

# BIOCHAR BENEFITS GREEN INFRASTRUCTURE: A GLOBAL META-ANALYSIS AND SYNTHESIS

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Green infrastructure, as a nature-based solution, has been increasingly developed in cities worldwide to enhance ecosystem services and urban sustainability. However, green infrastructure degradation or failures are often observed. Recent research has suggested that biochar can be an ideal substrate additive for a wide range of green infrastructure types to improve green infrastructure performance and long-term sustainability due to its favorable physicochemical properties. However, the generality of positive biochar effects on ecosystem services on green infrastructure is unclear. Therefore, we conducted a global meta-analysis and data synthesis to investigate the effects of biochar applications on ecosystem services on green infrastructure. A systematic literature search was performed to identify all the existing studies that examine biochar applications on green infrastructure. Data on biochar effects on green infrastructure ecosystem services, including substrate property, hydrological performance, plant response, greenhouse gas emission, and microbial response, were extracted for meta-analysis and qualitative synthesis. In total, 53 studies were included for data synthesis, with 32 studies used for meta-analysis. Our results show that biochar pervasively benefits a wide range of ecosystem services on green infrastructure. The most direct biochar effects are on the substrate properties of green infrastructure. We found that biochar additions reduce substrate bulk density by 11% and increase substrate water retention capacity and plant available water by 23% and 33%, respectively (Figure 1). In addition, biochar amendment enhances substrate total phosphorus, total potassium, and total carbon by 13%, 12%, and 31%, respectively (Figure 1). The improved substrate physicochemical properties enhance plant growth and alleviate plant drought stresses on green infrastructure. The enhanced substrate properties and plant performance together improve the hydrological performance of green infrastructure by reducing discharge volume and improving discharge water quality. In addition, biochar applications strongly increase microbial biomass and diversity, while mitigating N<sub>2</sub>O and CO<sub>2</sub> emissions. Overall, our findings show that biochar additions have a great potential to improve ecosystem services on green infrastructure and enhance long-term urban sustainability, providing incentives for biochar applications on existing and future green infrastructure. This study investigates the effects of biochar applications on green infrastructure and contributes to mitigating environmental problems resulting from climate change and urbanization.

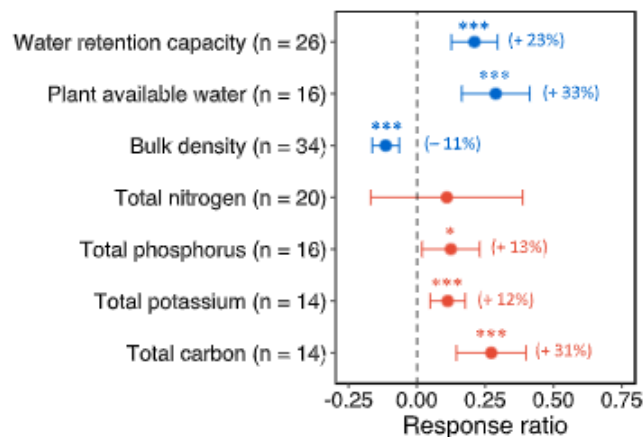


Figure 1 – Substrate property responses to biochar applications on green infrastructure