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Sulfur isotope mass balance reveals $^{32}S/^{34}S$ fractionation during sulfate uptake and translocation in rice

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Four stable isotopes of sulfur exist (^{32}S, ^{33}S, ^{34}S, ^{36}S) whose natural isotopic percentage abundances are 0.94499, 0.0075, 0.0425 and 0.0001 atom fraction, respectively. The most abundant isotopes – ^{32}S and ^{34}S – are now commonly measured using elemental analyzers coupled with isotope ratio mass spectrometers (EA-IRMS). Such an approach is based on the complete transformation of total S to SO_2, which is subsequently analyzed by the mass spectrometer with regards to masses 64 ($^{32}S^{16}O_2$) and 66 ($^{35}S^{16}O_2$or $^{32}S^{16}O^{18}O$) atomic mass units. S stable isotopes have been used to trace the movements of the related compounds in plants, in testing S flux models, and in identifying and determining the impact of natural and anthropogenic S sources on the environment. However, the isotope technique applied for S metabolism investigations, as well as for sulfate transport and allocation within the plants, is limited by our current knowledge of the potential $^{32}S/^{34}S$ isotope discrimination that may occur during both S metabolism and sulfate transport.

The relative ^{34}S abundance is traditionally quantified using the δ value:$\delta\,^{34}S = (R_{sample} - R_{standard})/R_{standard}$, were R is $^{34}S/^{32}S$ isotope ratio.

The $\delta\,^{34}S$ signature of the total biomass produced by a plant generally reflects that of the available sulfate in the soil solution, thus suggesting the fractionation against ^{34}S during sulfate acquisition negligible. However, a careful analysis of rice plant organs revealed that the $\delta\,^{34}S\text{-}SO_4^{2-}$was higher in the shoot than in the root, indicating that fractionation occurs during sulfate uptake, allocation and metabolism.

Now we are approaching the topic of $^{32}S/^{34}S$ fractionation in rice by investigating the hypothesis that the $\delta\,^{34}S\text{-}SO_4^{2-}$of the leaves could be determined by the activities of the sulfate transporters involved in sulfate uptake, as well as in root-to-shoot sulfate translocation. The experimental approach will be mainly based on the comparison of the effects of different growing conditions – known to modulate sulfate uptake and/or translocation – on the $\delta\,^{34}S$ signature of the sulfate ions in the leaves. Results will be related to the relative transcript levels of the sulfate transporter genes involved in sulfate uptake and translocation, in order to obtain a comprehensive picture of the $^{32}S/^{34}S$ isotope effects occurring during sulfate distribution within the plant.