Enhanced decomposition and nitrogen mineralisation sustain rapid growth of Eucalyptus regnans after wildfire

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Eucalyptus regnans grows rapidly from seed after wildfires, outcompeting other species, thereby forming pure stands of mature forests that rank amongst the world's most carbon-dense. By global standards, these forests grow on infertile soils. It is unclear how E. regnans is able to obtain large amounts nitrogen (N) from these infertile soils to support its rapid growth after fire. We measured carbon (C) and N stored in plant biomass and photosynthetic rates of E. regnans two years after a wildfire and examined whether E. regnans stimulated its own N supply through root-induced increases in microbial decomposition and N mineralisation. We compared microbial biomass, gross N mineralisation rates and soil C in trenched and rooted plots. Photosynthetic rates of E. regnans seedlings were large and comparable to photosynthetic rates observed in fertilised crops. Presence of roots of E. regnans and allied microflora enhanced gross N mineralisation more than five-fold compared to soil without roots present. Soil microbial biomass was more than doubled by root presence. The soil N pulse caused by the fire and N mineralisation rates in the absence of roots were too small to account for the large amount of N stored in E. regnans two years after the fire. Our results suggest that E. regnans facilitated its rapid growth by enhancing microbial activity and N mineralization. This enhanced microbial activity also contributed to a substantial loss of soil C (~62% of carbon gained in plant biomass was concurrently lost from soil). We conclude that at the ecosystem scale, the synergistic effects of plant growth and soil N mineralisation need to be carefully assessed against costs to soil C for forests regenerating after disturbance.