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Nutrient Controls on Seasonal Dynamics of Root Production in a Water Limited Ecosystem

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The below-ground component of ecosystems is made up of roots, fungi and microbes which all potentially respond to global change factors in different ways and on different timescales. Above- and below- ground systems differ in their function (light harvest or water and nutrient uptake respectively) and below-ground responses cannot always be assumed if only above-ground responses are measured. Nonetheless, many seasonal cycles are inferred from time series of aboveground measurements.

We were interested in how nutrient availability and imbalances in a seasonally water-limited Mediterranean tree-grass systems are affecting root production and phenology, and in comparing those to aboveground productivity. Extra N and P availability may lead to more (due to release from nutrient limitation) or less (due to less need to acquire nutrients) roots, but effects may differ between productivity, turnover, and absolute stocks. In such highly seasonal systems, nutrient effects on roots also interact with seasonal C availability and water-dependent soil properties influencing both nutrient availability and ability to explore soil.

Here we focus on root responses to nutrient treatments (one-off additions of N/NP) from a combination of methods (minirhizotrons, direct soil sampling, ingrowth cores) at both tree- and grass- dominated microsites in the context of a large, heavily instrumented ecosystem-scale experiment (Majadas del Tiétar, Spain). We show that nutrient additions are driving increased root activity in nutrient-addition treatments, particularly in pasture areas, and that root production continues over ‘dormant’ winter months with little above-ground productivity but high water availability and easy to explore soil. The strength (but not trend) of this signal differs between methods, with variable abilities to diagnose and distinguish between root production, root stocks and trade-offs between disturbance and repeatability. We compare this evidence of nutrient-driven root production with both soil fluxes and other microsite-level measurements and site-level trends to understand the implications of this increase in the context of the whole-ecosystem.