Effects of arbuscular mycorrhizal symbiosis on plant water relations and greenhouse gas emissions under changing soil moisture regimes

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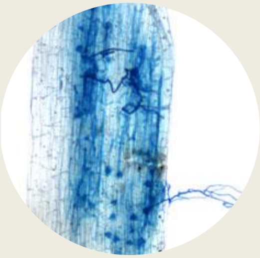
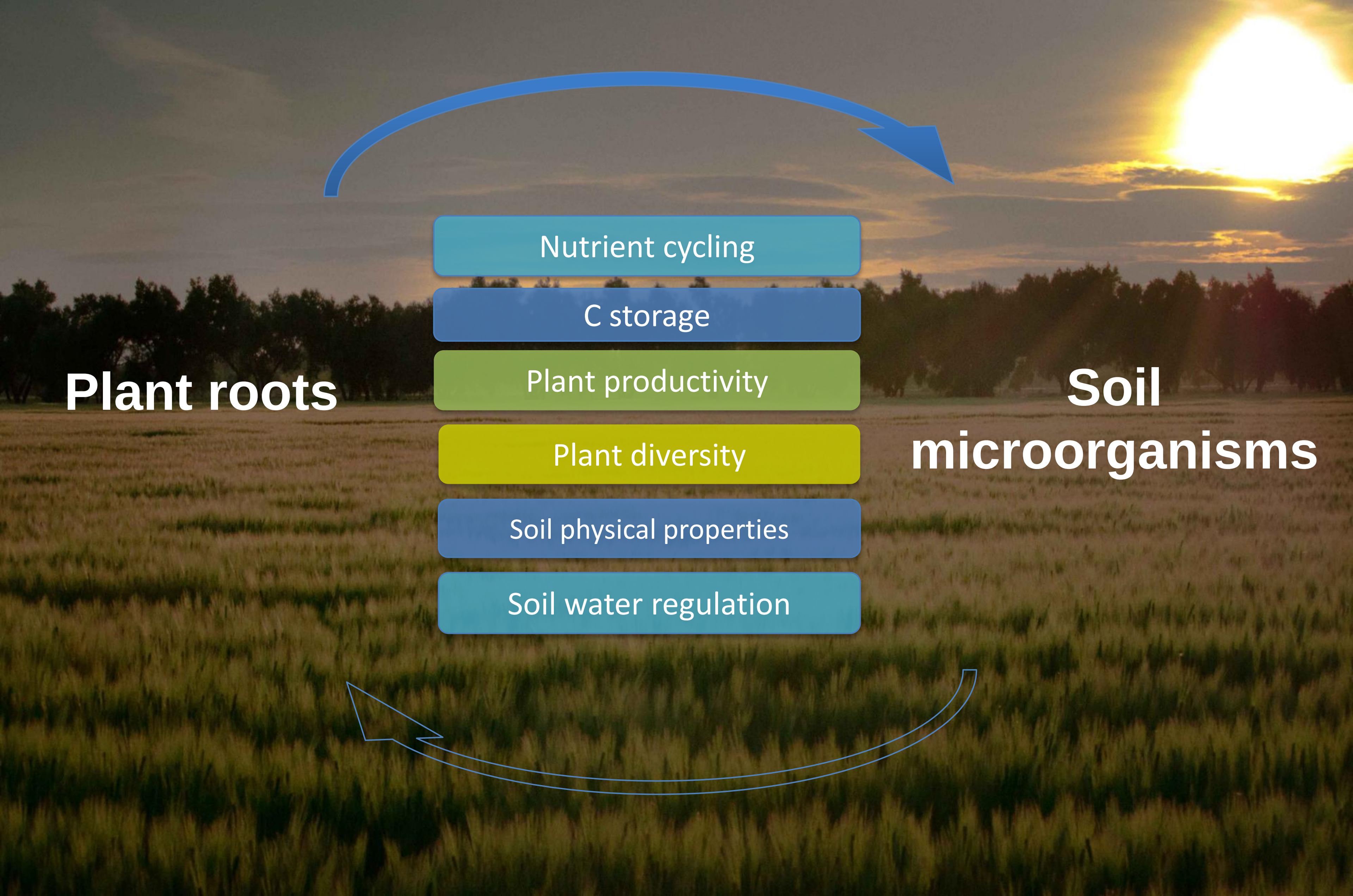



Belowground microbial-plant interactions



Arbuscular mycorrhizal (AM) symbiosis

Present in 80% of the plant sps, different terrestrial ecosystems

Plant productivity

- ✓ Increased uptake and assimilation of N
- ✓ Higher absorptive area, higher access to soil nutrients: mycorrhizal network
- ✓ Preferential uptake of NH_4^+

Plant water relations

- ✓ Increased tolerance to water stress
- ✓ Higher access to soil water: mycorrhizal network
- ✓ Regulation of hormones (ABA)

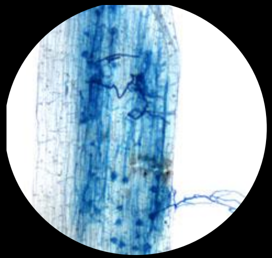
Nutrient cycling??

