The Effects of Bio-char on Concentration of Metals In Leachates of Soil Samples

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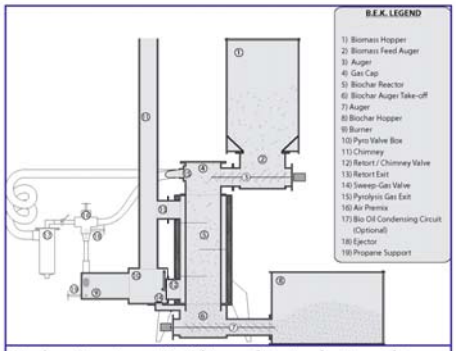
Abstract & Introduction

The San Juan Mountains are an area once overwhelmed with silver and gold mining, and it was not without a trace. Mining agitated the soil associated with mining, exposing metals and sulfide minerals present in the soil and making it easy for these metals to contaminate surrounding ground water, resulting in acid mine drainage.11th graders at Animas High traveled to Silverton and collected soil samples at one of five mine sites. The samples were then analyzed, and the biochar was added, (10% of the volume of the sample, 20%, or 30%.) Biochar is a low density substance created by the pyrolysis (decomposition brought about by high temperatures) of bio-mass, and it is said to absorb the toxic metals in soil samples.

What we are investigating is whether or not it affects the levels of toxic metals in the leachate. Throughout the tests, the leachate was collected twice, and fixed with nitric acid. What we found was that, in general, the amount of metals in the leachate decreased as the amount of biochar was increased. What this means is that biochar is good for the soil, and good for the water around and in Silverton.



Biochar Experiment Kit. This machine is what is used to create bio-char. It supports multiple pyrolysis process modes in direct combustion, indirect combustion, and sweep gas through bed heat transfer.

Image courtesy of: http://bekbiochar.pbworks.com/w/page/6465132/Front- Page

Methods & Materials

Sample Collection:

Samples were collected at five different mine sites in Silverton, Colorado, and then sieved to be >2mm in size. The sample weights were collected and recorded. Then, after being stored in a 120 specimen jar, the bio-char was added, percent by weight. The next day the seed mix was added and the samples were left under the growth light for 72 hours for germination.

Trial Measurements:

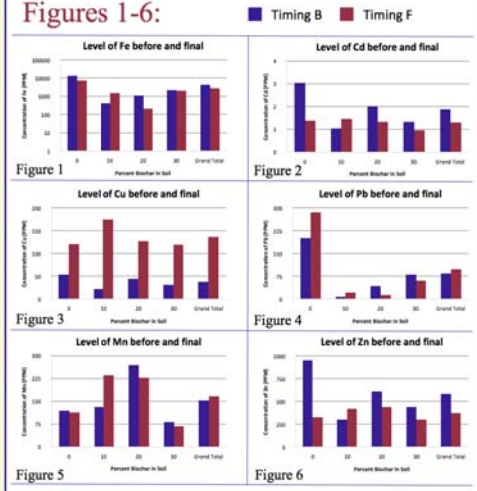
Throughout the experiment, the samples were kept under a growth light for 8 hours a day. Everyday they were taken out, and the masses were weighed and recorded in the pre-watering section of the data sheet. On Mondays, the plants were taken out, weighed on a scale that showed to the hundredth of a place, watered with 100 mL of tap water, the height of the plants was measured in "mm." Then, they were photographed and all the data was recorded in the data sheet. They were left to drain, and the pH of the water before and after was also recorded. After, they were placed back under the growth light for the remainder of the eight hours.

Leachate Collection:

At the beginning and end of the experiment, the leachate was collected. The plants were watered with 100 mL of tap water into a pie dish, and the water that drained out of the samples was poured into a sample collection bottle, and fixed with 12 drops of 70% Nitric Acid (so that the dissolved metals stayed dissolved.) After collection, they were sent to the RiverWatch institute, where they were analyzed by an ICP AES machine. In simple terms, this machine creates a prism using the sample, which shows the wavelength of each individual metal in the sample, so we can identify what is present.

Results

Figures 1-6:



Analysis:

Recalling the characteristics that make biochar desirable, the high surface area and high cation exchange capacity, we expect biochar to decrease the movability of these metals. For biochar to be environmentally necessary, it must decrease or filter the foreign metals keeping them from the water systems.

Based on these classifications, iron, cadmium, manganese, & zinc can be considered as metals that decreased over the trials, (Figs. 1, 2, 5, 6.) Copper is the only metal classified as increasing because it is the only one with all increasing levels before and after the trials, as shown in Figure 3. Lead is the only metal in the inconclusive category because the data collected was half and half. (Fig. 4)

The charts in this section represent the data in a few ways. Each figure also represents how each different level of biochar affects how the metals move through the soil. To best represent the trials and the central tendency, all of the data is averaged from all five of the different mine sites.

Discussion

As a general trend, biochar effectively decreased toxicity in areas affected by acid mine drainage. In most trials, the 20 and 30 percent biochar concentrations were most effective. Iron, cadmium, manganese, and zinc all displayed the trend of decreasing in all concentrations of biochar except for in the 10 percent. Copper was the only metal to display consistent increase in all trials, which implies that biochar could increase copper mobility. The most effective biochar concentrations were the 20 and 30 percent concentrations based on the fact that the concentrations of four out of the six tested metals displayed a decreased mobility after being subjected to these concentrations of biochar.

This study indicates that biochar is indeed beneficial to areas with large amounts of iron, cadmium, manganese, and zinc. In areas with high levels of copper, other amendments may be necessary to control mobility. Biochar is most effective in concentrations of 20 to 30 percent, additionally, based on the percent change, 20 percent biochar concentration is the most effective.

Acknowledgments

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References

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