Microbiome diversity and assembly in the phyllosphere of perennial bioenergy crops

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Project Goals: Our overarching objective is to understand the interactive dynamics of bioenergy crop phyllosphere microorganisms with each other, their hosts, and their environment. Toward this objective, we have two project goals. (1) Characterize the intra-annual temporal dynamics of phyllosphere microbial communities of switchgrass and miscanthus. (2) Quantify the contributions of soil microorganisms to switchgrass and miscanthus phyllosphere assembly.

The aerial surface of plants, known as the phyllosphere, makes up a large portion of the terrestrial microbial environment (an estimated 10^8 km^2 globally). Phyllosphere microbes have can influence ecosystem services by moderating biogeochemical fluxes of greenhouse gasses. They also can benefit their hosts by improving plant stress tolerance or promoting the production of plant growth hormones. However, we have limited information about the composition, dynamics and functions of bioenergy crop phyllosphere microbiota. Here, we characterize the diversity and assembly of microbial communities present in the phyllosphere and nearby soil of two perennial cellulosic feedstocks for biofuel - switchgrass (*Panicum virgatum*) and miscanthus (*Miscanthus x giganteus*) over the course of the 2016 growing season at the Great Lakes Bioenergy intensive cropping sites (Kellogg Biological Station, Hickory Corners, MI). We sampled both nitrogen-fertilized and unfertilized sub-plots to assess the effect of N-fertilization on phyllosphere community structure and function. We used 16S rRNA gene sequencing to assess microbiome diversity and structure. We found that community membership of the phyllosphere was distinct from that of soils. The leaves harbored relatively simple communities of less than 100 taxa, and had a core microbiome (persistent and abundant taxa) that included several Proteobacteria. There were directional changes in the phyllosphere communities over the growing season, suggesting that these consortia were fit for life on the leaf surface rather than vagabonds randomly assembling from the air or soil. The highest numbers of taxa were observed early and late in the growing season, and the lowest at mid-summer. Miscanthus and switchgrass phyllosphere communities became more differentiated over time, indicating an influence of host on the late-season phyllosphere community. There was no strong influence of fertilization on the phyllosphere structure. Understanding the dynamics of community assembly, structure, and function of phyllosphere microbiota is a first step toward managing these communities to benefit their hosts. In the case of bioenergy crops, we interrogate these communities for functions that may improve crop productivity or wellness, or enable efficient cellulose degradation from plant material.

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