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Differential magnitude of rhizosphere effects on soil aggregation at three stages of subtropical secondary forest successions

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Roots and their rhizosphere considerably influence soil structure by regulating soil aggregate formation and stabilization. However, what factors regulate the magnitude of rhizosphere effects remain largely unexplored. In this study, effects of roots and their rhizosphere on soil aggregation in two subtropical secondary forest successions were examined by separating soils into rhizosphere and bulk soils. Soil aggregate mean weight diameter (MWD), soil organic carbon (SOC), soil nutrients, and fine-root traits were simultaneously measured. Soil aggregate MWD increased significantly in the bulk soils along secondary forest successions, but did not differ in the rhizosphere soils. Rhizosphere effects on soil aggregate MWD (i.e. root-induced differences between the rhizosphere and bulk soils) were thus significantly higher at the early-successional stage of subtropical forest with low soil fertility than those at the late stages with high fertility. Rhizosphere significantly increased SOC, soil total nitrogen (TN), and CEC throughout the entire secondary forest succession, which was non-linearly correlated with soil aggregate MWD. Principal components regression analysis showed that SOC was the primary abiotic factor and positively correlated with soil aggregate MWD. As for biotic factors, fine-root length density and N concentration were two important root traits having significant effects on soil aggregate stability. An improved conceptual framework was developed to advance our understanding of soil aggregation and rhizosphere effects, highlighting the roles of soil fertility (i.e. SOC and available nutrients), root traits, and forest age in driving soil aggregation.