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Plant inter-species effects on rhizosphere priming of soil organic matter decomposition

Johanna Pausch (1), Biao Zhu (2), and Weixin Cheng (2)

(1) Soil Science of Temperate Ecosystems, University of Göttingen, Büsgenweg 2, 37077 Göttingen, Germany, (2) Department of Environmental Studies, University of California, Santa Cruz, CA 95064, USA

Living roots and their rhizodeposits can stimulate microbial activity and soil organic matter (SOM) decomposition up to several folds. This so-called rhizosphere priming effect (RPE) varies widely among plant species possibly due to species-specific differences in the quality and quantity of rhizodeposits and other root functions. However, whether the RPE is influenced by plant inter-species interactions remains largely unexplored, even though these interactions can fundamentally shape plant functions such as carbon allocation and nutrient uptake.
In a 60-day greenhouse experiment, we continuously labeled monocultures and mixtures of sunflower, soybean and wheat with 13C-depleted CO_2 and partitioned total CO_2 efflux released from soil at two stages of plant development for SOM- and root-derived CO_2. The RPE was calculated as the difference in SOM-derived CO_2 between the planted and the unplanted soil, and was compared among the monocultures and mixtures.
We found that the RPE was positive under all plants, ranging from 43% to 136% increase above the unplanted control. There were no significant differences in RPE at the vegetative stage. At the flowering stage however, the RPE in the soybean-wheat mixture was significantly higher than those in the sunflower monoculture, the sunflower-wheat mixture, and the sunflower-soybean mixture. These results indicated that the influence of plant inter-specific interactions on the RPE is case-specific and phenology-dependent. To evaluate the intensity of inter-specific effects on priming, we calculated an expected RPE for the mixtures based on the RPE of the monocultures weighted by their root biomass and compared it to the measured RPE under mixtures. At flowering, the measured RPE was significantly lower for the sunflower-wheat mixture than what can be expected from their monocultures, suggesting that RPE was significantly reduced by the inter-species effects of sunflower and wheat. In summary, our results clearly demonstrated that inter-species interactions can significantly modify rhizosphere priming on SOM decomposition.