plant crops horizontal on hill sides. They used to plant vertical rows because this was easier, but during rain, the soil would erode, leaving gullies and rendering the field unable to be planted. Horizontal planting helps to prevent erosion by providing rows to slow the rainfall.

During the dustbowl, drought and high winds made life on the plains almost unlivable and soil erosion by wind was very severe. Farmers now plant windbreaks, that is, a row of trees to separate out fields and slow down the wind. This best practice slows down soil erosion by wind.

Most crops grow with soil pH around 7 (neutral). Around where I live, when the fields become too acidic, the farmers will apply lime to raise the pH to more neutral, making the fields look snow white.

When observing black walnut farms, there is a lack of plants growing in the soil beneath them. By taking pH levels beneath black walnut trees, I am trying to either confirm or deny black walnut trees affect the pH of the soil around them.

RESEARCH HYPOTHESIS

The research hypothesis is the soil under black walnut trees will have a lower pH than soil under American elm trees.

CONTROL

- 40 ml distilled water
- 40 g soil
- 1.83 g crushed black walnut leaves
- 1.83 g crushed American elm leaves
- 250 ml boiled water for each type of leave
- pH test strips (*Lo Ion pH TEST KIT*)

VARIABLE

1. Soil 1 meter away from black walnut trees
2. Soil 1 meter away from American elm trees
3. Soil 2 meters away from black walnut trees
4. Soil 2 meters away from American elm trees
5. Black walnut leaves
6. American elm leaves

MATERIALS

- Soil 1 meter away from black walnut trees by Clear Fork River
- Soil 1 meter away from American elm trees by Clear Fork River
- Soil 2 meters away from black walnut trees by Clear Fork River
- Soil 2 meters away from American elm trees by Clear Fork River
- Black walnut leaves by Clear Fork River
- American elm leaves by Clear Fork River
- Plastic spoon
- 3 plastic cups with lids
- Graduated cylinder
- Plastic bag
- Measuring cup
- Distilled water
- pH test paper slips (*Lo Ion pH TEST KIT*)
- Leaf container (tea bag)
- Boiled distilled water

METHODS

SOIL pH TEST PREPARATION

The following GLOBE Program protocol was used to test the soil pH.

1. Dry and separate soil
2. Weigh 40g of soil
3. Measure 40 ml of distilled water
4. Put 40g of soil and 40 ml of distilled water into cup
5. Put lid on and shake for 30 seconds then let sit for 3 minutes
6. Do step 5, 5 times, then let sit for 5 minutes
7. Record pH with pHydrion Lo Ion WR paper test strips

LEAF pH TEST PREPARATION

The following GLOBE Program protocol was used to test the soil pH.

1. Crush leaves and measure 1.83g of crushed leaves
2. Put crushed leaves into tea bag
3. Put container into cup
4. Boil 250 ml of water
5. After boiling water let sit for 30 seconds
6. Pour water into cup
7. Let steep for 2 minutes
8. Record pH with pHydrion Lo Ion WR paper test strips

SOIL pH RESULTS

Black Walnut:

Sample 5:

1 meter from the tree pH 4.3

2 meters from the tree pH 4.3

Sample 4:

1 meter from the tree pH 4.3

2 meters from the tree pH 4.3

Sample 1:

1 meter from the tree pH 5

2 meters from the tree pH 5.6

American Elm:

Sample 2:

1 meter from the tree: pH 5

2 meters from the tree: pH 5

Sample 3:

1 meter from the tree: pH 4

2 meters from the tree: pH 4

Sample 6:

