Phosphorus addition decreases plant lignin but increases microbial necromass contribution to soil organic carbon in a subalpine forest

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First published: 20 April 2022 https://doi.org/10.1111/gcb.16205

Abstract

Increasing phosphorus (P) inputs induced by anthropogenic activities have increased P availability in soils considerably, with dramatic effects on carbon (C) cycling and storage. However, the underlying mechanisms via which P drives plant and microbial regulation of soil organic C (SOC) formation and stabilization remain unclear, hampering the accurate projection of soil C sequestration under future global change scenarios. Taking the advantage of an 8-year field experiment with increasing P addition levels in a subalpine forest on the eastern Tibetan Plateau, we explored plant C inputs, soil microbial communities, plant and microbial biomarkers, as well as SOC physical and chemical fractions. We found that continuous P addition reduced fine root biomass, but did not affect total SOC content. P addition decreased plant lignin contribution to SOC, primarily from declined vanillyl-type phenols, which was coincided with a reduction in methoxyl/N-alkyl C by 2.1%–5.5%. Despite a decline in lignin decomposition due to suppressed oxidase activity by P addition, the content of lignin-derived compounds decreased because of low C input from fine roots. In contrast, P addition increased microbial (mainly fungal) necromass and its contribution to SOC due to the slower necromass decomposition under reduced N-acquisition enzyme activity. The larger microbial necromass contribution to SOC corresponded with a 9.1%–12.4% increase in carbonyl C abundance. Moreover, P addition had no influence on the slow-cycing mineral-associated organic C pool, and SOC chemical stability indicated by aliphaticity and recalcitrance indices. Overall, P addition in the subalpine forest over 8 years influenced SOC composition through divergent alterations of plant- and microbial-derived C contributions, but did not shape SOC physical and chemical stability. Such findings may aid in accurately forecasting SOC dynamics and their potential feedbacks to climate change with future scenarios of increasing soil P availability in Earth system models.