Phytoliths, agriculture and environmental stress

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Résumé

Recent studies have suggested that land use and particularly agriculture can modify the Si cycle through depletion of soil available Si. The extent of the perturbation, yet, is not known although it may be a critical factor for maintaining high yields of crops that are Si accumulators i.e. most of the cereals. Albeit generally not considered as an essential element, Si is used as a fertilizer in a few countries including Japan, China, South America and USA (Florida), essentially to overcome the depletion of the bioavailable Si in rice cultivation. The beneficial effects of Si have been demonstrated by many studies using pots, hydroponic and field experiments and are particularly remarkable in plants exposed to biotic or abiotic stresses such as drought. Si in the plants is mostly composed by dissolved Si in the xylem and by phytoliths in the cells and cell walls. How phytoliths may help the plants to mitigate environmental stress is still poorly documented. In order to determine if plant develop specific phytolith distribution under drought stress, we conducted hydroponic experiments using PEG-6000 for simulating water stress at the root level. Durum wheat (Triticum durum) was used because of its common occurrence under dry climate. In addition to morphological plant measurements and analysis of Si concentration in plant parts, we analysed phytolith morphotypes under the microscope after a wet extraction/acid digestion, and using in situ analysis of phytoliths in leaves by X-ray imaging, i.e. combining 2D chemical mapping by micro X-ray fluorescence spectroscopy (micro-XRF) and 3D imaging by X-ray micro-computed tomography (micro CT). Si application in the nutrient solution provides some evidence that Si mitigates the effect of water stress by improving shoot and root development and water uptake and retention in the leaves of *Triticum durum*, in agreement with previous studies. PEG affects the concentration of Si in the shoots and its distribution in the epidermal cells, notably by limiting the formation of silicified trichomes. The mitigating effect of Si is attributed to the reinforcement of the structure of leaves through preferential phytolith accumulation above the veins. The development of silicified trichomes in durum wheat depends primarily on the availability of Si in soil and is not an adaptation to water stress.

Mots-Clés: phytolith, agriculture, water stress

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