Exploring cover crop phenotype-ecosystem function relationships for enhancing soil health

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Cover crops, plants grown during fallow periods between cash crops, are a promising solution to mitigating soil degradation induced by conventional agricultural practices and improving soil health. Cover crops can provide several beneficial ecosystem functions, such as soil structure remediation, soil microbial diversification, and nutrient recycling, depending on the plant species. Interactions between plant roots and the surrounding soil are key to the plant's ability to perform their ecosystem functions. The lack of data on cover crop roots inhibits our understanding of cover crop phenotype-ecosystem function relationships. We combine aboveground and belowground phenotyping measurements with physicochemical soil measurements to evaluate the field performance of 19 different plant species in monocultures and polycultures as winter cover crops in Missouri. Canopy cover imaging reveals significant differences in winter hardiness and weed suppression among cover crop varieties. Root biomass and root length density measured at depths up to 1 meter indicate differences in rooting behavior between cultivars suggesting the ability to breed cover crop varieties with improved root system architecture. I will also highlight our collaborative efforts utilizing remote sensing technologies (aerial RGB and hyperspectral imaging) to model carbon and nitrogen cycling in cover crop systems at a field scale. Finally, we have begun to characterize 3D root system architecture traits at the seedling stage using a gel-imaging system. Better understanding of cover crop rooting behavior will allow us to breed varieties with enhanced performance of beneficial ecosystem functions for sustainable agricultural systems.