Silica formation in sorghum (Sorghum bicolor) roots

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Silicon oxides are the most abundant mineral group in soils. Therefore, plant roots are always exposed to some silicic acid (Si(OH)4), which is the soluble form of silicates. Monosilicic acid molecules are taken up by roots, carried in the xylem, and subsequently polymerize to silica in varied silicifying target sites. This biogenic silica (SiO2·nH2O) can constitute several percent by dry weight in certain plant taxa. However, the mechanisms of its formation remain mostly unknown. In the roots of sorghum (Sorghum bicolor), silica aggregates form in an orderly pattern along the cell walls of endodermis cells. To investigate the structure and composition of root silica aggregates, we studied their development along roots of hydroponically grown sorghum seedlings. By using Raman micro-spectroscopy, auto-fluorescence, and scanning electron microscopy, we found that putative silica aggregation loci could be identified in roots grown under Si starvation. These micrometer-scale spots were constructed of tightly packed modified lignin and were capable of nucleating trace concentrations of silicic acid. Substantial variation in cell wall auto-fluorescence between roots grown with and without silicic acid demonstrated the impact of silicon on cell wall chemistry. Taken together, this work demonstrates a high degree of control over lignin and silica deposition in cell walls. Such regulation implies an important, yet unknown, function for silicon in plant biology.