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Impact of phosphorus application on the indigenous arbuscular mycorrhizal fungi, soybean growth and yield in a 5-year phosphorus-unfertilized crop rotation

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Abstract

Arbuscular mycorrhizal fungi (AMF) are particular soil fungi that benefit many crops and require a symbiosis with plant roots to survive. In our previous study, there was a positive correlation between AMF root colonization and soybean grain yield in a four-year consecutive winter cover crop-soybean rotational system without phosphorus fertilizer. It is suggested that higher AMF root colonization can be a better solution for improving soybean growth and grain yield in P-limited soil. Our purpose in this study was to test the hypothesis that a P application is the main factor improving soybean growth, P nutrition and grain yield, and the benefit from AMF to soybean P uptake and growth in a P-limited soil. Impact of a P application on AMF root colonization and communities in soybean roots and their potential contribution to soybean growth and P nutrition under a five-year P-unfertilized crop rotational system were investigated over two-years. In this study, four cover crop treatments included 1) wheat (*Triticum aestivum*); 2) red clover (*Trifolium pratense*); 3) rapeseed (*Brassica napus*); and 4) fallow in the crop rotation. The amount of triple superphosphate as a P fertilizer applied rate after cultivation of cover crops was 120 and 360 kg ha^{-1} in 2014 and 2015, respectively. Soybean roots were sampled at full-flowering and analyzed for AMF communities using polymerase chain reaction-denaturing gradient gel electrophoresis (PCR-DGGE) and quantitative real-time PCR (qPCR) techniques. The AMF root colonization in the soybean roots at full bloom stage was significantly influenced by cover crop and P application throughout the two-year rotation. The two-year rotation of different cover crops or fallow impacted the molecular diversity of AMF communities colonizing roots of soybean. Redundancy analysis (RDA) indicated that AMF communities colonizing roots of soybean were significantly different among cover crop rotations. The AMF communities colonizing roots of soybean were clearly influenced by a P application in the two-year trial. Moreover, a P application may have positively impacts on the AMF communities under P-deficit soil due to the continuous cover crop-soybean rotational system without a P fertilizer.

Keywords: Arbuscular mycorrhizal fungi, Cover crops, Crop rotation, Phosphorus application, Soybean

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