Geophysical Research Abstracts
Vol. 21, EGU2019-4526, 2019
EGU General Assembly 2019

Interaction between root hairs and soil P controls the root-priming of soil organic matter decomposition

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The “root priming effect” (RPE) is defined as a rate change in soil organic matter (SOM) decomposition due to the presence of living roots. A positive RPE may be due to labile root C stimulating soil microbial communities to decompose SOM in order to acquire C-bonded nutrients. Root hairs were hypothesized to play an important role in releasing labile root C and amplifying RPE. Therefore, it was counter-intuitive that a mutant barley (Hordeum vulgare L.) strain lacking root hairs was recently shown to produce a higher RPE than wild-type barley. On the other hand, mutant barley associates with substantially more arbuscular mycorrhizal fungi (AMF), and these are major conduits for the transfer of plant C to soil microbes. It is therefore understandable that a higher RPE could be observed in the mutant barley strain. Given that P fertilization generally reduces AMF colonization, we predicted that phosphate addition to soil would reduce RPE of the mutant barley but not that of the wild-type. Our study included narrowleaf plantain (Plantago lanceolata L.), which shares root traits of both mutant and wild-type barley. An agricultural soil, previously cultivated with barley, was transferred into 36 pots and planted. A ring was inserted (2 cm depth) into the middle of each pot, and seeds were planted in soil outside of the ring. Pots were placed in a growth chamber and continuously supplied with 13C-depleted air. The resulting plant biomass had a delta 13C value approximately 34 ‰ more 13C-deplete than SOM. After 3, 4 and 5 weeks, pots were sampled for the flux and delta 13C value of soil CO_2. Using equivalent data from control pots without plants, we compared the expected vs. observed contributions of CO_2 from roots and SOM to calculate RPE. Each plant-type exerted a positive RPE, with both barley lines having significantly higher RPE than plantain. We also found a weak interaction between plant-type and P on RPE. Orthogonal contrasts revealed significantly higher RPE for mutant barley under high-P than under low-P conditions, but no effect of P in the other plant-types. As this result is opposite to our prediction, we discuss alternative mechanisms.