- ✓ Decrease the N available in the soil for inmobilization, leaching or gas emissions
- ✓ Changes in soil moisture, effects on mineralization, nitrification and denitrification

Does AM colonization of plant roots influence soil greenhouse gas emissions?

i) AM symbiosis decreases N_2O and CO_2 emissions through modulation of plant nutrient uptake and direct impacts to N cycling

i) Effects to the GHG emissions are indirect through the modulation of plant water use




Experimental design

Tomato plant genotype

Mycorrhizal type: 76R MYC

Reduced mycorrhizal colonization: *rmc*

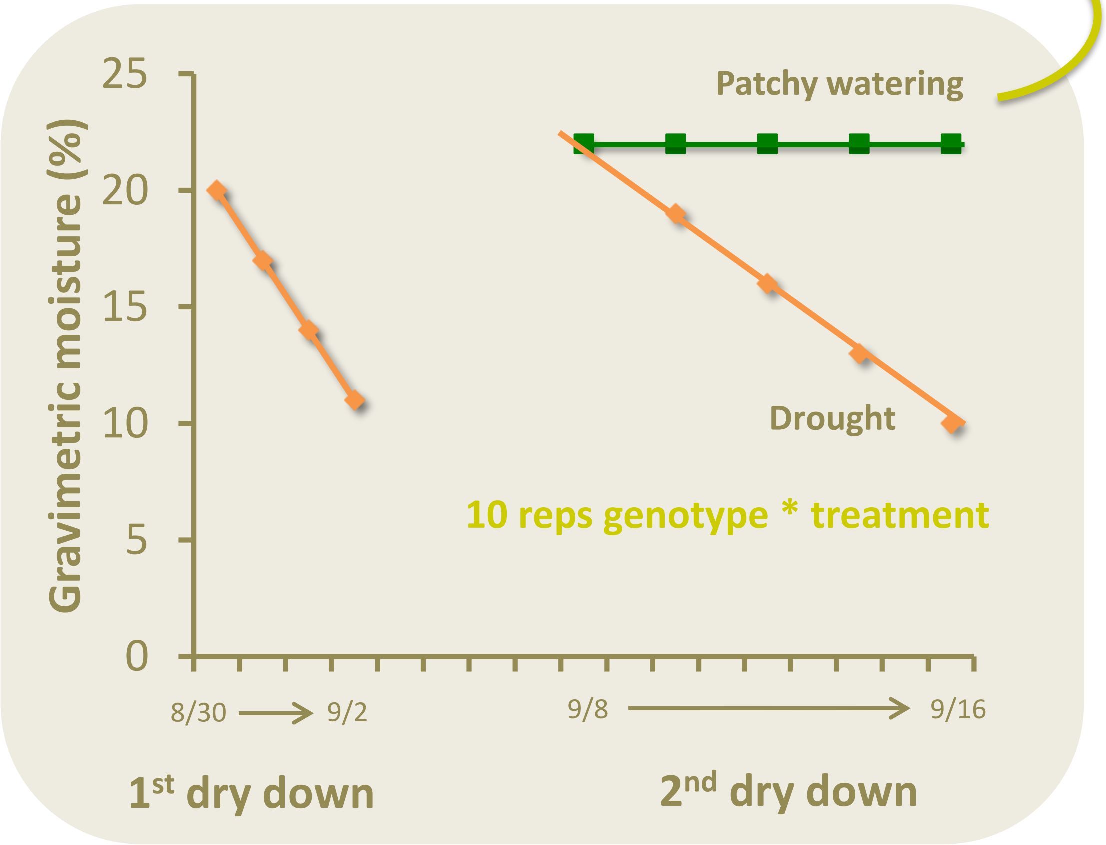
- **20 reps per genotype**
- **Root in growth cylinders**

- **Soil: Organic farm**
- **Established AM fungi population (15-25% colonization)**
- **High soil organic N pools**
- **Compost: 8 ton ha^{-1}**

