Bioirrigation: a common mycorrhizal network facilitates the water transfer from deep-rooted pigeon pea to shallow-rooted finger millet under drought

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 4522469
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Year 2019
Title Bioirrigation: a common mycorrhizal network facilitates the water transfer from deep-rooted pigeon pea to shallow-rooted finger millet under drought
Journal PLANT AND SOIL
Volume 440
Number 1-2
Pages / **Article-Number** 277-292
Keywords AM fungi; Bioirrigation; Drought; Finger millet; Intercropping; PGPR; Pigeon pea; Water relations
Mesh terms Science & TechnologyLife Sciences & BiomedicineAgronomyPlant SciencesSoil ScienceAgriculturePlant Sciences

Background and aimbHydraulically lifted water can be redistributed to a neighbouring plant, a process referred to as ”bioirrigation”. Facilitation of bioirrigation by beneficial microbes such as arbuscular mycorrhizal (AM) fungi that form a common mycorrhizal network (CMN) between neighbouring plants has often been suggested but is not yet well explored. In this study, we tested if the presence of a CMN can facilitate the transfer of hydraulically lifted water from pigeon pea (PP) to finger millet (FM) and ameliorate thereby thewater relations of the shallow-rooted FM during drought.Methods In a compartmented microcosm set up, PP roots were grown up to the bottom layer of the pot to access the soil moisture. Whereas FM roots were restricted into a shallow compartment, separated through a 21 mu m nylon mesh, without access to the moist bottom layer. We applied deuterium labelled water to the bottom layer of the pot to test if PP can perform hydraulic lift (HL) and if hydraulically lifted water is transferred to FM via a CMN. During the drought period we also assessed the water relations of FM to determine if bioirrigation mediated through a CMN can support the water relations of FM.Results Application of deuterium-enriched water to the moist bottom layer of the microcosms demonstrated the capability of PP to hydraulically lift water to the drier topsoil through an insulation layer of coarse gravel. Only FM plants that were connected to PP via a CMN were able to utilize HL water. As a consequence, FM bioirrigated by PP in the presence of a CMN was able to maintain its water relations during drought conditions and showed higher rates of survival than FM plants in monoculture.Conclusions Connecting the rhizosphere of two intercropping partners with a CMN can improve the water relations of shallow-rooted crops by bioirrigation. This finding has great potential for reducing drought induced crop yield loss in arid and semi-arid tropics.

Publisher SPRINGER
ISSN/ISBN 0032-079X
edoc-URL https://edoc.unibas.ch/73514/
Full Text on edoc No;
Digital Object Identifier DOI 10.1007/s11104-019-04082-1
ISI-Number 000475977600020

Document type (ISI) Article