1 meter from the tree pH 4

2 meters from the tree pH 4

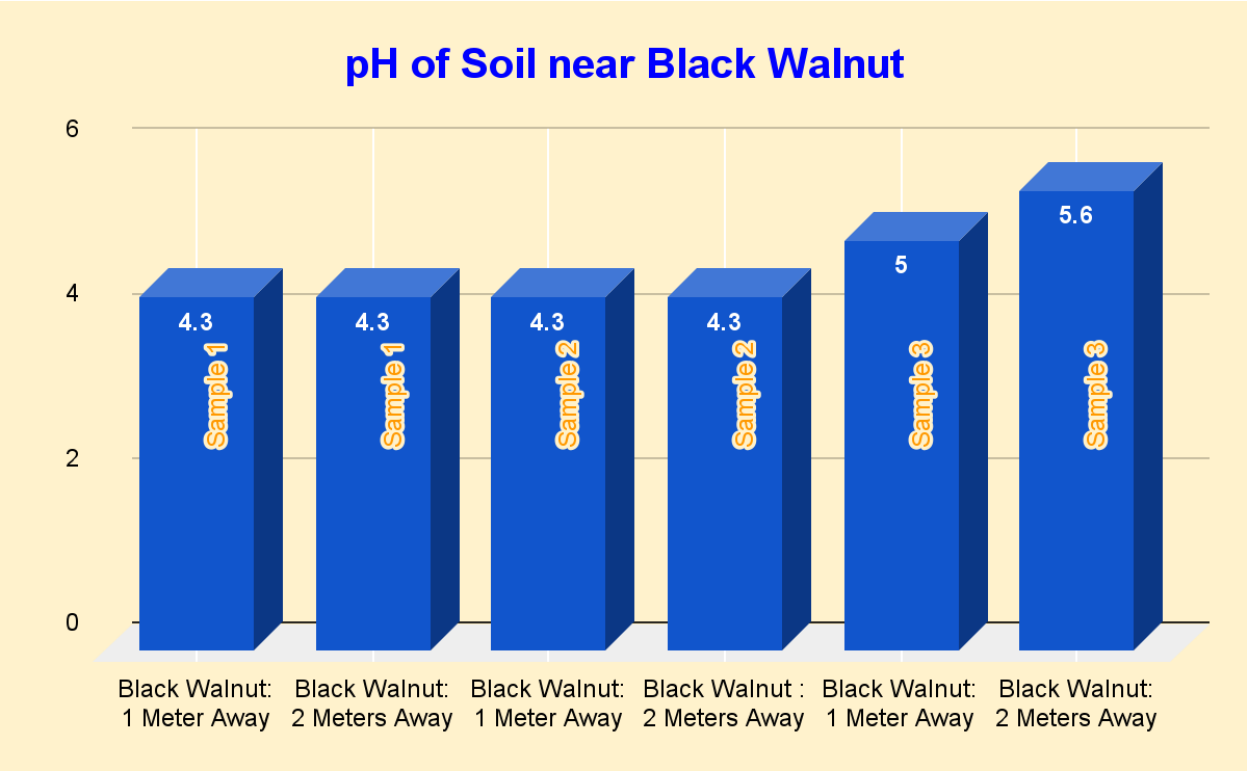
LEAF pH RESULTS

Black Walnut: pH 7

American Elm: pH 7

