Tallgrass Prairie Center: Soil Legacy Effects of Prairie Biomass Feedstocks with Different Diversity

Alec Glidden
*University of Northern Iowa*, gliddena@uni.edu

Mark Sherrard
*University of Northern Iowa*, mark.sherrard@uni.edu

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Soil Legacy Effects of Prairie Biomass Feedstocks with Different Diversity
Alec Glidden and Mark Sherrard
Department of Biology, University of Northern Iowa, Cedar Falls, IA

Background /Previous Research

- A high-diversity mixture of native prairie vegetation could be an ideal biomass feedstock for marginal farmland in the Midwestern United States [1].
- Previous research suggests that a high-diversity biomass feedstock should require less fertilizer than a low-diversity feedstock [1] because of complementarity effects (e.g., greater niche differentiation and legume enhancement of soil N) [2].
- Over the past seven years, we have studied the ecosystem services provided by prairie biomass feedstocks with different diversity (1, 5, 16, and 32 species) at Cedar River Ecological Research Site (CRERS) in Black Hawk County, Iowa, U.S.A.
- Research at CRERS has shown that the 5-species feedstock is less productive than the other three feedstocks (Fig. 1), that soil nutrient depletion has been highest in the 5-species feedstock, and that switchgrass plants in the 5-species feedstock have lower photosynthetic capacity than switchgrass plants in the other three feedstocks (Fig. 2).

Methods

- **Study Site:** This study was conducted in the UNI greenhouse using soil from CRERS. There are three soil types and four feedstocks: 1-species (a *Panicum virgatum* (switchgrass) monoculture), 5-species (a mixture of *C. glutinosa* grasses), 16-species (a mixture of *C. glutinosa* and *C. virgata* grasses, forbs, and legumes), and 32-species (a mixture of *C. glutinosa* and *C. virgata* grasses, forbs, legumes, and sedges) at CRERS (Fig. 3).
- **Design:** We grew 40 switchgrass plants in field soil collected from each feedstock (40 × 4 = 160 plants). Field soil was collected from three randomly selected positions in each plot on the sand soil on June 8 2016. Soil samples collected from the same feedstock were combined, pushed through a 10mm sieve, homogenized, and placed into 160 - 1L containers. Pre-germinated seeds were sown on June 9 2016.
- **Plants that had not emerged by June 13 2016 were excluded from analyses.**
- **On September 1 2016, we harvested aboveground and belowground plant biomass. The tissue was dried to a constant mass and weighed.**
- **We compared plant growth between feedstock soil sources using one-way ANOVA with soil source as a fixed factor.**

Results

- **Switchgrass plants grown in soil collected from the 5-species feedstock produced significantly less aboveground and belowground biomass than switchgrass plants grown in soil collected from the other feedstocks.**
- **Plants grown in soil collected from the 1-, 16-, and 32-species feedstocks produced the same amount of aboveground and belowground biomass.**
- **Percent emergence was not significantly lower in soil from the 5-species feedstocks than soil from other feedstocks (data not shown).**

Conclusions

- **Our results support the hypothesis that the low productivity of the 5-species feedstock at CRERS is due to higher N stress.**
- **Reduced plant growth in this feedstock soil source, relative to the high-diversity feedstock soil sources, was likely driven by the absence of legumes. Legumes form symbiotic associations with soil microbial organisms, which enhances soil N and increases plant performance [6].**
- **The absence of N stress in the 1-species feedstock could be because switchgrass has lower N uptake and higher root length density than other *C. glutinosa* grasses [7], resulting in slower soil N depletion.**
- **In summary, our results suggest that a 5-species *C. glutinosa* mixture is not an ideal candidate feedstock for biomass production because it depletes soil N at a faster rate than the other three feedstocks at CRERS.**

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References

1. Tilman et al. (2006) Science 314:1598-1600
3. Abernathy et al. (2016) GCB Bioenergy 8:1082-1092
5. Catherine Kokemuller (2017) UNI Honors Thesis