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Impacts of phosphorus fertilizer on the canola (Brassica napus) root and rhizosphere microbiomes

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Abstract

As an important source of food-grade and industrial oil, canola (B. napus) plants have high phosphorus (P) demand, but the small seeds are susceptible to P fertilizer toxicity. Optimizing P fertilizer management for canola could be aided by a better understanding of microbial community dynamics under different fertilizer application strategies. We conducted a 2-year field experiment at Scott, SK, Canada, supplying seed-placed P fertilizer at three rates (0, 35 and 65 lb P2O5 ac1) with either 1- or 4-inch openers. Bulk soil, rhizosphere soil and roots were collected at vegetative and peak-flowering stages, with bacterial and fungal microbiomes characterized by amplicon-based DNA profiling.

High-rate P fertilizer only minimally contributed to better yield and biomass, however, plant density was largely reduced at early growth stage, suggesting early season P toxicity. Phosphorus had little effect on alpha-diversity of all samples, while root microbial community structures were impacted by year-to-year variation and plant growth stage, together explaining 23% of the variance in bacterial and 16% in fungal community structures, with a minor impact from P fertilizer. Members of the Gammaproteobacteria and Dothideomycetes classes were most P-responsive bacteria and fungi. Redundancy analysis revealed that soil total P was strongly correlated with root bacterial community structure, and plant biomass was highly correlated with the root fungal community structure at peak-flowering. Under our field conditions, the impacts of P fertilizer on canola root microbiomes were realized through subtle but significant changes in specific P-responsive taxa with minimal changes to the overall bacterial and fungal communities.