GRAPHS

GRAPH 1



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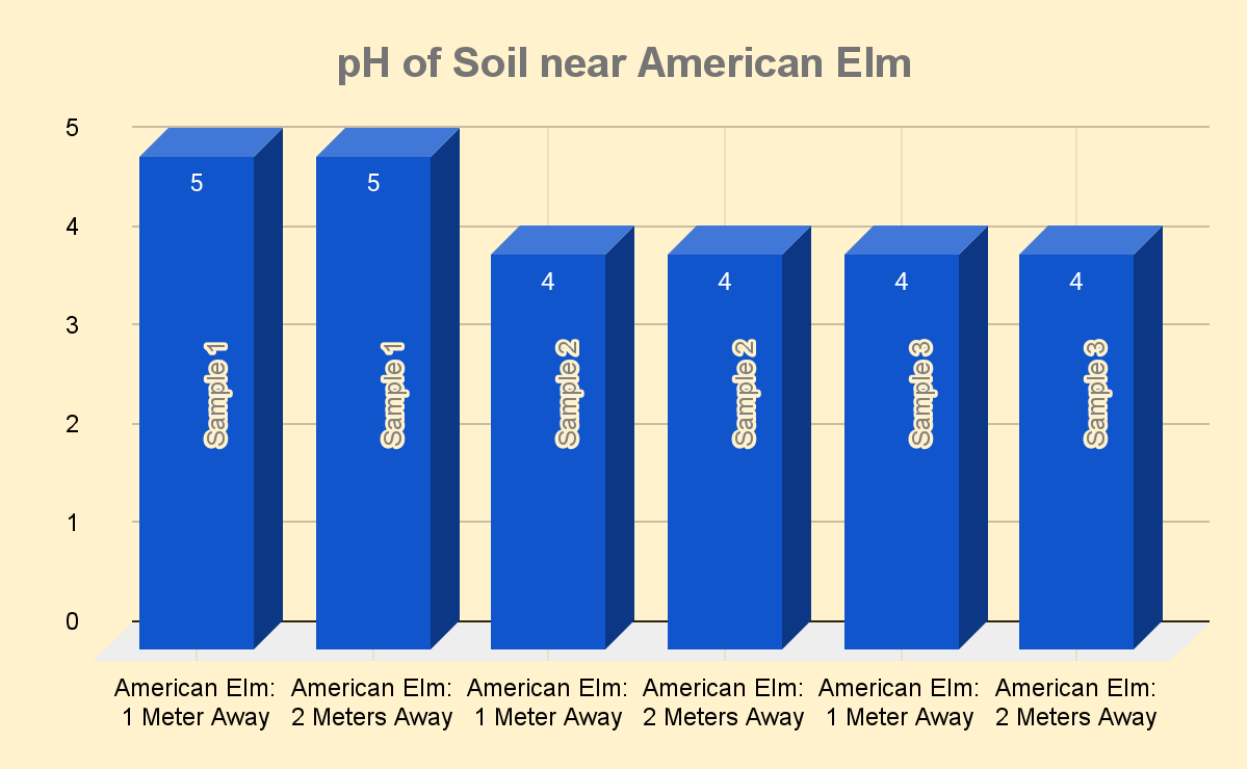
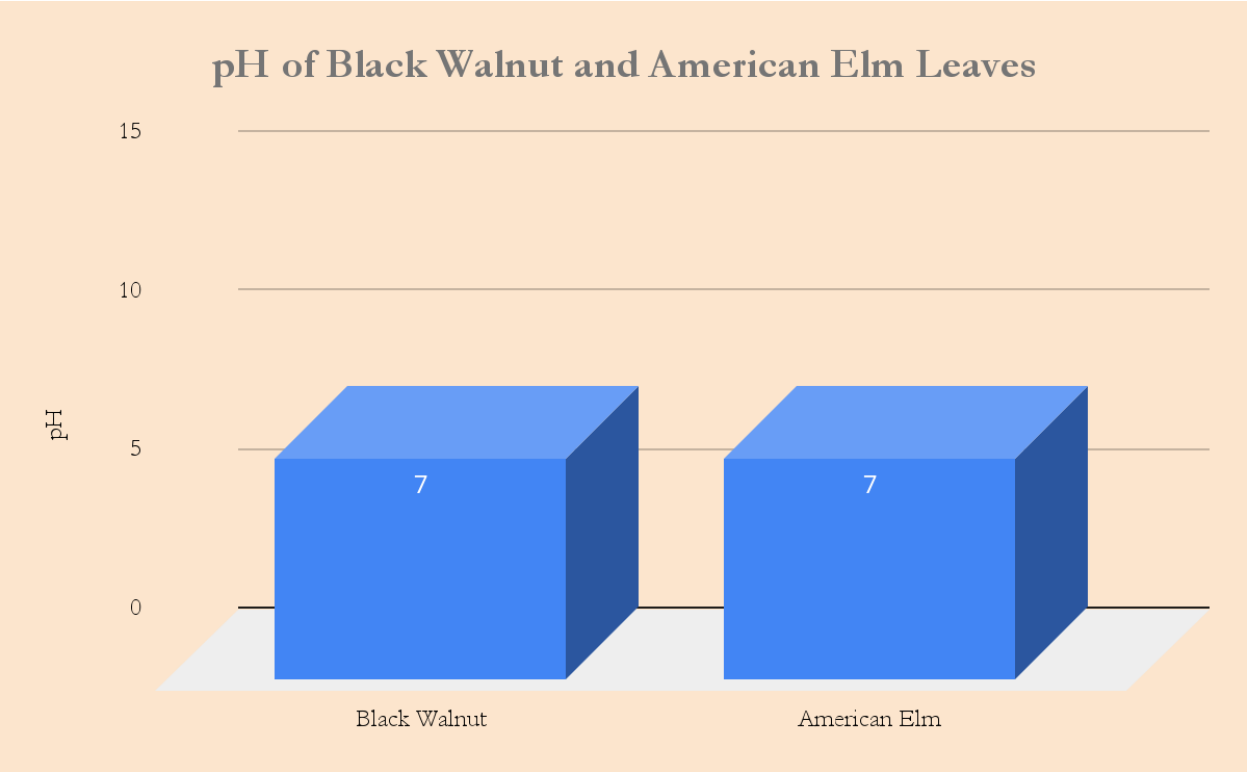

