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BREEDING FOR MYCORRHIZA FUNGI TO IMPROVE CROPS' NUTRIENT AND WATER USE EFFICIENCY

AT FIRST GLANCE

Mycorrhizal fungi are able to increase plant access to soil resources and to improve plant disease resistance. Selecting genotypes with enhanced positive AMF associations could be a valuable tool to improve crops' nutrient and water use efficiency.

Embedding crop diversity and networking for local high quality food systems

Beneficial microbes for sustainable production

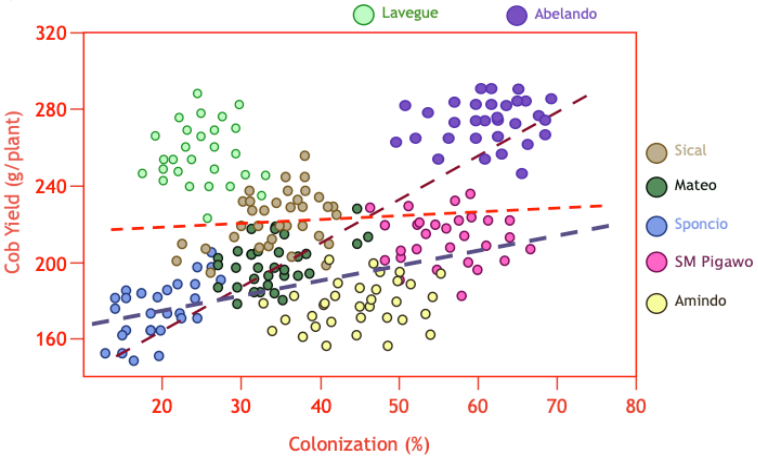
There is a tremendous need to increase productivity and to diversify food systems to face future challenges such as demography and climate change. Intensification based on increasing inputs in agricultural systems is not an option since they are associated with environmental deterioration and biodiversity loss. Thereby, enhancing beneficial mutualistic relationship between crops and functional soil microbial guilds could be a valuable alternative strategy to improve both productivity and resilience of cropping systems.

Plant breeding for efficient Arbuscular Mycorrhizal Fungi (AMF) symbiosis

When colonizing plant roots, Arbuscular Mycorrhizal Fungi (AMF) are able to increase plant access to soil resources, i.e., nutrients and water through an extensive hyphae network. At the same time, AMF can also improve plant disease resistance. The responsiveness of plant species on AMF colonisation is strongly related to plant species/genotypes and it is not always positively related to improved plant performance. Thereby plant breeding for enhanced AMF associations to improved nutrient and/or water use efficiency could be a valuable tool to maintain or improve crop productivity with reduced inputs under a climate-changing environment.

Case Study I: Mycorrhizal colonization is genotype dependent in maize

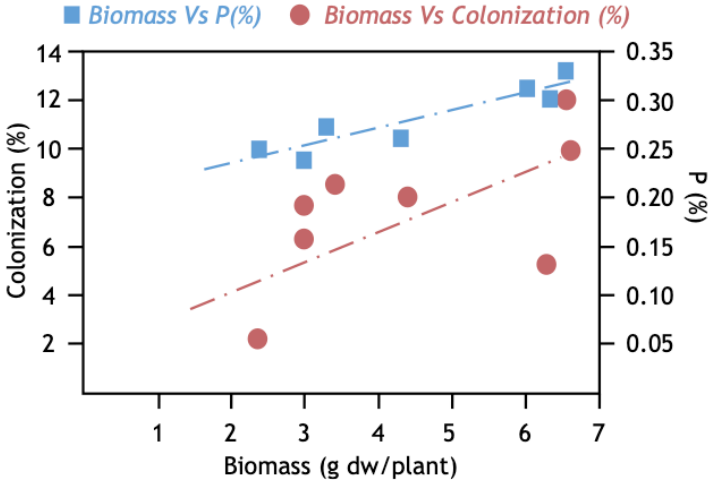
During the DIVERSIFOOD project, the association between AMF colonization and seven different maize landraces have been field evaluated and monitored for three years. AMF colonization significantly varied within landraces and was not always associated with increased plant performance.



Evaluation of individual plants under organic nutrient management schemes and special field selection designs resulted in selections with higher biomass and yield production associated with increased AMF colonization.

Case Study II: Chickpea genotypes performing better to water limitation are exhibiting higher AMF colonization

Two chickpea genotypes were grown with two different water level treatments: normal water conditions and reduced irrigation. The effect of drought conditions on plant biomass and plant nutrient content (nitrogen, phosphorus, and potassium) was assessed. Results show that the biomass of the more drought-stress-tolerant chickpea is positively associated to AMF colonization. This genotype also exhibited substantially higher levels of nutrients.



The way forward

The assessment of AMF presence during a breeding programme could be a valuable tool for the selection of plant genotypes with improved biotic and abiotic stress tolerance. Breeders should have in mind that mycorrhizal colonization as a plant-fungal trait could not be always positively associated with increases in crop yield because it depends to the plant genotype as well as the soil and environmental conditions.

Suggested readings

Turrini A., Giordani T., Avio L., Natali L., Giovannetti M., Cavallini A. (2015) *Large variation in mycorrhizal colonization among wild accessions, cultivars, and inbreds of sunflower (Helianthus annuus L.).* Euphytica DOI 10.1007/s10681-015-1546-5

Omirou M., Fasoula D., I.M. Ioannides (2016) *Bradyrhizobium inoculation alters indigenous AMF community assemblages and interacts positively with AMF inoculum to improve cowpea performance.* Applied Soil Ecology 108: 381-389

Triverdi P., Schenk M.P., Wallenstein D.M., Singh K.B. (2017) *Tiny Microbes, Big Yields: enhancing food crop production with biological solutions* Microbial Biotechnology 10:999-1003

Duhamel M., Vandenkoornhuyse P. *Sustainable agriculture: possible trajectories from mutualistic symbiosis and plant neodomestication*. Trends in Plant Science 18: 597-600

This Innovation Factsheet is the result of the collective work of DIVERSIFOOD partners, coordinated by Michalis Omirou (ARI) with the support of Dionysia Fasoula (ARI), Veronique Chable (INRA) and Frederic Rey (ITAB).