Mine reclamation using bioenergy crops: An investigation into plant-microbe interactions of switchgrass (*Panicum virgatum*)[1]

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Abstract: Bioenergy crop production has recently increased, initiating demand to find alternative growing land. One attractive option is the use of marginal soils, such as reclaimed minelands, for bioenergy crop agriculture. Switchgrass (*Panicum virgatum*) is a promising bioenergy crop that can be grown on marginal lands due to its robust growth in various soil types and climates. However, little is known regarding plant-microbe interactions among switchgrass systems within reclaimed minelands. Investigating the mineralization and acquisition of critical nutrients, i.e. carbon (C), nitrogen (N), and phosphorus (P) will provide insight into reclamation impacts on plant-microbe interactions in marginal soils. Data were obtained from two switchgrass cultivars grown on high- and low-quality reclaimed mine sites (Hampshire and Hobet, respectively) in West Virginia[3]. Switchgrass yields at Hampshire were nearly an order of magnitude higher than Hobet (8.4 Mg ha^{-1} vs 1.0 Mg ha^{-1}). Within Hampshire, the Cave-in-Rock cultivar yield was approximately 2-fold greater than that of Shawnee (12.9 Mg ha^{-1} vs. 7.6 Mg ha^{-1}). Here, we illuminate plant-microbial interactions that may account for this drastic shift in cultivar yield by combining enzymatic activity analyses with shotgun metagenomics. Hampshire showed significant increases in extracellular enzymes associated with mineralization and acquisition of critical nutrients as compared to Hobet. A significant site × cultivar interaction was found for acid phosphatase activity, indicating differences in the genomic capacity of the soil microbiome to cycle P between sites and cultivars. Metagenomic analyses showed significant differences in C- and P- associated gene abundances, but showed no difference in N-associated or "housekeeping" genes. Further, genes associated with phosphonate metabolism had significantly greater abundance in Hampshire versus Hobet (+1350%; $p<0.01$) and a significant site × cultivar interaction was found ($p<0.01$). Together, these data suggest microbial community differences that potentially affect nutrient cycling capabilities and switchgrass biomass yield between both Hampshire and Hobet.

Additional Key Words: shotgun metagenomics, marginal land use.

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3. Work reported here was conducted near 39° 24' N; 79° 06' W (Hampshire) and 38° 06' N; 81° 36' W (Hobet).