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Phosphorus applications improved the soil microbial responses under nitrogen additions in Chinese fir plantations of subtropical China

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Nitrogen (N) deposition and low soil phosphorus (P) content aggravate the P limitation in subtropical forest soils. However, the responses of soil microbial communities, enzyme kinetics, and N cycling genes to P additions in subtropical plantations are still not clear. The hypothesis that P application can alleviate the limitation and improve the soil microbial properties was tested by long term field experiment in the Chinese fir plantations in subtropical China. Thirty 20m×20m plots were established in November 2011 and six different treatments were randomly distributed with five replicates. The treatments are control (CK, no N and P application), low N addition (N1: 50 kg N ha-1 yr-1), high N addition (N2: 100 kg N ha-1 yr-1), P addition (P: 50 kg P ha-1 yr-1), low N and P addition (N1P: 50 kg N ha-1 yr-1 and 50 kg P ha-1 yr-1) and high N and P addition (N2P: 100 kg N ha-1 yr-1 and 50 kg P ha-1 yr-1). A suite of responses of soil microorganism across four years (2012-2015) during three seasons (spring, summer and autumn) were measured. Following 4 years of N amendments, fertilized soils were more acidic and had lower soil microbial biomass carbon contents than CK. However, P alleviated the soil acidification and increased the soil microbial biomass carbon contents. Increases in microbial PLFA biomarkers and exoenzyme kinetics in N fertilized plots were observed in the initial year (2013) but reduced since then (2014 and 2015). Whereas P amendments increased the soil PLFA biomarkers and exoenzyme kinetics through the four years except that the acid phosphatase activities declined after 3 years applications. P applications enhanced the soil N cycling by increases the abundances of nitrifiers (ammonia-oxidizing archea) and denitrifiers (nos Z, norG, and nirK). The bacterial and fungal residue carbons (calculated by amino sugar indicators) were higher under NP fertilizations than the other treatments. Our results suggest that P application could improve the soil microbial properties and increase the soil carbon contents and stability.