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"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

Relay intercropping of durum wheat and lentil enhances mycorrhizal functionality, weed control and crop productivity

Gilbert Koskey[1], Federico Leoni[1], Stefano Carlesi[1], Luciano Avio[2], Paolo Barberi[1]

[1] *Sant'Anna School of Advanced Studies, Group of Agroecology, Center of Plant Sciences, Italy*
[2] *University of Pisa, Agriculture, Food and Environment, Italy*

Abstract

Complementary and inter-specific plant-plant associations, like the case of cereal-legume intercrops, drive the recruitment of rhizosphere microbial communities such as the arbuscular mycorrhizal fungi (AMF) important in the provision of ecosystem services that stabilise crop yields and restore soil health. Attempts to assess the impact of intercropping on the functional presence of native AMF communities and their agronomic potential in rain-fed fields remain inconclusive, more so in intercropping systems involving winter-spring crops such as durum wheat and lentils. We carried out a 3-year (2019, 2020, and 2021) field experiment in Central Italy to assess the agronomic performance and mycorrhizal selection of relay intercropped winter durum wheat (*Triticum durum* Desf. cv. Minosse) and spring lentil (*Lens culinaris* Medik. cv. Elsa) under a low-input management system, comparing different crop stand types (monocrop vs intercrop) and intercrop densities (350 plants m^2–100 % wheat dose vs 116 plants m^2–33 % wheat dose). Relay intercropping enhanced lentil grain yield, durum wheat grain protein concentration and P uptake but marginally reduced durum wheat grain yield and lentil grain protein concentration. Both intercropping strategies were effective in controlling weeds and proved beneficial in stabilising the overall yield productivity (LER 164–648 %) compared to sole cropping. Intercropping enhanced soil mycorrhizal activity but differentially influenced mycorrhizal root colonisation compared to sole cropping. Root mycorrhizal analyses via Illumina Miseq sequencing generated a total of 234 amplicon sequence variants belonging to Glomeromycota, which were assigned to 31 virtual taxa using the MaarjAM reference database. Glomeraceae and Claroideoglomeraceae were the most abundant AMF taxa but had contrasting abundances in 2020 and 2021. The overall changes in AMF diversity and community structure were affected by the interaction between crop species and year, and not by intercropping. Claroideoglomus and Septoglomus showed a strong association with lentil roots while Rhizophagus and Paraglomus were associated with durum wheat roots in 2020, affirming a strong host genotype-AMF preference. PCA analysis showed that grain protein concentration was associated with mycorrhizal parameters such as community richness and AMF root colonisation. This study reveals the importance of relay intercropping winter-spring crops in stabilising crop productivity and maintaining soil functionality.

Keywords: AMF community structure, relay intercropping, weed control

Contact Address: Gilbert Koskey, Sant'Anna School of Advanced Studies, Group of Agroecology, Center of Plant Sciences, Piazza martiri della libertà 33, 56127 Pisa, Italy, e-mail: gilbert.koskey@santannapisa.it