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Shading controls rhizosphere respiration and priming effect

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Rhizosphere respiration (RR) is a significant component of soil respiration, and rhizosphere priming effect (RPE) is crucial for regulating soil carbon cycling. However, the responses of rhizosphere respiration and priming effect to aboveground processes (such as light availability and photosynthesis rate) are not fully resolved.

In this study, we investigated RR and RPE of two species (Glycine max (soybean) and Helianthus annuus (sunflower)) using a non-destructive, continuous isotope-labeling technique. The two species were subjected to five intensities of shading by shade cloth, which created five levels of light availability – 0%, 15%, 59%, 76%, and 100% of full light (507 μmol/m2/s at canopy level) in the growth chamber. Plants were maintained at full light from seeding for 45 (soybean) or 59 (sunflower) days, and switched to shading treatments for four days, and then destructively harvested. Soil respiration was partitioned into root-derived CO_2 (RR) and soil-derived CO_2 by the isotopic method during the last five days (day 1, full light; day 2-5, shading). RPE was calculated as the difference in soil-derived CO_2 between planted and unplanted pots.

We found that during the first day of shading, soybean RR was not responsive to shading. During the next three days of shading, however, we found a positive relationship between RR and light availability. Similarly, during all four days of shading, sunflower RR showed a significant positive relationship with light availability. Moreover, both plants showed positive RPE (soybean 98%, sunflower 44%) at full light (day 1), but with increasing time and intensity of shading, the RPE declined and even became negative (up to –29% for soybean and –29% for sunflower). Indeed, a positive relationship between light intensity and RPE was observed in both species, particularly at the end of shading treatment. Overall, our results showed that shading, by influencing light availability and presumably photosynthesis rate, exerts a significant control of rhizosphere respiration rate and priming effect of the two species.