pH of Soil near American Elm
5
4
3
2
1
0
5
5
4
4
4
4
Sample 1
Sample 1
Sample 2
Sample 2
Sample 3
Sample 3
American Elm: 1 Meter Away
American Elm: 2 Meters Away
American Elm: 1 Meter Away
American Elm: 2 Meters Away
American Elm: 1 Meter Away
American Elm: 2 Meters Away

GRAPH 3


pH of Black Walnut and American Elm Leaves
15
10
5
0
pH
7
7
Black Walnut
American Elm

RESULT ANALYSIS

Graphs one and two represents the pH of soil one meter and two meters away from three different black walnut and American elm trees. I found the overall soil was much more acidic than I originally thought (I thought the soil around black walnut trees would be more acidic than the soil around American elm trees).

The first black walnut tree had a pH of 4.3 at both locations. The first American elm tree had a pH of 5.0 at both locations. This data supports my hypothesis. The second black walnut tree had a pH of 4.3 at both locations. The second American elm tree had a pH of 4.0 at both locations. While this data does not support my hypothesis, I do not feel there is such a big difference to matter. The third black walnut tree had a pH of 5.0 one meter away and 5.6 two meters away. The second American elm tree had a pH of 4.0 at both locations. This data does not support my hypothesis.

Every location tested had a pH level too acidic for most plants to grow. From what I understand, plants need close to neutral soil in order to grow. Perhaps because my testing site was on a flood plain, when the Clear Fork River floods in the spring, it causes the acid to be washed out of the soil. My samples were taken in the fall of the year, perhaps allowing the acid levels to build of over the summer. The results are almost the opposite from each other. Black walnut tree one was more acidic than American elm tree one. Both number two trees were very close in pH. Black walnut tree three was less acidic than American elm tree three. Tree-pairs were fairly close by each other. Was one tree influencing the other? This lack of consistency led me to graph number three, where I tested the pH of the tree leaves.

Graph three shows the pH of black walnut leaves and American elm trees to both be seven (neutral). This data does not support my hypothesis. I thought black walnut leaves would

be more acidic than American elm leaves. This even further compounds the soil results. With neutral pH leaves falling onto the soil, I thought the leaves would help the soil to not be so acid. While soil samples were taken in the fall, very few leaves had fallen to be able to prove or disprove my theory. Regardless, it does not seem black walnut leaves would contribute to the acidification of surrounding soil.

CONCLUSION

In conclusion I learned the pH of soil around black walnut and American elm are very similar. The data does not support my hypothesis. The black walnut graph shows pH levels ranging from 4.3 to 5.6, which is actually a little more neutral than American elm. The American elm graph shows pH levels ranging from 4 to 5. When I tested the leaves, I found both had a pH of 7. The results tell me pH of black walnut and American elm trees do not determine whether or not other plants will grow in the soil beneath them. These results made me very confused. Upon digging deeper, I later found out black walnut trees produce juglone which makes toxins in the tree.

This has raised more questions for me. For starters, does the flooding waters of the Clear Fork River contribute to leaching out minerals along its banks, resulting to the acidification of the soil? Why do the black walnut and American elm trees appear to be so healthy when growing in acidic soil? What is the overall impact of juglone? I did not find the method for how to test for juglone in my literature review. There must be some method to test for juglone, or is there?

