Precipitation, rather than temperature drives coordination of multidimensional root traits with ectomycorrhizal fungi in alpine coniferous forests

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Abstract

The interactions between roots and mycorrhizal fungi are critical for our understanding of the multidimensional root economics space. Our knowledge on their relationships comes mainly from arbuscular mycorrhizal (AM) plants, and less is known about how roots are coordinated with ectomycorrhizal (ECM) fungal communities, especially in ECM-dominated alpine forests that are highly sensitive to climate change worldwide.

Here, we investigated the coordination between roots and ECM fungi and their drivers by measuring multiple root traits, ECM fungal composition and environmental factors of 47 coniferous populations across the alpine coniferous forests on the Tibetan Plateau.

Our results reveal two independent fine-root trait dimensions, that is root foraging dimension and root uptake dimension, which are represented by root diameter-specific root length, root tissue density-root N concentration. Importantly, the hyphal exploration type based ECM foraging correlated significantly with both root foraging and root uptake dimension. Further, in the low temperature plateau, it is precipitation-induced changes in soil moisture, soil nutrients and pH that drive the proportion of longer-distance hyphal exploration types to increase with higher root foraging by higher specific root length, and to decrease with higher uptake by higher root N concentration.

Synthesis. The coordination of multidimensional root traits with ECM fungi differs greatly from the well-recognized pattern in AM plants that mycorrhizal fungi connect predominantly with root foraging and that roots and mycorrhizal fungi are temperature sensitive. These findings provide a new insight for our holistic understanding of how roots and mycorrhizal fungi vary collaboratively and hence driving plant community assembly and responses to the changing climate.