Experimental design

Soil moisture

- Two consecutive dry downs
- Simulate wet-dry cycles and patchy water availability typically occurring in the field



Experimental design

Plant growth

- Aerial, root biomass
- AM fungi colonization
- Shoot N, P, K

Plant water relations

Photosynthetic rate, stomatal conductance

Portable open flow infrared analyzer (IRGA)

WUE: photosynthetic rate/ stomatal conductance

Greenhouse gas emissions

Static chamber

N_2O, CO_2

Soil Moisture

Soil temperature

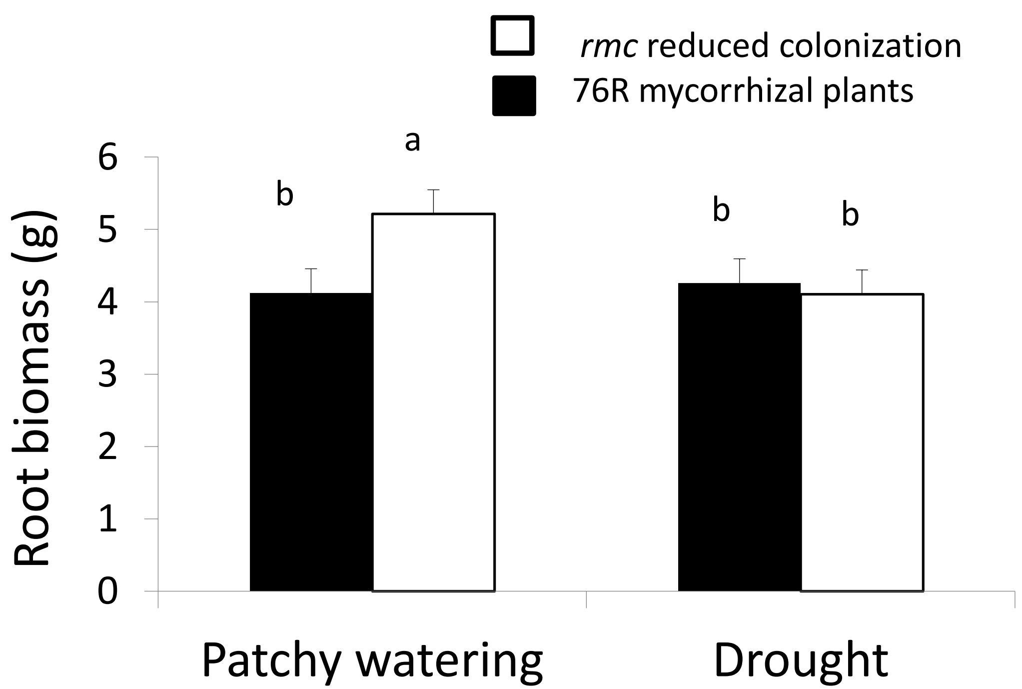
Inorganic N (NH_4^+-N, NO_3^--N), DON, microbial biomass C, DOC

Did AM symbiosis increase plant growth and nutrient uptake?