NEXT STEPS

This project was very fun and exciting. I got to test out different things, go outside and get dirty! I did struggle with the “book” parts of this. Some of the information was very hard to find.

For my next steps, I would like to figure out how to test for juglone, then get some juglone to test on which plants might be able to survive with this toxin present in the soil. This would be a way to help walnut farmers better use the land under their walnut trees and be able to produce a second crop.

This also showed me American elm trees also have acidic soil under them. Trying to determine why both black walnut and American elm trees thrive in such an acidic soil would be useful when trying to revegetate areas such as strip mine land, chemical spill areas, or other places where the soils are acidic.

I still believe there must be a way to be able to better utilize the soil beneath trees to grow second crops. All together this project was very fun and exciting. I had the opportunity to talk to adults who also like to go outside and get dirty.

ACKNOWLEDGEMENTS

I would like to thank my father for helping me do this project and my mom helping me when I needed it most, and my sister for giving me very useful tips and tricks. Dr. Lee was especially helpful in directing me toward the toxin juglone.

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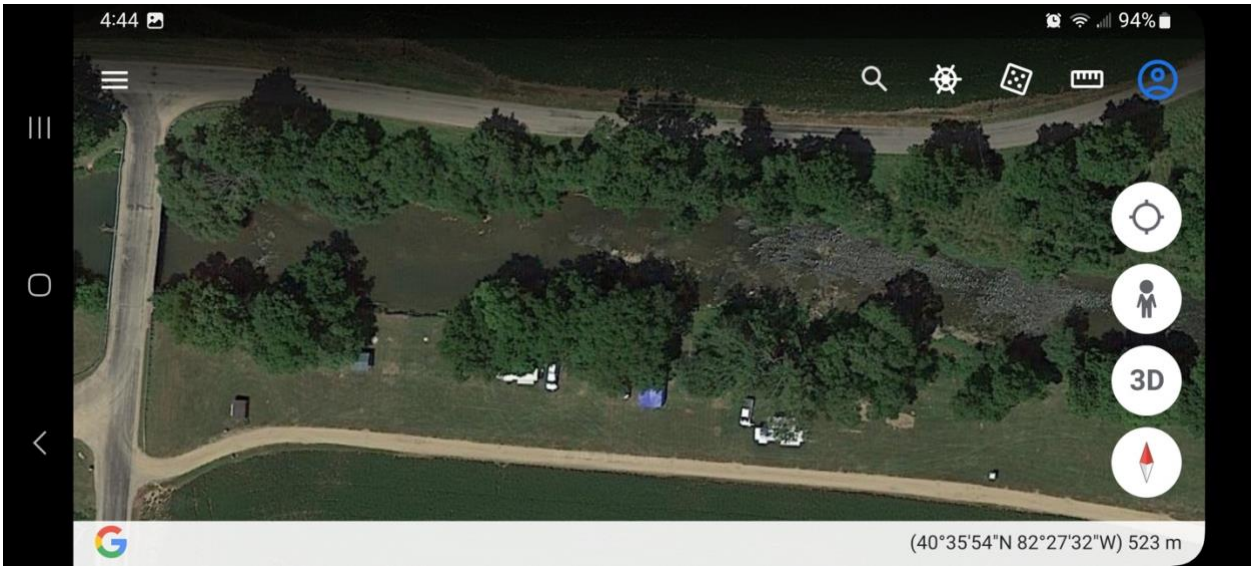
APPENDIX

Study Site:



The soil samples, black walnut leaves, and American elm leaves were collected from the bank of Clear Fork River. There were 48 American elms and 9 black walnut trees along the bank of Clear Fork River. Black walnuts were everywhere on the ground, causing me to roll my ankles a couple of times. The whole creek was owned by the GPAA (gold prospecting site) and close to the creek was a stair case leading down to the river so the gold prospectors could easily get down to the river. The climate in the study site area is cool in the fall. When I was doing the project, it was during the fall so the overall temperature was in the mid 50s-60s degrees Fahrenheit and was not too windy. Overall, it was pleasant to be out in the creek doing my project, soaking up the sun in the fall.