

One page summary for the NREC end of the year report

NREC Project: 2019-4-360232-925

Primary Investigator: Wei Zheng

### **How does designer biochar recover dissolved phosphorous from tile drainage?**

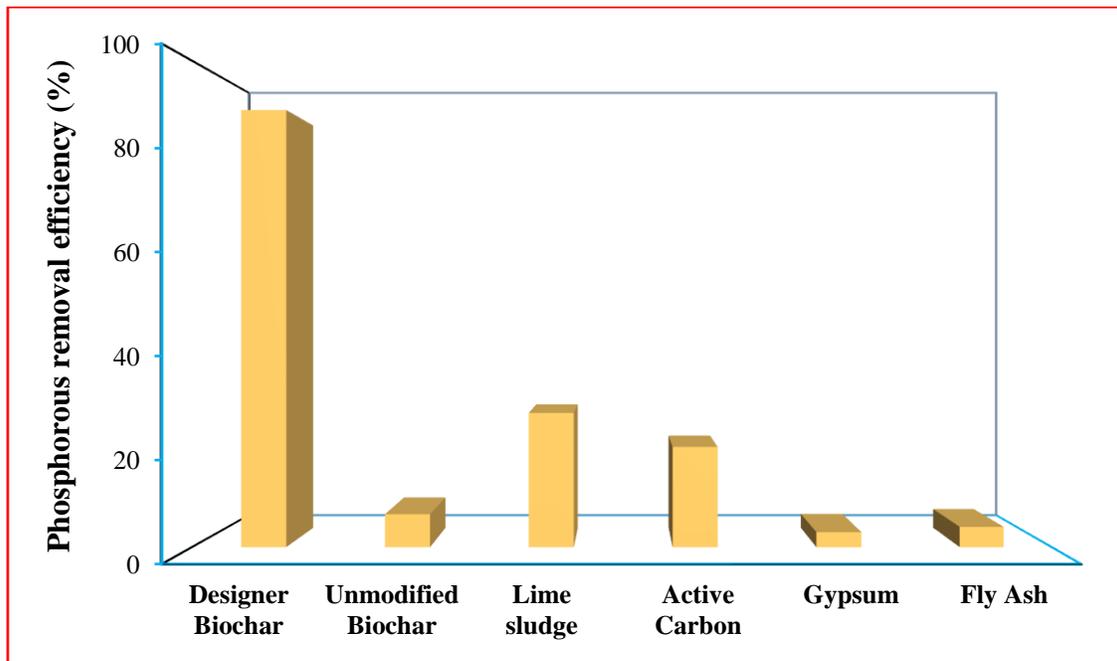
Biochar is a carbon-rich material produced from biomass under oxygen-limiting conditions (Figure 1). Biochar application in soils has been proposed as a good strategy for carbon sequestration, providing simultaneous benefits for improving soil quality, and increasing agronomic productivity. In this project, we pretreated biomass with lime sludge to generate a designer biochar using pyrolysis. The designer biochar has extremely high capacities for holding anions such as dissolved phosphorus, which could completely remove phosphate ions if the concentration of phosphate were less than 10 mg/L. In 50 mg/L phosphate solutions, the designer biochar could adsorb >90% of dissolved phosphorus, which was significantly higher than unmodified biochar (Figure 2). This result suggests that the pretreatment of biomass with lime sludge for biochar production has a significantly synergic effect on phosphate removal. In addition, the sorption capacity of the designer biochar is much higher than other common phosphorous adsorbents including lime sludge, activated carbon, gypsum, fly ash, and steel slag (Figure 2).

In this project, we will develop a refillable biochar-sorption-channel to attach to denitrification bioreactors (Figure 3) to effectively capture dissolved phosphorus from subsurface drainage water, to recycle phosphate-captured biochars as a slow-release fertilizer, and to keep nutrients in the closed agricultural loop. Compared to the traditional bioreactors, this innovative treatment system using woodchip denitrification followed by biochar-sorption-channel can comprehensively reduce the losses of both nitrogen and phosphorus nutrients from tile drainage.

We will manufacture designer biochar pellets using optimal production conditions and then apply them into the biochar-sorption-channel (Figure 3). After treatment, phosphorus-captured biochars can be removed from the channels and refilled with fresh designer biochars. The phosphorus-captured biochars will be used as a slow-released fertilizer to mitigate the excess nutrient loads to watersheds from agricultural fields, enhance nutrient use efficiency, and improve crop yields.



**Figure 1.** Biochar produced from sawdust via pyrolysis



**Figure 2.** Comparison of phosphate removal by different adsorbents

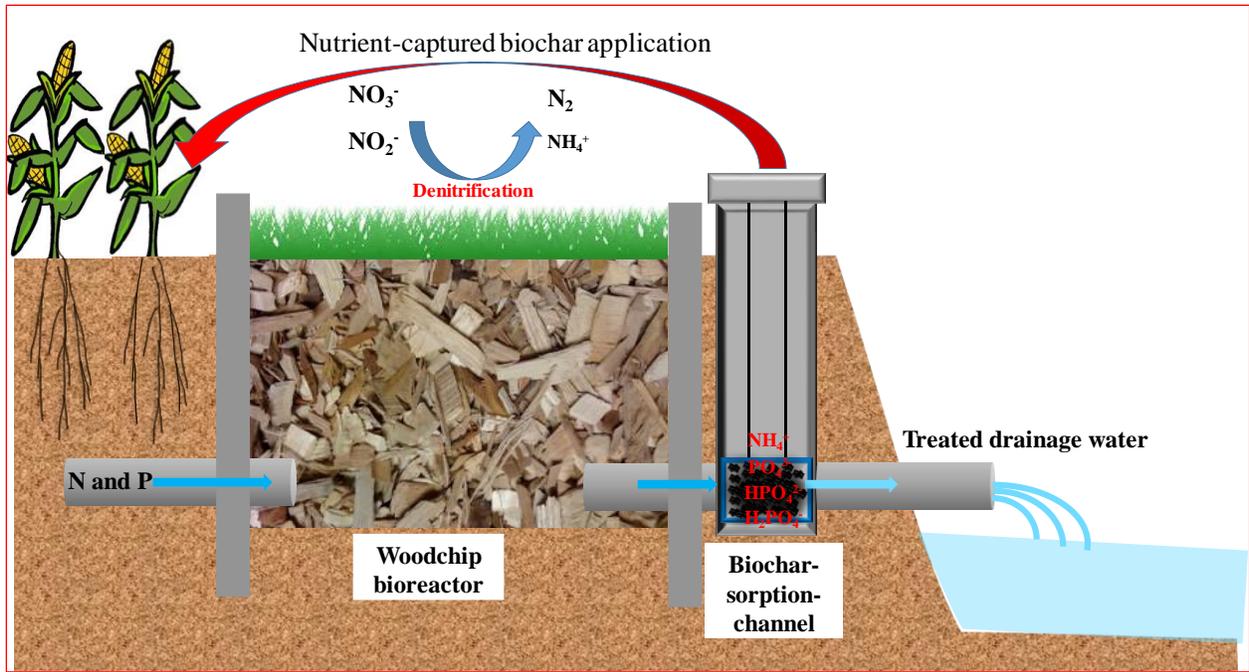


Figure 3. Woodchip bioreactor and biochar-sorption-channel