Colonization rates- 76R Mycorrhizal plants: 35%, ***rmc***: 7%

Root biomass

Genotype * treatment: P=0.03

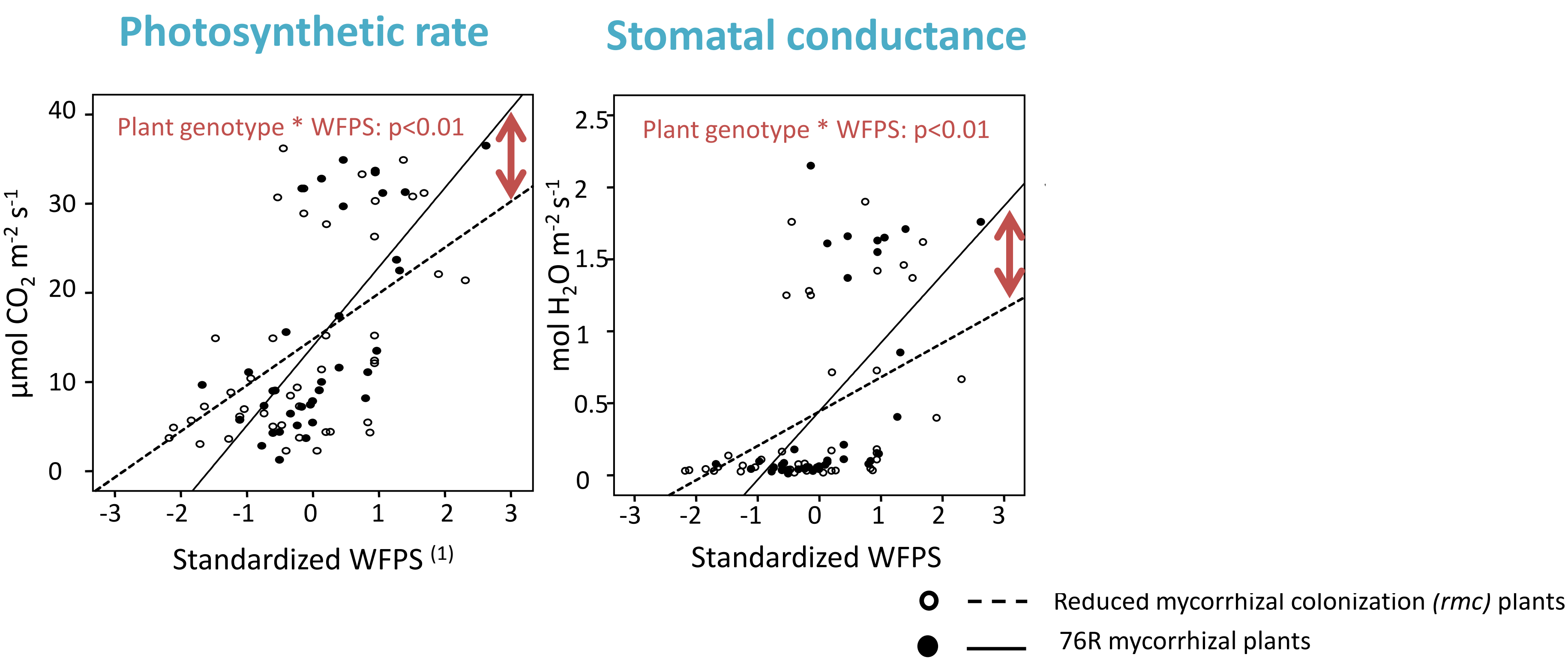


No effects on shoot biomass or N, P K content

Reduction of root biomass

rmc: higher susceptibility to water stress

Did AM symbiosis regulate plant water relations?



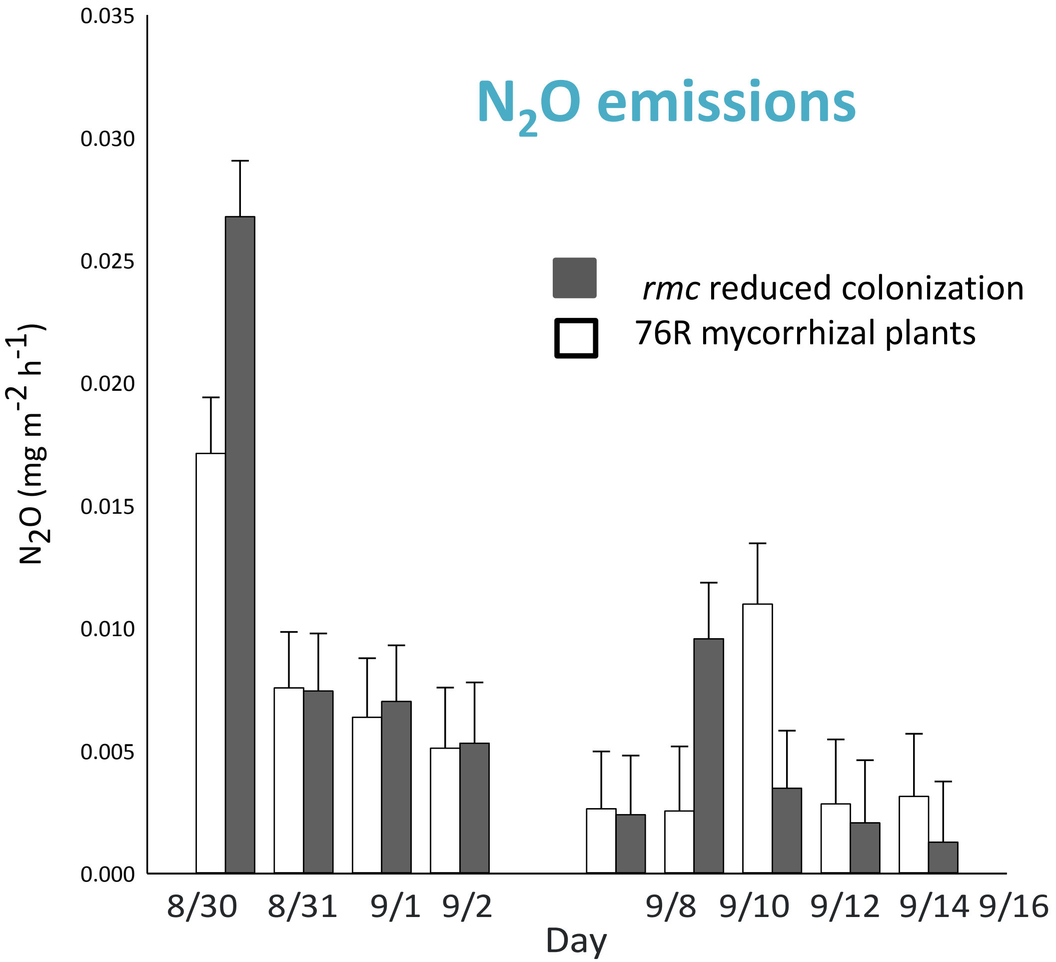
- AM plants- higher slopes- faster reaction to changes in soil moisture
- Higher transpiration and assimilation at high soil moisture
- Lower transpiration and assimilation at low moisture: tighter water control

