Nutrient availability imbalance modify the relationship between root traits and carbon assimilation at the community level

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Changes in the availability of nitrogen (N) and phosphorus (P) can modify plant species composition, traits, and functional diversity with potential consequences on ecosystem functioning. Previous research on the effect of nutrient imbalances has mostly focused on the response of aboveground traits, while the response of belowground traits and their relationship with carbon fluxes remains relatively underexplored. We measured gross primary production (GPP) using canopy chambers in a Mediterranean tree-grass ecosystem with different levels of N and P availability: i) N addition (N+), ii) N and P addition (NP) and iii) control. In the same locations, we sampled five functional traits (specific leaf area (SLA, cm² g⁻¹), leaf nitrogen content (g g⁻¹), ¹³C isotopic composition (δ¹³C, ‰), specific root length (SRL, cm g⁻¹) and root tissue density (RTD, g cm⁻³) in one individual for each species. We also measured above- and belowground biomass and plant species composition. For each functional trait, we computed community weighted mean values (CWM) to characterize dominant trait values in the community. We used linear mixed models to assess overall differences among treatments and structural equation models to assess indirect effect of plant traits through GPP on biomass. We fit a multigroup structural equation models to evaluate if relationships between traits and fluxes varied among nutrient availability treatments. Our results showed that species composition and below- and aboveground biomass were similar among treatments. We observed lower SLA CWM and higher RTD CWM values in the N+ treatment as compared to control and the NP treatment. The theoretic causal model fit the data well (R² = 0.47, P = 0.156), confirming the indirect effect of traits on biomass. ¹³C isotopic composition was positively related to GPP (P = 0.036), suggesting a positive relationship between water use efficiency and carbon assimilation. There were distinct relationships between root traits and GPP depending on the treatment (P = 0.035 and P = 0.027 for SRL and RTD, respectively). SRL was negatively related to GPP but the magnitude of the relationship varied among treatments, showing a stronger relationship in the N+ (-0.65) and NP (-0.84) treatment than in the control (-0.08). RTD also showed a negative relationship with GPP in the NP treatment (-0.66) and in the control (-0.18), but not in the N+ treatment (0.07) that showed a positive relationship. GPP showed a positive effect of aboveground biomass (0.16, P = 0.044), but no effect on belowground. Overall, our results demonstrate the potential effect of nutrient imbalances on carbon fluxes. Despite being SLA similarly sensitive to nutrient imbalances than root traits, both SRL and RTD showed a significant relationship with GPP, suggesting that root traits could be better indicators of ecosystem functioning.