Coupling Bio/Phytoremediation with Switchgrass to Biofuel Feedstock Production in Mixed-Contaminant Soils

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1. Introduction

- Soil contamination with anthropogenic chemicals is a worldwide concern.
- Occurrence of contaminant mixtures is characteristic of most contaminated sites, yet most studies and implementations still focus on single contaminants in soil.
- Bio/phytoremediation - a cost effective, environment-friendly and natural-based strategy for contaminant remediation – is appealing to the public (Ali *et al.,* 2013).
- The U.S. EPA and USDA are presently dedicated to increasing biomass production for bioenergy to ensure energy security (Lee *et al.,* 2007)
- Therefore, the need exist to determine the potential of switchgrass (*Panicum virgatum* L.), a model bioenergy feedstock, to bio/phytoremediate mixed contaminated soil and simultaneously produce biomass for biofuel. This will save prime land for food and feed.

From waste to biofuel

2. Objectives

- This study was conducted to determine whether switchgrass **(SG)** productivity is inhibited in mixed contaminant **(MC)** soil with or without vermicompost **(VC)** amendment and mycorrhizal **(AMF)** inoculation.
- To determine the fate of chromium (Cr) and dissipation of bifenthrin, a nursery insectide, in SG rhizosphere.

3. Methods

- **Soil Contamination:** Soil was spiked with 50 mg.kg^{-1} Cr, 10% coal fly ash (w/w), and 10 mg.kg^{-1} bifenthrin, a nursery insecticide, to form mixed contaminant (MC) soil.
- **Soil Amendment:** The mixed contaminant soil was amended with 67mg N/kg vermicompost, and inoculated with 32 spores' count of AMF (*Glomus etunicatum **(Ge)*** or *Scutellospora heterogama **(Sh)***) per gram of soil, or both.

3. Methods

- **Planting:** SG was grown in a 50 ml microcosm containing 50 g of soil for eight weeks.
- **Biomass Determination:** Root and shoot biomasses of SG were harvested after eight weeks and oven dried at 70^{o}C to constant weight.
- **Chemical Anlyses:** Elements in the soil, and in root and shoot of SG (including Cr) were analyzed by inductively coupled plasma optical emission spectrometer (ICP-OES) while bifenthrin in soil was analyzed by gas chromatography (GC).
- **Experimental Design:** Experiment consisted of eight treatments with six replications arranged in completely randomized design. Treatment included the following:

- Uncontaminated/Unamended Soil **(Control)**,
- Unplanted, Unamended MC Soil **(MC/0-Np)**,
- Planted, Unamended MC Soil **(MC/0)**,
- MC Soil + Vermicompost **(MC/VC)**,
- MC Soil + *Glomus etunicatum* **(MC/*Ge*)**,
- MC Soil + *Scutellospora heterogama* **(MC/*Sh*)**,
- MC Soil + Vermicompost + *Glomus etunicatum* **(MC/VC/*Ge*)**,
- MC Soil + Vermicompost + *Scutellospora heterogama* **(MC/VC/*Sh*)**

