# Shift of belowground traits during perennial grain growth phase in annual grains crop rotation

Olivier Duchene, Florian Celette, Ana Barreiro, Linda-Maria Dimitrova Mårtensson, Grégoire T. Freschet, Christophe David

# SHIFT OF BELOWGROUND TRAITS DURING PERENNIAL GRAIN GROWTH PHASE IN ANNUAL GRAINS CROP ROTATION

*Olivier Duchene[1], Florian Celette[1], Ana Barreiro[2], Linda-Maria Dimitrova Mårtensson[2], Grégoire T. Freschet[3], Christophe David[1]*

[1] ISARA, Agroecology and Environment Research Unit, 23 Rue Jean Baldassini, 69364, Lyon cedex 07, France. olduchene@isara.fr
[2] Swedish University of Agricultural Sciences, Department of Biosystems and Technology P.O. Box 103, SE-230 53 Alnarp, Sweden
[3] Station d'Ecologie Théorique et Expérimentale, CNRS, Université Toulouse III, 2 route du CNRS, 09200 Moulis, France

A range of 'agroecological practices' are currently proposed to increase the sustainability of intensive grain systems. However, little attention has been paid to the use of perennial grains in the crop successions. The use of the perennial grain 'intermediate wheatgrass' (Thinopyrum intermedium (Host) Barkworth & D.R. Dewey) may have the potential to sustain soil fertility through the development of an extensive root system beneficial to a range of soil functions. In the context of cereal grain crop rotation, we compared young stands of intermediate wheatgrass to annual grains during two growing seasons, with the aim to determine how the rooting system of a perennial crop differs from an annual crop along a 1.6 m deep soil profile.

Our results indicate that the two-year-old intermediate wheatgrass promotes denser and deeper rooting systems with proportionally higher root distribution and biomass downward the soil profile. In the first growing season, higher root biomass was observed under the perennial grain than under the annual wheat at 0-10 cm depth. In 12 months, between the first and second spring growing seasons, perennial belowground biomass increased by 111%. Consequently, root biomass was larger under the perennial treatment at each soil layer, leading to 5.3 average more tons of roots (dry weight) per hectare compared to the annual grain at the same time. Looking at the root to shoot ratio, perennial roots represented 38.6% of the aerial biomass produced during the first growing season, compared with 24.4% for the annual grain; while reaching 55.3% the second year, compared to 22.9% for the annual grain. Higher level of soil colonization were also observed under the perennial grain between 10 and 160 cm depth, including greater evenness of the roots vertical distribution and improved soil structure between 10 and 20 cm. From the first growing season, the perennial grain also harbors a suite of root traits (specific root length, root diameter, root tissue density) typical of a more resource-conservative strategy, and more belowground-oriented resource allocation. Additionally, soil fungal biomass indicators, including those of arbuscular mycorrhizal fungi, were enhanced under perennial grain, which potentially show improved soil quality under such management.

Overall, this study brings evidence that grain agriculture would benefit from the possibility to rely on deeper and long-lived root systems to manage soils. The periodic use of a perennial phase in the crop rotation has the potential to improve soil functioning in the long term, while allowing both forage and grain production.

**Keywords:** *perennial grains, rooting system, root traits, soil microbial indicators, soil quality*