Soil microbes: Prairie restoration tool

Researchers from Western Michigan University (WMU) are investigating ways to improve soil microbial communities (SMCs) in reclaimed agricultural land, which could help mitigate climate change.

Tallgrass prairies, a disappearing ecosystem, have been established in agricultural fields in recent years as land managers seek to reduce soil erosion, reintroduce native plant diversity and provide habitats for native pollinators. Yet the SMCs in these restored prairies do not resemble those in remnant North American prairies.

While a graduate student at WMU, Zach Whitacre conducted a study aimed at enhancing soil bacterial communities in prairie restorations — work that may have implications for mitigating climate change.

Investigating biomass

"We'd like land managers to be able to restore prairies completely because the soil's bacterial community has the potential to increase the amount of carbon in the soil and reduce greenhouse gas emissions," says Zach Whitacre, who led the project while he was a graduate student at WMU and a member of Kathryn Docherty's research lab. "In addition to potentially increasing the amount of soil carbon, shifting the soil's bacterial communities could accelerate the establishment of late-successional plants, such as nodding wild onion and rattlesnake master," he adds.

Previous research indicates that cellulose microcrystalline (refined wood pulp), a recalcitrant carbon source, can be added to the soil to change the bacterial community. Yet cellulose microcrystalline is not a practical solution, due to the amount needed and its high cost. Whitacre's idea is to use biomass instead. "Cellulose is found in the cell walls of most plants, so the application of plant material could produce the same results at a relatively low cost," he explains.

Working with researchers at the University of Minnesota and land managers at the Edward Lowe Foundation and the Washington Conservation District, Whitacre began a field experiment in April 2019.

Fine and coarse soil sites

Two prairie restorations sites were selected: one in Michigan at Big Rock Valley (BRV), the foundation's headquarters, and the other in a reclaimed ag field in Afton, Minnesota. The sites were selected due to their different soil textures. BRV has silty, clay-based soil while the Minnesota site has sandy soil.

At each site, Whitacre's team established 18 plots of tallgrass prairie — six were inoculated with cellulose microcrystalline, six with little bluestem biomass (seed heads removed) and six as the control group. One objective was to see if the cellulose microcrystalline would produce the same microbial shift in the field as it did in a previous greenhouse study. Another key goal was to compare the plots with the bluestem biomass to see if it produced a similar

result, or even better, a shift.

Preliminary testing in August 2019 showed the bluestem biomass in the Minnesota plots was, indeed, altering the soil community towards microbes that may lead to increased soil carbon in the future. Tests also indicated that the bluestem was doing a better job than the cellulose microcrystalline. "No change was seen at BRV, which could be a result of soil type or environmental factors," Whitacre says, noting that southwest Michigan experienced a drought that summer while Minnesota did not. "Microbes need water to better access nutrients in the soil, so that could have been part of the reason."

Final test results

In August and September 2020, soil samples were taken again and analyzed over the next few months. This time, both sites showed an increase in soil organic matter for plots treated with the bluestem biomass. However, there was no increase in soil organic matter at either site where the cellulose microcrystalline had been added. In addition, there was a shift in the bacterial communities at both sites with the biomass amendments, but it was difficult to draw specific conclusions about the response, Whitacre said.

"The study was successful in being the first step to determine whether it's possible to add biomass into a newly restored prairie and also see an appreciable increase in soil carbon a year later," says Whitacre, now a stewardship coordinator at the Kalamazoo Nature Center where he focuses on prairie fen restoration. "Adding biomass into the soil is a potential approach for land managers.

Top and bottom left: A gas analyzer in one of the prairie plots at Big Rock Valley was used to measure the rate at which carbon dioxide was released from the soil. Bottom right: Soil collars were used as a platform for the analyzer to rest upon so it did not directly touch the soil. (Researchers took measurements in the morning to avoid changes in flux as temperatures warmed.)

Yet there is more research that needs to be done before we can say this works 100% of the time, and if the plots amended with biomass will continue to show carbon gains in the future."

Whitacre's project is novel in that most prairie research focuses on aboveground methods rather than the underground bacterial community.

"It can take years to fully establish a prairie corridor if you're just relying on native plant seeding alone," Whitacre says. "Yet if successful, restoring microbial diversity would enhance the establishment of native prairie plants while also increasing soil carbon and reducing greenhouse emissions on a small scale."