1.2 - Performances of mycorrhizal tomatoes under water and nutrient stress conditions

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Our work is developed in the frame of the TOMRES European Project, whose purpose is to enhance resilience to combined water and nutrient stress in tomato, as a model crop, with the aim to reduce the environmental impact of agricultural activities. Tomato has been one of the first non-legume models to be used in Arbuscular Mycorrhiza (AM) studies, since it responds to mycorrhizal colonization (1) and native microbiota (2) and it does not establish the Rhizobium symbiosis that occurs in legumes (3), thus permitting to investigate additional clues concerning the non-common symbiotic signaling pathway. Our working hypothesis is that mycorrhization is a beneficial driver for tolerating adverse environmental conditions.

AIM

To assess the performances of the tomato (*Solanum lycopersicum*) commercial genotype M82 when grown in a miniature industrial culture system, with and without a monospecific inoculum of the AM fungus *Funneliformis mosseae* under nutritional and water stress.

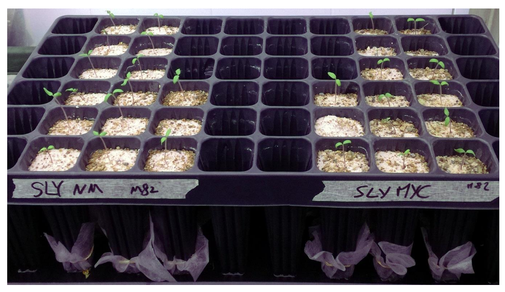
The experimental system: four conditions were set up: well watered non mycorrhizal plants (WW-NM), well watered mycorrhizal plants (WW-MYC), water stressed non mycorrhizal plants (SS-NM) and water stressed mycorrhizal plants (SS-MYC) (Fig. 1).

Well watered non mycorrhizal plants → **WW-NM**

Well watered mycorrhizal plants → **WW-MYC**

Water stressed non mycorrhizal plants → **SS-NM**

Water stressed mycorrhizal plants → **SS-MYC**

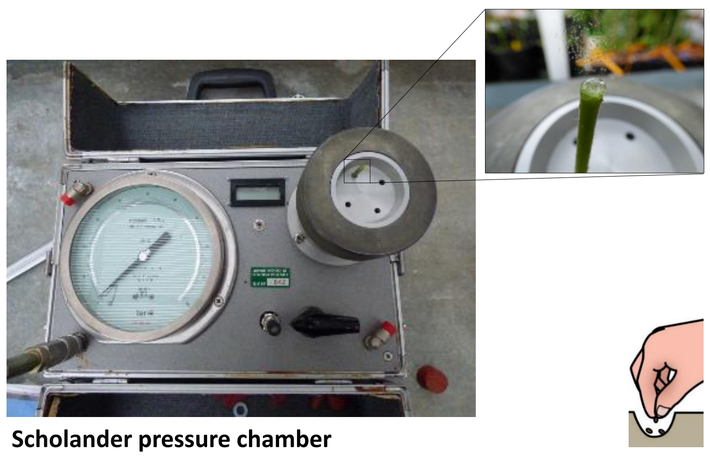


Well Watered (WW)

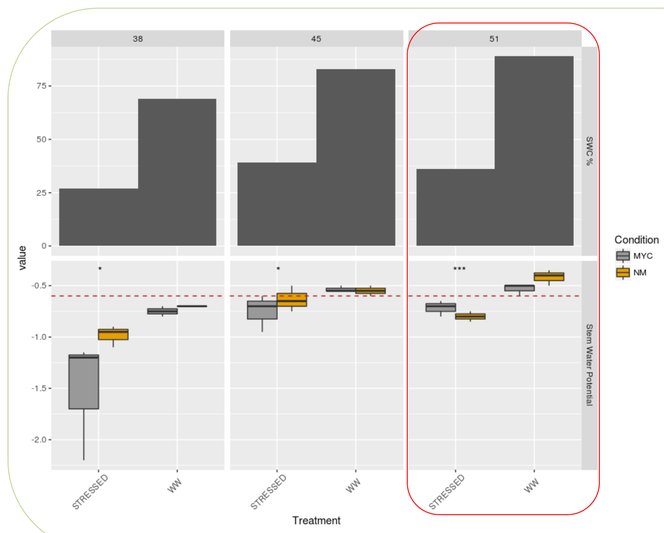
Stressed (SS)

S. lycopersicum (SLY) M82 was watered with a modified Long-Ashton (LA) low nutrient solution containing 3.2 µM phosphate to favor mycorrhization.

