

Phytoremediation

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Abstract

Four heavy metal concentrations in soils Cu, Cr, As, and Pb were examined to see if removal through the process of phytoremediation was possible. Through the use of Geochemical Techniques, an investigation was conducted to evaluate the contaminations of heavy metals removed from the contaminated soils. The heavy metals were up taken through the roots of plants with phytoremediative qualities and the soils analyzed. Tomato and lemon scented geranium plants were able to extract different concentrations of each heavy metal from the soils. The length of time that the soils were exposed to the contaminants affected the levels of concentrations. The soils located under older CCA treated lumber decks had higher concentrations of Cu, Cr, and As. The soils that were around higher flows of traffic also had higher instances of Pb contamination.

Introduction

There is a remarkable agricultural practice that “is defined as the use of green plants to remove pollutants from the environment or to render them harmless” (Salt, 1). There are several species of plants known for their phytoremediative abilities. Several of these plants are Indian mustard, Sudan grass, sunflowers, and lemon-scented Geraniums. Lemon-scented Geraniums are more importantly known as a hyperaccumulator. This means that they are able to uptake large quantities of heavy metals and continue to thrive while storing these heavy metals in its plant tissue.

CCA treated wood is widely used because of its availability and its lower cost. It reduces the amount of lumber used because it preserves and protects the lumber from

rot and insects. However, CCA can be very harmful to the environment. CCA is named for the presence of copper, chromium, and arsenic. Trace amounts are found in rocks, animals, soil, food, and water, but ingesting too much can have carcinogenic effects and even cause death. High concentrations of CCA have been found in the soils below decks made from the treated lumber. Phytoremediation may help to solve this problem. With the uptake of the heavy metals Cu, Cr, and As, many backyard soils could have lower levels of these heavy metals.

Lead was in gasoline, which made it more efficient in car engines. The use of Pb in gasoline was banned after research showed that the Pb was contaminating the air, water, and soil. This form of Pb that polluted the environment has been found to be in an insoluble form. Lower concentration levels of Pb can cause brain damage and retardation. Phytoremediation has been shown in studies to reduce the level of Pb in soils. There are several institutions that are currently investigating the phytoremediative properties of plants, trees, and weeds such as Trinity College in Hartford, Conn.

Phytoremediation is an alternative to the more expensive practices of cleaning up the soil, such as excavation and soil flushing. “Phytoremediation can be used to clean up metals, pesticides, solvents, explosives, crude oil, polyaromatic hydrocarbons, and landfill leachates” (USEPA, 1). Also, the practice of phytoremediation leaves the soil in better condition than before the plants were utilized. Through phytoremediation we will show that plants do uptake heavy metals from the soil they are grown in. The levels of heavy metals such as those leached from CCA treated lumber and Pb pollution will be reduced by phytoremediation. It is believe that the Lemon-scented Geranium plant will uptake more of the harmful heavy metals than the Tomato plant.

Methods

For this study, the lemon-scented geranium was chosen because of its renowned ability in phytoremediation, and the tomato plant because it also was a remediator. Soils containing elevated concentrations of lead were chosen. The high-density traffic intersection of Battlefield and Glenstone was chosen for Site 1. The intersection of

Cherry and Oak Grove was chosen as a less dense traffic intersection and labeled Site 2. Also, soils that were supposedly contaminated with CCA from the treatment of deck lumber were also used. Site 3 was chosen because the soil was located under a 12-year-old treated lumber deck. Soil located under a 19-year-old treated lumber deck was the area for Site 4. The control needed to be “free” of the contaminants of lead and CCA. A field located on Bennett east of Oak Grove as a control site was chosen.

The soils were collected in the same manner. The top layer of organic matter and about the first inch of soil was removed. The next few inches of soil were collected within a 14-inch diameter and placed in plastic bags. The points of the soil collection sites were marked and stored using a GPS unit.

The soil samples were brought to the lab and sieved using the parameters of 149 and 74 microns. The sieved soil samples were placed in beakers and dried. They were then stored until further analysis.

The remaining amounts of soil were treated the following way; the tomato plants were planted in half of the soil and the lemon-scented geraniums in the other half. The plants were then allowed to grow in the greenhouse for a span of three weeks.

After the three weeks, the soils were removed and brought to the lab. The plants were discarded. The soil samples were dried overnight and sieved using the same parameters of 149 and 74 microns. All of the soil samples were then weighed to two grams, dissolved in a solution of nitric acid and doubly deionized water, and placed in centrifuge tubes. The centrifuge tubes were placed in a warm bath for over 24 hours. The soil samples were then placed in the centrifuge for four minutes and the solution decanted. Standard solutions of 10 ppm and 2 ppm concentrations were made for Pb, Cr, Cu, and As. The decanted solutions and the standards were taken to the ICP for analysis.

Results

The data from the ICP analysis shows the [concentrations of Pb](#). In Site 1 and Site 2 the concentrations of Pb were lower than in the Control Site. Site 1 did have a higher level of Pb than the intersection with the less traffic, Site 2. However, the level of Pb in all of the soils after the three weeks was reduced. In the Control Site and Site

1, the Tomato plant showed the greatest amount of Pb uptake. The Pb level in Site 2 was reduced more by the Geranium plant.

[For the element arsenic \(As\)](#), the soil that had the highest concentration at Site 4, followed by the Control Site, and finally Site 3. For this experiment, the Geranium plant was the most effective in reducing the level of As in the soils taken at Site 3 and Site 4. However, in the Control Site the level of As increased. The tomato plant did help to reduce the level of As in the Control Site, Site 3, and Site 4.

[For Cr](#), Site 4 contained the highest concentrations. Site 3 had the next highest level of Cr and the Control Site had the smallest amount. The Geranium plant up took more Cr than the Tomato plant at each of the sites with the exception of the Control Site. The level of Cr in the Control Site increased slightly for both the Tomato plant and the Geranium plant. [Copper \(Cu\) concentrations](#) were also the highest at Site 4. Site 3 had higher levels of Cu than the Control Site did. The Geranium plant worked best at removing the Cu level at Site 3 and Site 4. Moreover, the Tomato plant up took more Cu for the Control Site.

Conclusion

I believe that the results agreed for the most part with the hypothesis. The Lemon-scented Geranium plants absorbed more of the Cr, Cu, As, and Pb concentrations from the soils at Site 3 and Site 4. The tomato plant, however, disproved the hypothesis for the Pb levels for Site 1, Site 2, and the Control Site. The tomato plant also disproved the hypothesis for the Control Site by up taking more Cu than the Geranium plant. The lemon-scented Geranium plants were more able to cope with the concentrations of heavy metals in the soils. The Geraniums all thrived and remained green. The control tomato was the only plant that thrived and remained green. The other tomato plants yellowed and the tomato plant from Site 4 hardly increased in size.

Phytoremediation is an experiment that should be done when a longer interval of time can be given to the growth of the plants in the sample soils. Different plants such as sunflowers and possibly even several species of weeds should be tested to see if they have phytoremediative properties. Better soil removal techniques should be practiced to help provide more reliable results. Above all, more elements should be

tested to see if plants through phytoremediation could up take them.