Legume adaptation to sulfur deficiency revealed by comparing nutrient allocation and seed traits in Medicago truncatula

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Résumé en anglais	Reductions in sulfur dioxide emissions and the use of sulfur-free mineral fertilizers are decreasing soil sulfur levels and threaten the adequate fertilization of most crops. To provide knowledge regarding legume adaptation to sulfur restriction, we subjected Medicago truncatula, a model legume species, to sulfur deficiency at various developmental stages, and compared the yield, nutrient allocation and seed traits. This comparative analysis revealed that sulfur deficiency at the mid-vegetative stage decreased yield and altered the allocation of nitrogen and carbon to seeds, leading to reduced levels of major oligosaccharides in mature seeds, whose germination was dramatically affected. In contrast, during the reproductive period, sulfur deficiency had little influence on yield and nutrient allocation, but the seeds germinated slowly and were characterized by low levels of a biotinylated protein, a putative indicator of germination vigor that has not been previously related to sulfur nutrition. Significantly, plants deprived of sulfur at an intermediary stage (flowering) adapted well by remobilizing nutrients from source organs to seeds, ensuring adequate quantities of carbon and nitrogen in seeds. This efficient remobilization of photosynthates may be explained by vacuolar sulfate efflux to maintain leaf metabolism throughout reproductive growth, as suggested by transcript and metabolite profiling. The seeds from these plants, deprived of sulfur at the floral transition, contained normal levels of major oligosaccharides but their germination was delayed, consistent with low levels of sucrose and the glycolytic enzymes required to restart seed metabolism during imbibition. Overall, our findings provide an integrative view of the legume response to sulfur deficiency.
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