EGU22-3419
https://doi.org/10.5194/egusphere-egu22-3419
EGU General Assembly 2022

The role of root physiological and structural plasticity for carbon allocation in plant-soil systems

Tino Colombi[1] and Arjun Chakrawal[2,3]
[1]Swedish University of Agricultural Sciences (SLU), Department of Soil and Environment, Uppsala, Sweden
[2]Department of Physical Geography, Stockholm University, Stockholm, Sweden
[3]Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden

Plant roots are essential for acquiring water and nutrients from soils and constitute a major input source for soil organic matter. Plants invest a significant proportion of the photosynthetically fixed carbon into the growth and maintenance of their root system. The carbon supplied from the shoot fuels both anabolic (i.e., biosynthesis including root growth) and catabolic (i.e., respiration and fermentation) processes in roots. The partitioning of carbon between anabolic and catabolic processes can be expressed as the carbon use efficiency of roots. Root carbon use efficiency determines how much of the total carbon allocated to roots remains in the plant-soil system in the form of root biomass and how much carbon is lost via catabolic pathways. Hence, the carbon use efficiency of roots plays a pivotal yet underexplored role for root growth and associated ecosystem functions such as primary production and carbon sequestration. Here, we present a conceptual framework to assess carbon allocation patterns in plant-soil systems that explicitly accounts for the interactions among root physiology, root trait plasticity, whole plant growth, and soil conditions. Using our framework, we illustrate how soil conditions such as soil aeration, soil moisture, and soil strength interfere with root carbon use efficiency and carbon allocation patterns between different plant organs. We show how edaphic stress and the resulting decrease in root carbon use efficiency may limit root growth, thereby reducing whole plant productivity and inputs of organic matter to soil. Moreover, we provide theoretical and experimental evidence that the plasticity of root structural traits such as cortical cell size and cortical cell number enables plants to maintain their growth upon decreased carbon use efficiency of roots. This suggests that root trait plasticity is a key mechanism that allows plants to adjust to edaphic stress and heterogenous soil environemnts. We, therefore, propose that the framework presented here may provide new insights into the complex interactions between root physiology, soil (micro-)environments, and associated soil functions.