Distinct foliar isotopic nitrogen signatures in non-mycorrhizal plants as compared to mycorrhizal plants in varying climatic and soil nutrient conditions

Lauren M Gillespie*[1], Jeanne Dore[1], and Juliana Almario[1]

[1]Laboratoire d'Ecologie Microbienne - UMR 5557 – INRAE, Université Claude Bernard-Lyon I - UCBL (FRANCE), CNRS, VetAgro Sup – France

Résumé

Most plants depend on symbioses with mycorrhizal fungi to obtain nutrients, but certain plants have lost the ability to establish these mycorrhizal symbioses. However, these non-mycorrhizal (NM) plants may have evolved new microbial strategies to acquire nitrogen (N) and phosphorus. Varying N and carbon (C) isotopic signatures in plant foliar tissues can inform us about the type of nutrient uptake pathway exploited by the plant, including microbe-derived nutrients. Indeed, the isotopic fractionation of the nitrogen stable isotope ratio (δ15N) has been found to vary among climate, species, resource availability, and, notably, microbial associations. Recent studies on NM plants suggest the presence of root-associated fungi, phylogenetically distant from mycorrhizal lineages, that functionally replace mycorrhizal fungi, but their contribution to plant N acquisition is still poorly understood. We hypothesized that nutrient acquisition pathways used by NM plants, likely via these "mycorrhizal-like" fungi, are distinct from mycorrhizal plants which leads to deviating isotopic signatures in foliar tissues, a pattern we hypothesize to be more prominent in nutrient-poor soils where these fungal associations are more imperative for plant survival. To test this, we measured the aboveground vegetation N and C isotopic ratios (δ15N and δ13C, respectively) and CN contents of three mycorrhizal families (Asteraceae, Poaceae, and either Geraniaceae or Ranunculaceae) and three NM families (Cyperaceae, Brassicaceae, and Caryophyllaceae) at seven sites in France with varying climate and soil nutrient conditions: three plain sites, one intermediary site, and three alpine sites. The soil beneath each plant was also sampled, pooled by site, and analyzed for the same variables. Results show higher foliar δ15N in NM plants as compared to mycorrhizal plants when all sites were analyzed together. At the site level, this trend was most prominent at the intermediary site Chamrousse for the NM Brassicaceae and Cyperaceae plants, while Brassicaceae plants at the alpine site Galibier had the highest average δ15N enrichment overall. The 15N enrichment found in NM plants lends support that these plants associate with fungal root endophytes that provide the plant access to 15N-enriched organic compounds. Our next steps are to analyze potential correlations between isotopic enrichment and NM root microbiota taxa, notably with the aforementioned mycorrhizal-like fungi, and experimentally test the ability of these fungi to transfer complex organic N to NM plants. This study utilizes isotopic fractionation to discern potential differences in N acquisition pathways of NM plants, but further testing is required to fully elucidate these variations.

*Intervenant

Mots-Clés: Plant nutrition acquisition, isotopic carbon, isotopic nitrogen, non, mycorrhizal plants, nutrient, poor soil, severe climate adaptation, symbiosis