The well watered and water stress conditions, with about 100% and 40% soil water capacity (SWC), respectively, were identified in a **pilot experiment** measuring the stem water potential (Ψw) by using a Scholander pressure chamber.



Scholander pressure chamber



Set up of a protocol to induce moderate water and nutrient stress in tomato genotypes inoculated with AM fungi in alveolar trays to test tomato responses:

- tomato genotype tested: M82;
- AM fungus: *F. mosseae*;
- low nutrient levels (modified LA): P = 3.2 µM;
- use of a blank inoculum in the non mycorrhizal condition.

The stem water potential was measured at 38, 45 and 51 days.

- At 38 days a SWC less than 75% already induced a moderate water stress; considering the following time points, SWC has to be set up at 100% in WW.
- In the SS condition SWC has to be around 35% (at lower values plants were suffering too much). The last time point (51 days) seems to offer the ideal conditions.

The statistical analysis highlights an effect of the treatment (WW vs SS) but not of the condition (MYC vs NM).

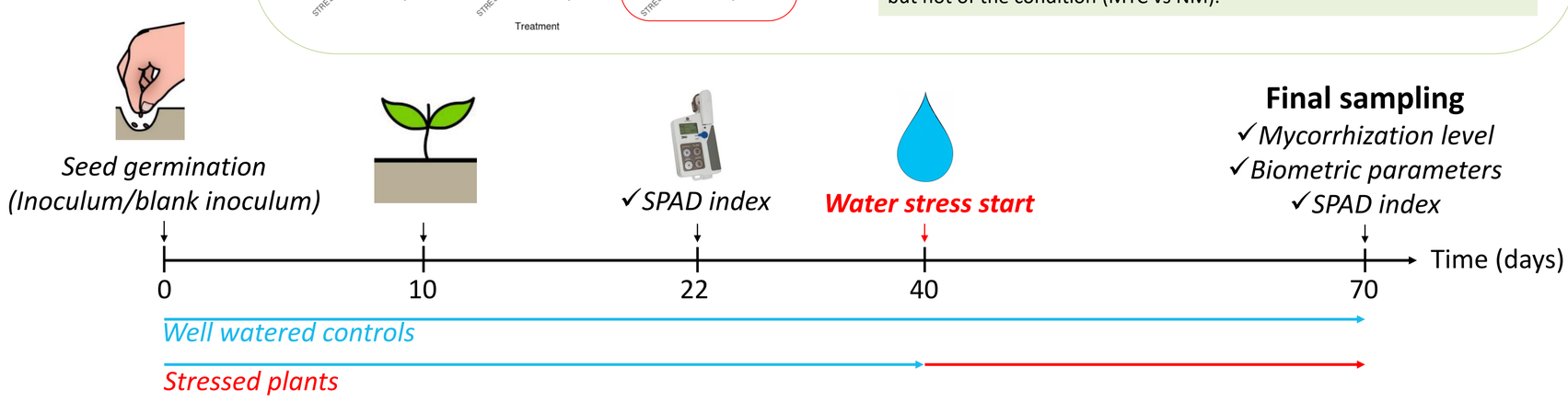


Figure 1. Experimental system.

✓ **At 70 days SS-MYC and WW-MYC showed a good level of mycorrhization:** there were not significant differences for the treatment (WW vs SS) (Fig. 2).

✓ **The AM symbiosis seems to improve the nutritional status of SS-MYC over time**: after 22 days from the start of the experiment the SPAD index of SS-MYC was lower than that of SS-NM, but after 70 days the values were reversed (Fig. 3).

✓ **Under nutrient limitation and in a small substrate volume the growth of M82 was in general stunted and water stress reduced root and shoot biomass, regardless of the AM fungus presence.**

The AM symbiosis led to a growth reduction: NM showed higher biomass compared to MYC in both the treatments (WW vs SS) (Fig. 4).

