Crop type determines how root system architecture and microbial diversity indices relate in different phosphate fertilization conditions

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Synthetic phosphate fertilizers are frequently used in agriculture; however, their overuse can increase production costs and cause negative environment impacts. Soil phosphorus (P) availability can be increased by the contribution of the rhizosphere microbiota associated with the plant root system. This work aimed to generate and validate a more robust method of identifying root system architecture traits from maize and sorghum plants grown under different phosphate fertilization conditions and associate them with microbial genetic diversity indices and grain yield. Four commercial genotypes of maize and four of sorghum were cultivated for two seasons under seven treatments, no addition of P fertilizer, rock phosphate (Itafós and OCP) and triple superphosphate with 50 and 100 kg P_2O_5 ha^{-1}. During flowering time, the root system was collected according to the Shovelomics method, analyzed by the modified Digital Imaging of Root Traits (DIRT) system and the bacterial genetic diversity indices were calculated. Modifications in the image pre-processing step made the analyses via the DIRT platform less error-prone. A decision tree was trained and a simpler and more understandable classifier was defined, based on only two root traits (area and solidity), which was more effective than the original methodology. The type of crop followed by the genotype and fertilizer were the main factors that affected the root system, grain yield, genetic diversity and abundance of microorganisms. The most productive genotypes had higher root angle and area, increasing foraging on the soil surface and P acquisition. The combined use of less reactive sources, that couldn't be more soluble over time by the physicochemical processes and soil microbiota activity, together with more efficient genotypes could reduce the amount of soluble phosphate fertilizers applied annually to crops.