A polykingdom approach to bioremediation:

Exploring plant performance for determining bioamendment-mediated decreases in soil toxicity

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Introduction

Chemical analyses of petroleum contaminated soils can be used to monitor the progress of soil clean-up efforts, but these tests are expensive and do not necessarily reveal the status of all relevant toxins. For this study, we investigated the effectiveness of two soil amendments at lowering levels of diesel contamination and the use of a plant bio-assay to assess soil toxicity.

Bioamendments

Digestate: a by-product of anaerobic digestion of dairy manure solids and aquatic vegetation

Mycelium of *Pleurotus ostreatus*: a gilled basidiomycete in Agaricales; white-rot fungus capable of digesting lignin, grown on a substrate of rice straw and hulled wheat grain

Research Questions

- What effect do these bioamendments have on plant growth in uncontaminated soil?
- Can these bioamendments help remediate diesel-contaminated soil, effectively making the soil more hospitable for plant establishment?
- Does a combination of the bioamendments demonstrate a synergistic effect in enhancing plant performance?
- Is there an inversely proportional relationship between a decrease in TRPH (Total Recoverable Petroleum Hydrocarbons) and an increase in plant performance?

Study Design

- Loam soil contaminated with:
  - 0.0% or 5.0% diesel (vol./vol.)
  - Bioamendments added to soil (vol./vol.):
    - 20% digestate
    - 20% mycelium
    - 10% digestate and 10% mycelium
    - control - no amendment
- Planted 96 seeds of *Lolium perenne* / treatment conetainters
  - Response variables measured:
    - shoot height (mm)
    - germination frequency
    - biomass (mg/seedling)
    - Laboratory analysis
      - Total Recoverable Petroleum Hydrocarbons (TRPH)

Results

Effects of bioamendments in uncontaminated soil

Figure 1

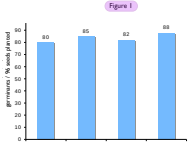

Figure 2

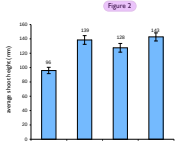

Figure 1. Total seedlings germinated at 19 days after sowing
Figure 2. Average shoot height of seedlings at 19 days after sowing (mean ± SE)

Effects of bioamendments in diesel-contaminated soil

Figure 3

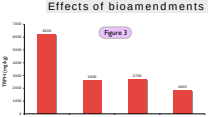

Figure 4

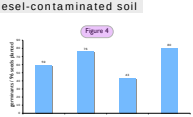

Figure 5

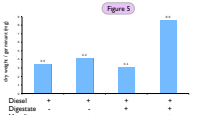

Figure 6

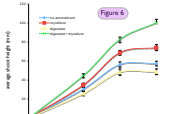

Figure 3. Reduction of Total Recoverable Petroleum Hydrocarbons measured 42 days after amending soils
Figure 4. Total seedlings germinated at 21 days after sowing
Figure 5. Average shoot dry weights (mg) per seedling
Figure 6. Time course of average shoot heights (mean ±SE)

Conclusions

- Both amendments, alone or in combination, significantly improve growth of *L. perenne* in uncontaminated soil (Fig. 1)
- The presence of bioamendments promotes degradation of diesel hydrocarbons in soil (Fig. 2)
- The combination of mycelium and digestate in diesel-contaminated soil synergistically enhances plant growth and decreases levels of diesel hydrocarbons (Figs. 2,4,5)

Future Research

- Determine the role of *L. perenne* in the observed TRPH decline
- Assess various substrates for mycelial growth, including alder sawdust and digestate
- Examine other plant species for the potential to serve in this bioassay
- Evaluate other plant species' capacity to treat petroleum hydrocarbon-contaminated soils
- Apply this plant performance bioassay in Ecuador in December 2009 with species appropriate to the region

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