Geophysical Research Abstracts
Vol. 20, EGU2018-15458-1, 2018
EGU General Assembly 2018

The rhizosphere size and shape: Temporal dynamics and spatial stationarity

Yakov Kuzyakov and Bahar Razavi
RUDN University, Moscow, Russia

Soil volume affected by roots – the rhizosphere – is the most important microbial hotspot determining the processes, dynamics and cycling of carbon (C), nutrients and water in terrestrial ecosystems. For better understanding of the rhizosphere, the visualization is necessary. Visualization of some properties and processes in the rhizosphere is possible, but quantitative conclusions are very uncertain because: 1) the continuum of properties between the root surface and root-free soil – so, there is no clear borders, 2) differences in the distributions of various properties (C, nutrients, pH, enzyme and microbial biomass activities, gases etc.) across and along roots, 3) temporal changes of properties and processes with root grow and ageing, with water and C flows.
Based on literature data obtained by destructive approaches (thin layer slicing), rhizotrons and in situ techniques: optodes, zymography, sensitive gels, 14C and neutron imaging, we calculated the rhizosphere size and gradients of a broad range of physico-chemical and biological properties: pH, CO_2, O_2, redox potential, water content, various nutrients (C, N, P, K, Ca2+, Mg2+, Mn and Fe), organic compounds (glucose, carboxylic acids, amino acids), activities of enzymes of C, N, P and S cycles.
The rhizosphere size for the most properties assessed by non-destructive visualization techniques extends for 1 - 3 mm but was more than 20 mm for gases (CO_2 and O_2). The shape of the rhizosphere gradients of all properties corresponded to sigmoidal or diffusion curves. All destructive approaches showed much (3-5 times) larger rhizosphere size. Despite the very short rhizosphere size for phosphate, the phosphatase activity had the largest extent compared to all enzymes.
Effects of duration of root occupation of soil, root morphology, soil properties, and environmental conditions on the rhizosphere size and gradients were analyzed. Sharp gradients were formed within few days for nutrients and enzymes, but more days or even weeks were necessary for establishment of specific microbial communities. Despite very high dynamics of most properties, their stationarity is reached within few days because the release or uptake of C, enzymes, water, nutrients by roots, are compensated very fast by utilization by surrounding microorganisms or/and sorption/desorption processes. The seldom disbalance leads to accumulation of the ballast elements around the roots and formation of root carapaces (e.g. rhizoliths, Fe plaque) ranging up to few cm. We conclude that despite very intensive process dynamics in the rhizosphere, its size and shape remains stationary but specific for individual properties.