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Do diverse mixtures of cover crop residues alter the soil microbial community and increase soil function?

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Cover crops are a contemporary tool to sustainably manage agricultural soils by boosting fertility, suppressing weeds and disease, and benefiting cash crop yields, thus securing future food supply. Due to the different chemical composition of crop residues from different plant families, we hypothesised that a mixture of cover crop residues may have a greater potential to improve soil health than the sum of the parts. Our experiment focused on the impact of four cover crops (clover, sunflower, radish and buckwheat) and their quaternary mixture on soil respiration and the soil microbial community in an 84-day microcosm experiment. On average adding cover crop residues significantly ($P < 0.001$) increased soil respiration from 29 to 343 μg C g^{-1} h^{-1} and microbial biomass from 18 to 60 μg C g^{-1}, compared to the unamended control during 84 days' incubation. Cover crop addition resulted in a significant ($P < 0.001$) alteration of the soil microbial community structure compared to that of the control. The quaternary mixture of cover crop residues significantly ($P = 0.011$) increased soil respiration rate by 23.79 μg C g^{-1} h^{-1} during the period 30 to 84 days after residue incorporation, compared to the average of the four individual residues. However, no significant difference in the size of the microbial biomass was found between the mixture and the average of the four individuals, indicating the mixture may invest resources which transit dormant microbial species into a metabolically active state and thus boost microbial respiration. Analysis of similarity of microbial community composition (ANOSIM) demonstrated the mixture significantly ($P = 0.001$) shifted microbial community structure away from buckwheat ($R = 0.847$), clover ($R = 0.688$), radish ($R = 0.285$) and sunflower ($R = 0.785$), respectively. This implies cover crop residues provide a niche specialization and differentiation on a selection of microbial communities that favour certain plant compounds. While applying cover crop residues has positive impacts on soil function, we found that applying a mixture of cover crop residues may provide greater potential to select for microorganisms or activate dormant microbial species which result in higher soil function. The outcome of this study will help seed suppliers to design, and farmers to select, novel cover crop mixtures which enhance soil function synergistically, leading to a greater potential to sustainably improve soil health.