Phytoremediation of Contaminated Soil Using Hemp

Nick Rogers
Lake Superior State University
Spring 2021

Introduction

- Phytoremediation is a type of soil remediation involving the treatment of polluted soils using plants that can and will grow in the contaminated soils.
- "Phytoremediation uses the natural ability of particular plants to bioaccumulate, degrade, or otherwise reduce the environmental impact of contaminants in soils, water, or air" [1]
- Plants that can efficiently act as a phytoremediator are a viable mitigation strategy to decontaminate areas such as farmlands and old mining operations. This process is highlighted in Figure 1.
- Hemp is an ideal candidate for phytoremediation due to its:
  - High metal tolerance
  - Its ability to grow in various climates around the world.[2]
- With the 2018 legalization of industrial hemp in the United States it has become a more viable and popular option to use as a phytoremediator.
- The objective of this experiment was to:
  - Grow hemp plants in contaminated soil
  - Verify hemp acts as a phytoremediator
  - Quantify how much of the heavy metals that the plant would remove from the soil

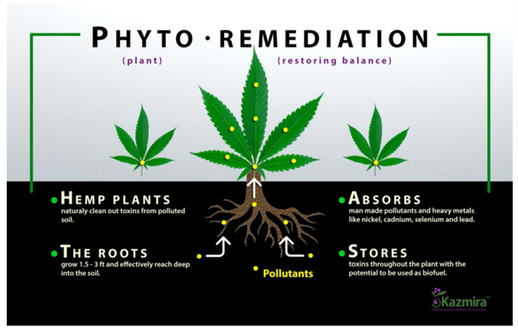

Figure 1: Highlights of phytoremediation process in the hemp plant

Methods

Soil samples collected from Harbor Springs, Michigan → Microwaved digested using Mars6 and analyzed using Agilent 7800 ICP-MS shown in Figures 2 and 3

Figure 2: Agilent 7800 ICP-MS

Feminized seeds acquired from AgMarvels → Grown in grow tent in greenhouse at LSSU as seen in Figure 4

- 200 x 10W lights
- 18 hours of light, 6 hours of darkness
- H_2O added every 23 hours

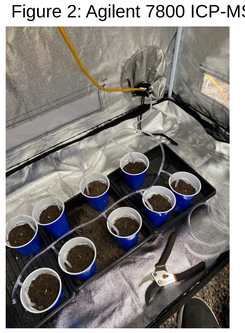

Figure 4: Grow setup with automated watering system inside a grow tent

Plants are harvested → Separated into roots/shoots; dried at 45°C for 30 minutes → Microwave Digested and analyzed via ICP-MS

Figure 3: Mars6 Microwave Digestion instrument

Results

- The average heavy metals concentration found in the root and shoot (stem/leaves) parts of the plant can be seen in Table 1
- The results from the ICP-MS analysis can be seen in both Figures 5 and 6:
  - Elevated amounts of Copper and Lead found in both root and shoot sections of plant

Table 1: Heavy metals concentration (µg/g) found in the shoot and root parts of the hemp plants

	Nickel	Copper	Arsenic	Cadmium	Mercury	Lead
Shoot Average	0.925	29.4	0.3	1.52	0.00874	7.66
Root Average	6.09	83.8	1.39	6.72	0.0252	44.9

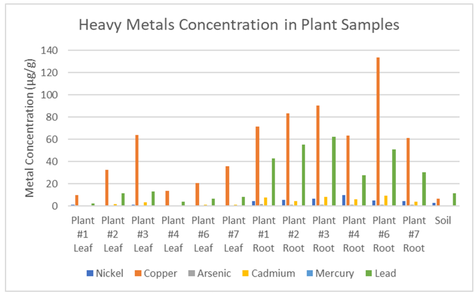

Figure 5: Heavy Metals found via ICP-MS that are regulated by MRA in all Cannabis products

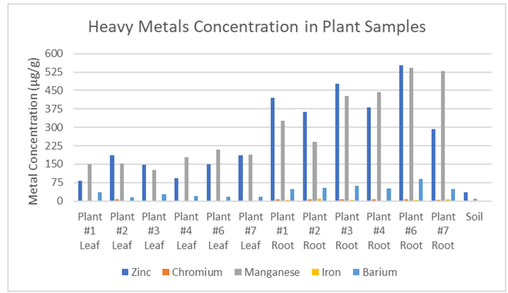

Figure 6: Heavy metals found via ICP-MS testing that had elevated amounts

Discussion

- Multiple heavy metal concentrations in the plants were over the MRA action limit for cannabis products including:
  - Copper, Lead and Zinc
  - The root samples on average had a higher concentration compared to the shoot samples
- Unregulated temperature levels and lack of outside nutrients added to the soil possibly contributed to the lack of growth of the hemp plants.
  - The hemp plants did not make it into the flowering stage so only the root and shoot parts of the plants were able to be tested

Conclusion

- If done on a large scale, using hemp as a phytoremediator could over a set amount of time help remove excess heavy metals from previously contaminated grounds
  - This would allow for land once thought as unusable to be used again for purposes such as agriculture

References

- Rhodes, C. J. Applications of Bioremediation and Phytoremediation. *Science Progress* **2013**, *96* (4), 417–427.
- Kumar, S.; Singh, R.; Kumar, V.; Rani, A.; Jain, R. Cannabis Sativa: A Plant Suitable for Phytoremediation and Bioenergy Production. Phytoremediation Potential of Bioenergy Plants **2017**, 269–285.

Acknowledgements

- I would like to give a special thanks to Benjamin Southwell and Dr. Wright for their guidance during this project.