4. Results

Fig. 1: SG biomasses not inhibited in mixed contaminant soil

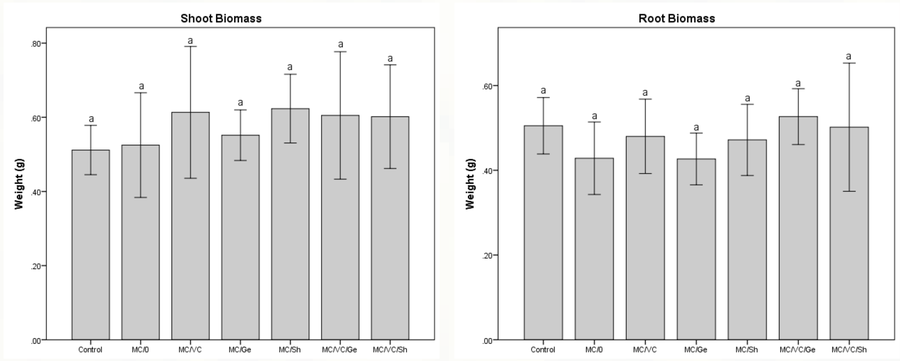
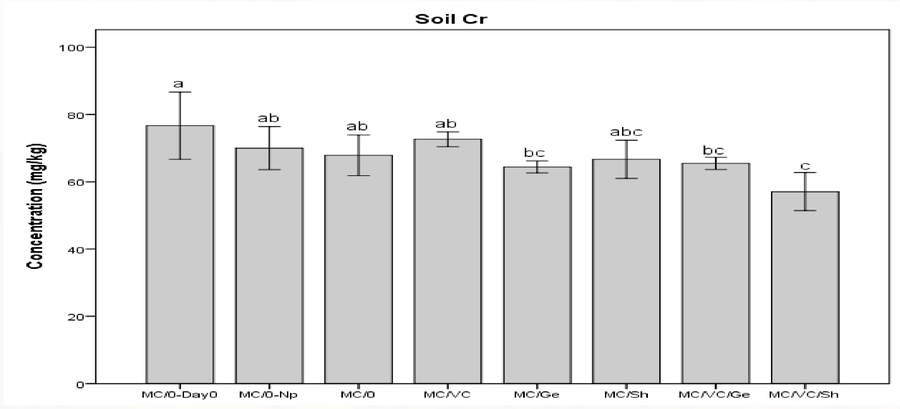
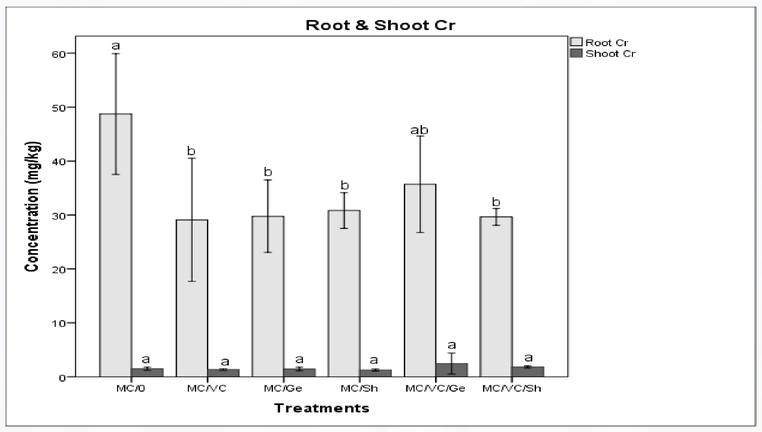


Fig. 2: Soil Cr with and without amendments



4. Results

Fig. 3: Cr concentration in SG roots and shoots



- Fig. 1-3: Bars with different letters are significantly different ($p < 0.05$)
- SG biomass productivity was not significantly ($p > 0.05$) different between unamended control and mixed contaminant (MC) soil treatments
- SG yields were enhanced slightly, but not significantly, by the application of VC, AMF, or both to the MC soil (1.09, 0.98, 1.09, 1.14 and 1.10g, compared to unamended-MC soil, 0.96g).
- There was a significant decrease in Cr in SG rhizosphere with application of *Ge* alone, VC+*Ge*, and VC+*Sh*
- Accumulation of Cr in SG roots was significantly higher than Cr accumulation in SG shoots
- Roots of SG grown with VC amendment, AMF inoculation, or both in MC soils contained less Cr than those grown in unamended MC soil.
- **Between 41 and 50% of initially added bifenthrin to the MC soils had dissipated after eight weeks**

5. Conclusion

- These findings indicate that SG biomass productivity was not significantly inhibited in the presence of mixed contaminants in soil.
- VC, AMF, or both have the potential to reduce accumulation of Cr in SG root; hence their potential for stabilizing Cr in soil
- SG have the potential to bio/phytoremediate mixed contaminant soils and simultaneously produce biomass for biofuel feedstock.

References

- Ali, H., E. Khan, and M. A. Sajad (2013). Phytoremediation of heavy metals--concepts and applications. *Chemosphere*, 91(7), 869–81. doi:10.1016/j.chemosphere.2013.01.075
- Lee, D., V. N. Owens, A. Boe and P. Jeranyama (2007). Composition of Herbaceous Biomass Feedstocks. Prepared by: North Central Sun Grant Center, South Dakota State University, Brookings, SGINC1-07.