



Plant roots can actively regulate hydraulic redistribution by modifying the hydraulic properties of the rhizosphere using exudates

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The phenomenon of hydraulic lift by roots of plants has been observed in many arid and semi-arid regions. The process involves water transfer from moist deep soil zone to shallow and dry layers, typically at night when transpiration is shut off. The widely held explanation is that hydraulic lift receives the strong water potential gradient created during the day when the plants are actively transpiring. However, it is not fully understood whether hydraulic lift is actively controlled by plants or it is a spontaneous response to the occurrence of pressure gradient. Here, we will present modeling study that demonstrates that plant roots can exert significant control on hydraulic redistribution via exudation and formation of rhizosphere. The model is based on results of potted experiments conducted by Nambiar in 1976 (*Plant and Soil*, 44:267-271), which have shown that plants are able to acquire essential micronutrients from very dry soil so long as water is available to the root system in sufficient quantity elsewhere. He also observed that the roots in the water-depleted zones exhibited evidence of substantial root exudation, which suggests that exudates are needed in order to provide moisture for mobilization and diffusion of nutrients in the dry regions. In addition, our own recent model-based research demonstrated that exudates play important role in facilitating water flow in otherwise dry rhizosphere region. Our models show that exudates facilitate the release of hydraulically lifted water to the rhizosphere by ensuring hydraulic continuity between the root walls and the surrounding dry soil. In addition, the high water retention capacity of root exudates permits the hydraulic conductivity to remain elevated even at low potential conditions. The results of this modeling study suggest that hydraulic lift is an actively controlled adaptation mechanism that allows plants to remain active during long dry spells by acquiring nutrients from the dry near surface soils while relying on deep soil moisture reserves for transpiration.