Search for new agronomic techniques for improving seed yield and quality of field crops

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Introduction

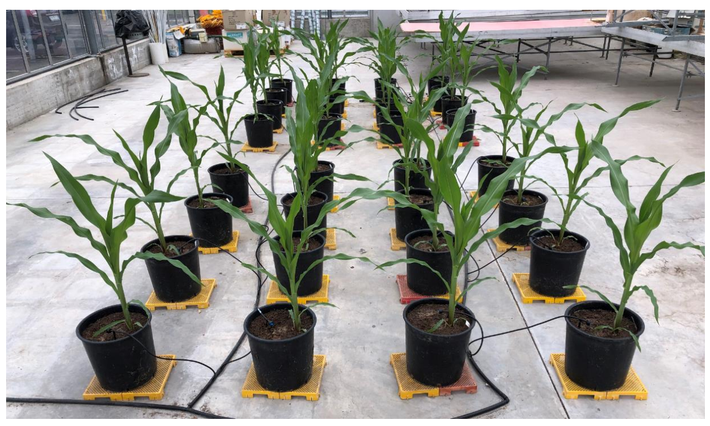
Conventional agriculture is facing increasing criticism from the public opinion both due to the environmental impact of high input production systems and to food safety concerns related to the use of synthetic agrochemicals. Minimizing both issues, while maintaining a high level of crops productivity is a primary objective for the agribusiness companies and for the whole agricultural context.
The seed industry is also touched by this tendency as it faces a decrease in the tools available for controlling the most important field adversities and new challenges generated by a constantly evolving scenario (global warming, resistant pests, environmental policies, market demand, etc…).
The studies about root microbiota as a factor affecting plants growth and health are constantly revealing new aspects about the role that microorganisms play; in this study, potentially useful microorganisms are being tested and their effect on seed crops (primarily maize) is being evaluated, through a series of greenhouse and field trials. During 2019, a dedicated greenhouse trial was conducted in order to test two species of arbuscular mycorrhizal fungi (AMF) and evaluate their potential to colonize maize roots and their effect on plants.

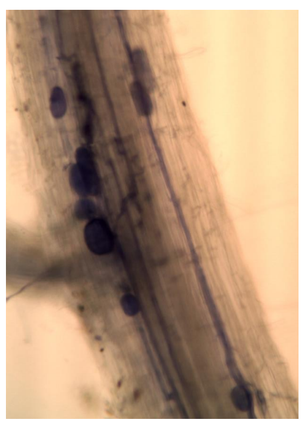
Materials and methods

The trial was conducted in a glass greenhouse located into the Corteva production facility in Sissa (PR), where two sectors of 16 pots each have been defined. Each sector was designed as a randomized complete block design with factorial, with 4 replications.
Funneliformis mossae (FM) and *Rhizophagus intraradices* (RI) have been respectively tested in each sector and compared to a control check. Seed of a well representative maize inbred was considered, both with (c) and without (nc) a commercial fungicide on it.
Sowing was done on March 18th, on a universal topsoil; 3 seed per pot were planted and then only the best plant was kept. In the case of the AMF inoculated pots, an amount of inoculum equivalent to 20 propagules was put right beneath each seed.
During the whole growing cycle, data about plant characteristics and growth stages have been continuously collected, and the following 2 destructive root samplings have been done:

- A preliminary sampling at V8 stage, on just 1 replication, in order to have a first evaluation of fungal root colonization.
- A final sampling at VT/R1 stage, by collecting root samples from all the remaining plants, as well as the whole aerial part of the plant for dry matter determination.

At each sampling time, phenotypical and physiological parameters have been measured on all the plants, before root sampling.
Root samples have then been stained and analyzed at the microscope according to Trouvelot et al. (1986) in order to estimate the mycorrhizal colonization of each plant.

