The Effect of Allelopathic Chemicals in Different Soil Types

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Introduction

Allelopathy is the suppression of growth of one plant species by another.[1] Many plants release allelochemicals to ensure their survival. The Black Walnut (*Juglans nigra*) is the most notorious of allelopathic trees.[2] Juglone is the allelopathic chemical that inhibits germination or growth in plants. Juglone becomes the most toxic when it is exposed to air.[3] As rain washes juglone from leaves and other plant material it builds up in the soil where the neighboring plants then absorb the allelopathic chemical. Because allelopathic chemicals might strongly reduce the germination success rate in some plants, the extraction of julone from the Black Walnut might be useful as a natural herbicide for agricultural plants.[1]

In this experiment we used wheat (*Triticum* sp.) to determine whether or not soil types would affect the response of juglone from *J. nigra* on wheat growth. Soil made up of sandy components has very little power of retaining water.[4] Soil that is very porous is at a disadvantage because plants tend to grow poorly in it.[5] However, that behavior is overridden if the soil is allowed to dry. At that point, porous soil is advantageous because it allows for the roots to move downward more easily to subsoil.[5] We decided to measure the height of the plant as well as the root length to establish the depth of which juglone affected such variables. We hypothesize that soil type will have an affect of juglone in wheat growth and germination.

Materials & Methods

- Eight sets with 24 inserts each.

Standard Soil No Juglone	Sandy Soil No Juglone
Standard Soil Juglone	Sandy Soil Juglone

Juglone added before germination

Standard Soil No Juglone	Sandy Soil No Juglone
Standard Soil Juglone	Sandy Soil Juglone

Juglone added after germination

- Juglone solution consisted of a walnut hull powder mixed with water to make a 15g:50ml solution.
- All inserts received three wheat seeds.
- Each insert in juglone treatments received 5 mL of the juglone solution.
- Sandy soil consisted of 2 parts standard potting soil to 1 part medium grain sand.

Results

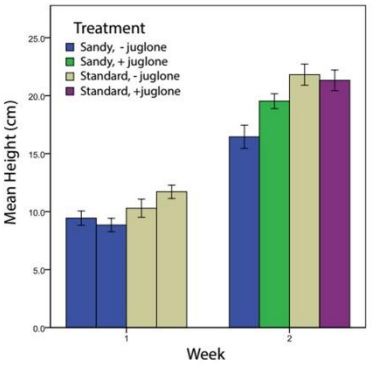


Figure 1: Experiment 1 represents the comparison between the height during Week 1 without juglone and the height during Week 2 with juglone. The error bars represent 95% confidence intervals.

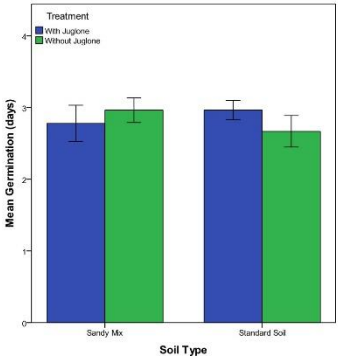


Figure 2: This graph from experiment 2 represents germination and the contrasts between soil types and juglone presence. The error bars represent 95% confidence intervals.

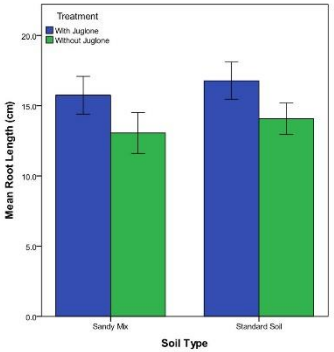


Figure 3: This graph from experiment 2 represents height grown in centimeters and the contrast between soil types and juglone presence. The error bars represent 95% confidence intervals.

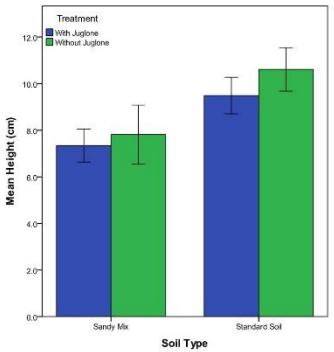
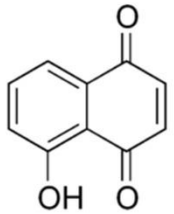


Figure 4: This graph from experiment 2 represents the root length in centimeters and the effects soil type and the presence of juglone have on it. The error bars represent the 95% confidence intervals.

Results

- Wheat in both soil types had greater root length when exposed to juglone ($p<0.05$) (figure 3)
- Wheat in the standard soil had greater height than the sandy soil ($p<0.05$) (figure 4)
- Wheat in the standard soil had lower height when exposed to the juglone ($p<0.05$) (figure 4)



Conclusion

- While wheat was resilient to juglone, the wheat grown in standard soil had significantly lower mean height when exposed to juglone.
- Further research would be required to determine whether or not its effects were due to the draining abilities of the soil.
- A petri dish may have been more suitable for experiment 1, when we were looking for effects after initial growth in week one.
- The thickness of the juglone solution might have affected the amount of chemicals that were actually able to drain through the soil.

Acknowledgments

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References

1. Cachiță-Cosma, D., C. Maior, & S. Corbu. 2015. Arguments for using the allelopathic compound juglone as a natural pesticide. *Environmental Engineering and Management Journal* 14: 1089–1095.
2. Rietveld, W. J. 1983. Allelopathic effects of juglone on germination and growth of several herbaceous and woody species. *Journal of Chemical Ecology* 9: 295-308.
3. Kilic, B., I. Kocacaliskan, & I. Terzi. 2014. Effects of walnut leaf extracts prepared in different solvents on seed germination and seedling growth of wheat. *Journal of Environmental Protection and Ecology* 3A: 1230–1235.
4. Russel, E.J. 1915. Soil conditions and plant growth: *monographs on biochemistry*. Longmans, Green and Company, Paternoster Row, London, England.
5. Passioura, J.B. 2002. 'Soil conditions and plant growth. *Plant, Cell and Environment* 25: 311-318