Semi-annual report ISCR project on Biochar and Digestates – Oct 1 2024- July 15 2025

In our previous year of funding, we devoted substantial effort toward developing and refining robust research methodologies to test the effects of soil amendment with biochar and digestate on soybean soilborne diseases, conducting 12 experiments in total that yielded 704 data points. In the current year of funding, we conducted greenhouse experiments to start understanding the impact of biochar and digestate amendments on soybean disease development and plant health.

Biochar experiments:

We conducted a total of 6 greenhouse studies experiments testing the effects of biochar amendments on soybean in the presence and absence of *F. virguliforme*, the pathogen that causes soybean Sudden Death Syndrome (SDS). We compared three types of biochar that represent contrasting pH, total carbon and ash diversity: Corn Stover (pH 8.8–9.2), Corn Stover + Iron (pH 5.1–5.4), and Yellow Pine Biochar (pH 6.8–7.2). These biochars were produced under autothermal (air-blown) pyrolysis conditions in Dr. Bakshi's program at the Bioeconomy Institute.

In the first two experiments, the biochars were added at a 5% rate (v/v) to pasteurized soil. The results of these experiments were inconsistent and we later found that issues related to seed quality and viral contamination may have affected our results. Therefore, we repeated the experiments with a new seed batch of Williams 82. In addition, we started adding the biochar to soil using a 2% rate per weight (wt/wt), as this is more applicable to field applications.

These experiments showed no clear and consistent effect of the biochars on SDS, but suggested that yellow pine biochar had the greatest potential to reduce SDS seedling root rot, while corn-based biochars had no effect or even worsened root rot. To investigate if the lack of consistent results was due to a low rate of biochar, we then conducted two experiments testing the yellow pine biochar at different rates: 0, 2, 3 and 4 % (wt/wt). Data are being analyzed.

In addition to *F. virguliforme*, two experiments were also conducted to evaluate the effects of the three biochars at 2% rate on *Pythium* root rot. In contrast to previous studies, where we found a reduction in root disease caused by *P. sylvaticum* with biochar amendments, in these experiments no significant differences were observed.

Digestate experiments:

For the digestate experiments, we compared three rates of solid digestate batches obtained from the commercially operated Sievers Farm as part of the C-Change Grass2Gas project directed by Dr. Schulte Moore. We conducted three experiments using digestate applied to the soil at 0%, 1%, 2%, and 3% amendment rates, by weight. We found that a 1% amendment had no effect on root rot but showed statistically significant enhanced plant growth compared to the 0% control against *F. virgulforme*. However, at 2% and 3% amendment rates, there was evidence suggesting an increase in disease severity likely due to the higher water-holding capacity associated with greater digestate levels. New experiments will be conducted under field soil conditions to further examine this trend.

Current Ongoing research

Experiments to date were conducted using pasteurized soil to focus on the interaction of the soil amendment with the pathogen in the absence of other confounding factors. We are now ready to transition to greenhouse studies using natural field soil to more closely resemble the conditions that occur on farmer fields, particularly in terms of interactions of the biochar and digestate with naturally occurring microbial communities. We have collected field soil from an ISU research farm with a history of corn-soybean production and will be establishing an experiment comparing the best biochar and digestate treatments, and their combination, in greenhouse conditions.

Presentations

The findings from these studies were presented in <u>poster</u> format at four venues:

Clausen, B., Silva, V., Rahic, E., Schulte Moore, L., Leandro, L. (2024). "Impact of Soil Amendments with Digestate and Biochar on Agriculturally Significant Plant Pathogens of Soybean." Iowa Soybean Center Research Day, Iowa State University, September 2024, 2025

Clausen, B., Leonor, L., Schulte Moore, L. (2024). "Reducing Reliance on Pesticides Through Biofuel Industry By-Products: The Role of Biochar and Digestate in Disease Management of Soybeans." Norman Borlaug Lecture, Iowa State University, April 2024

Oswald, D., Clausen, B., Leandro, L. (2024). "Impact of Biochar Soil Amendment on the Plant Pathogen *Globisporangium sylvaticum* in Soybean." Life Science Symposium, Iowa State University, December 2024

The findings from these studies were presented in <u>oral</u> format at four venues:

Clausen, B. and Leonor, L. (2025). “Effect of Biochar and Anaerobic Digestates Soil Amendments on Soybean Soilborne Diseases.” InnovPlantProtect, Elvas, Portugal, March 2025

Clausen, B. and Leonor, L. (2025). “Effect of Biochar and Anaerobic Digestates Soil Amendments on Soybean Soilborne Diseases.” University of Èvora (MED), Èvora, Portugal, March 2025

Clausen, B. (2025). “Reducing Reliance on Pesticides Through Biofuel Industry By-Products: The Role of Biochar and Digestate in Disease Management of Soybeans.” MDPI Plants 2025 International Conference, Barcelona, Spain, April 2025

Clausen, B., Rahic E. (2025). “Student-Led Collaboration: Building Peer Networks for Interdisciplinary Success.” USDA-NIFA SAS CAP, University of Wisconsin-Madison (online), July 2025