

How does Designer Biochar Improve Dissolved Phosphorus Sorption?

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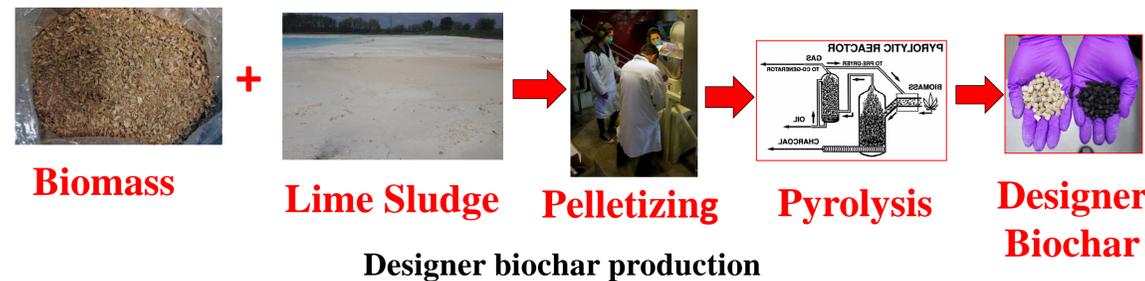
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Introduction

Agricultural subsurface drainage is water management practice that uses perforated conduits to remove excess water from the soil profile to increase crop production and promote soil conservation. However, subsurface drainage systems can also deliver large quantities of nutrients from agricultural fields to surrounding watersheds. The goal of this project is to produce designer biochars to improve their sorption on dissolved phosphorus, develop a refillable biochar-sorption-channel to effectively capture nutrients from subsurface drainage water, to recycle phosphate-captured biochars as a slow-release fertilizer, and to keep nutrients in the closed agricultural loop.

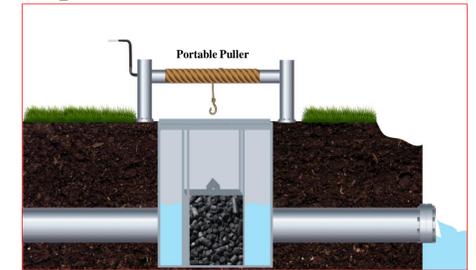
Method and Materials

- Eight lime sludge samples were collected and tested from various water treatment plants in Illinois & Ohio.
- Wood biomass was pretreated with a lime sludge at four different mixing ratios.
- The treated biomass was pyrolyzed under different temperatures to produce a series of designer biochars.



Future Work

- We will manufacture designer biochar pellets using optimal production conditions and then apply them into the biochar-sorption-channel



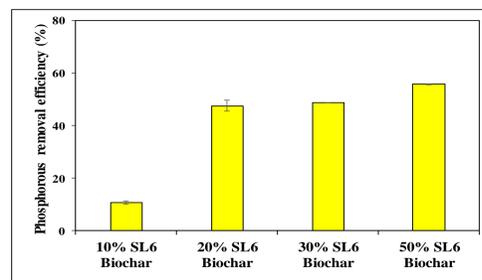
A scale-up biochar-sorption-channel with biochar sorption chamber

Objectives

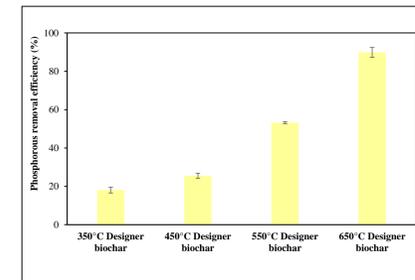
- Generate designer biochars to effectively capture phosphorus from subsurface tile drainage
- Recycle phosphorus-captured biochars as a slow-release fertilizer
- Keep phosphorus in the closed agricultural loop

Result

- The designer biochars with 10%, 20%, 30%, and 50% of lime sludge addition showed that the 20% addition ratio of lime sludge was selected for the further optimization studies.
- The sorption capacities of designer biochars for dissolved phosphorus increase with increasing pyrolysis temperature.

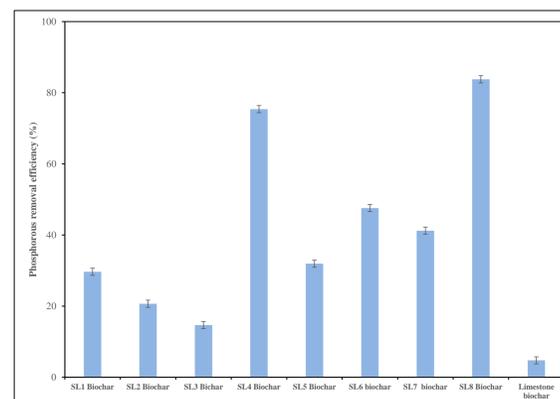


Effect of addition amounts of lime sludge on sorption capacities of designer biochars for dissolved phosphorus

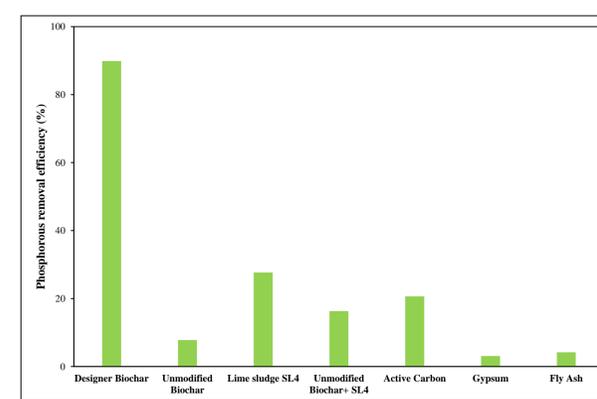


Effect of pyrolysis temperature on sorption capacity of designer biochars for dissolved phosphorus

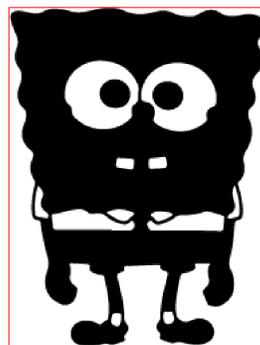
- The phosphate removal rates for all designer biochars are significantly associated with magnesium and calcium contents of the lime sludge samples. Therefore, **designer biochar for future field trials will be produced from wood biomass pretreated with 20% of lime sludge under 650 °C pyrolysis temperature.**



Phosphorus sorption capacities of designer biochars produced from different lime sludge additions



Comparison of phosphate removal by different adsorbents



BLACK SPONGE



Acknowledgment: This research is funded by the IL NREC