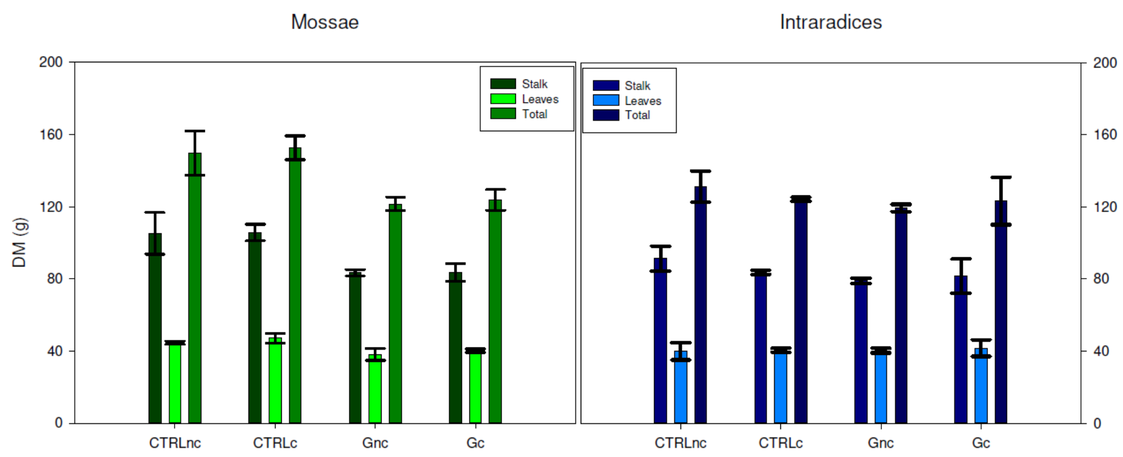




On the left, an overview of the greenhouse experiment. On the right, a microscope image of a root segment with mycorrhizal hyphae and vescicles.

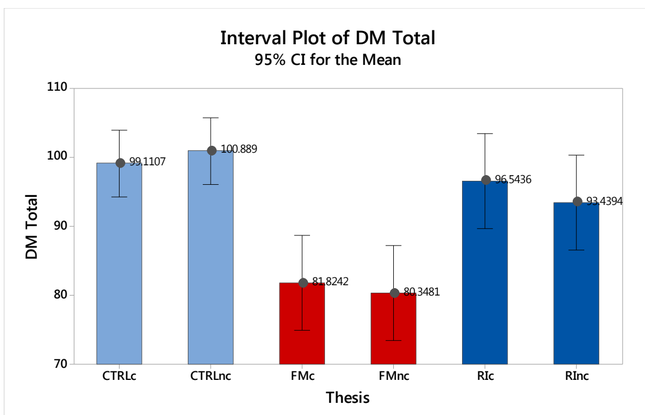
Results

Aerial dry matter by sector and by plant parts:



CTRL: control check **G:** inoculated thesis **nc:** untreated seed **c:** treated seed

Total dry matter by thesis:



Analysis of Variance

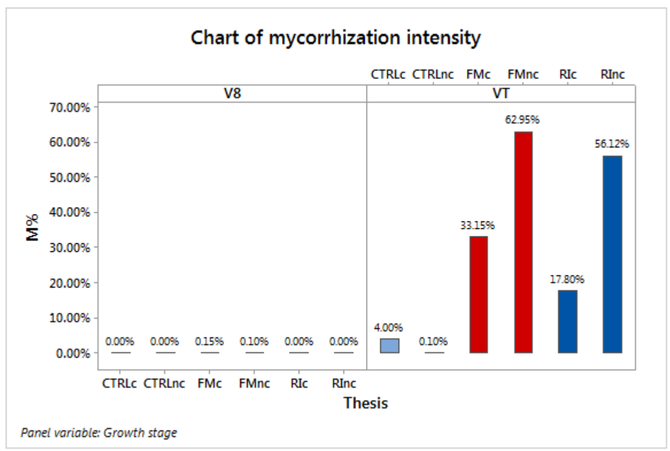
Source	DF	Adj SS	Adj MS	F-Value	P-Value
Thesis	5	1801.2	360.24	8.53	0.000
Error	18	760.5	42.25		
Total	23	2561.7			

Thesis	N	Mean	Grouping		
CTRLnc	6	100.89	A		
CTRLc	6	99.11	A		
RIc	3	96.54	A		
RInc	3	93.439	A	B	
FMc	3	81.82		B	
FMnc	3	80.35		B	

Means that do not share a letter are significantly different.

CTRL: control check **FM:** *F. mossae* **RI**: *R. intraradices* **nc:** untreated seed **c:** treated seed

Root mycorrhization intensity by thesis, at different growth stages:



Test

Null hypothesis	H_0: All medians are equal
Alternative hypothesis	H_1: At least one median is different

Method	DF	H-Value	P-Value
Not adjusted for ties	1	2.56	0.109
Adjusted for ties	1	2.95	0.086

CTRL: control check **FM:** *F. mossae* **RI**: *R. intraradices* **nc:** untreated seed **c:** treated seed

Conclusion

As a conclusion for this preliminary research experience, it's been verified that both the tested AMF species can establish symbiosis with maize plants and develop arbuscles and vescicles. This colonization led to significant effects on plant development, mainly expressed as a reduction in the aerial dry matter production for the inoculated thesis. This effect is particularly strong in the case of the *F. mossae*. An increased tendency to be more subjected to water and nitrogen stress was also observed in the inoculated plants.
It's important to remark that this effect was obtained with potted plants, characterized by a very limited soil resources availability and root space to explore. For this reason, it's not clear at this stage what could be the effect of the same fungus/plant relationship on seed yield and quality at field level and further studies are needed in order to understand these important aspects.

Acknowledgements

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