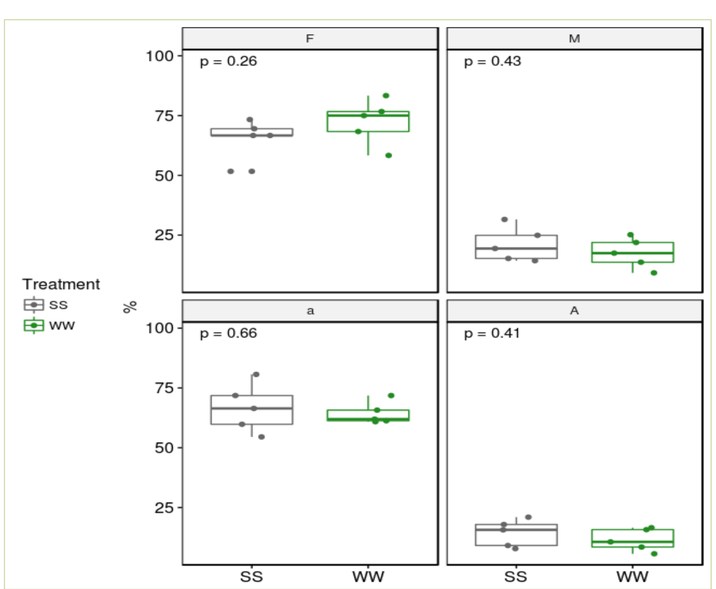


Figure 2. AM colonization levels in MYC SS and WW.
F%: colonized mycorrhization frequency; M%: mycorrhization intensity; a%: arbuscules in the colonized segments of roots; A%: arbuscules in the whole root.

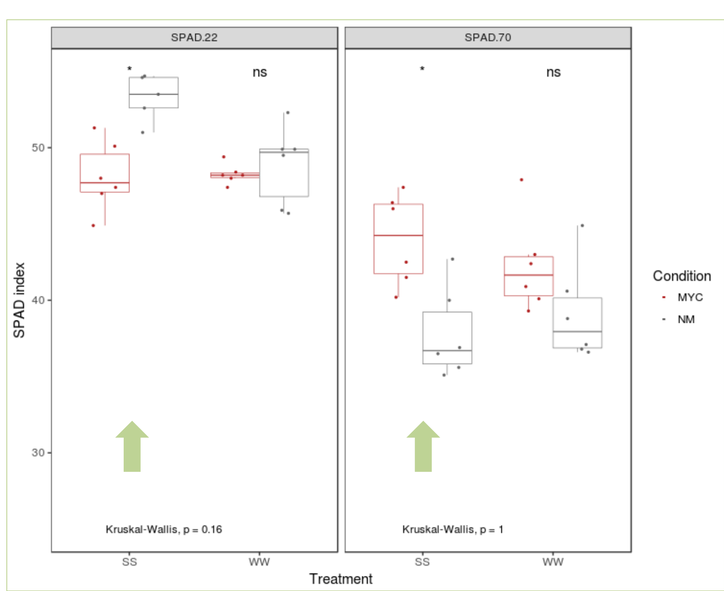


Figure 3. SPAD index after 22 and 70 days in SS MYC-NM and WW MYC-NM.

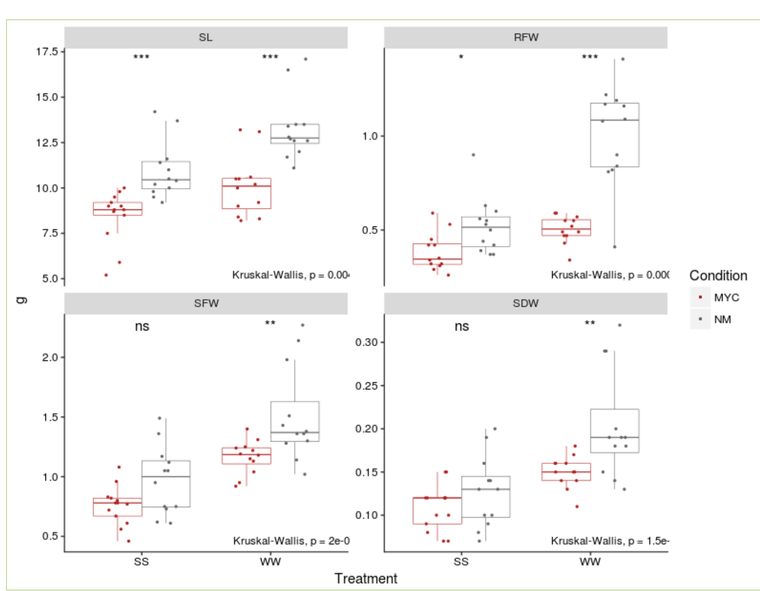


Figure 4. Biomass in SS MYC-NM and WW MYC-NM.
SL: shoot length; RFW: root fresh weight; SFW: shoot fresh weight; SDW: shoot dry weight.

The beneficial effects usually provided by AM fungi to tomato are more limited when the M82 cultivar is grown in small-plastic pots, but the general nutritional status seems to be positively affected in water stress condition.

REFERENCES

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