Effects of AM symbiosis on soil biochemistry

10% lower soil WFPS over the first dry down (genotype * date: p= 0.04)

Lower N_2O emissions

Effects of AM plants on N_2O emissions depended on soil moisture



Effects of AM symbiosis on soil biochemistry

AM symbiosis: 10% lower soil WFPS over the first dry down (genotype * date: p= 0.04)

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Lower N_2O emissions

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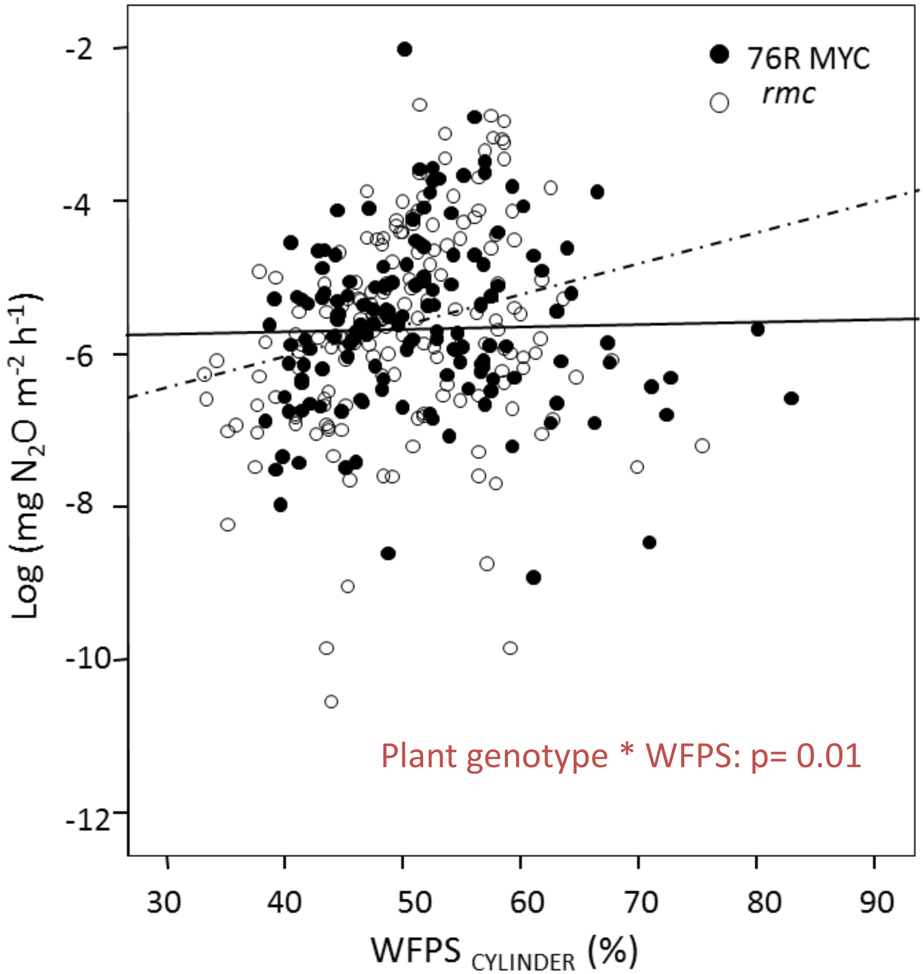


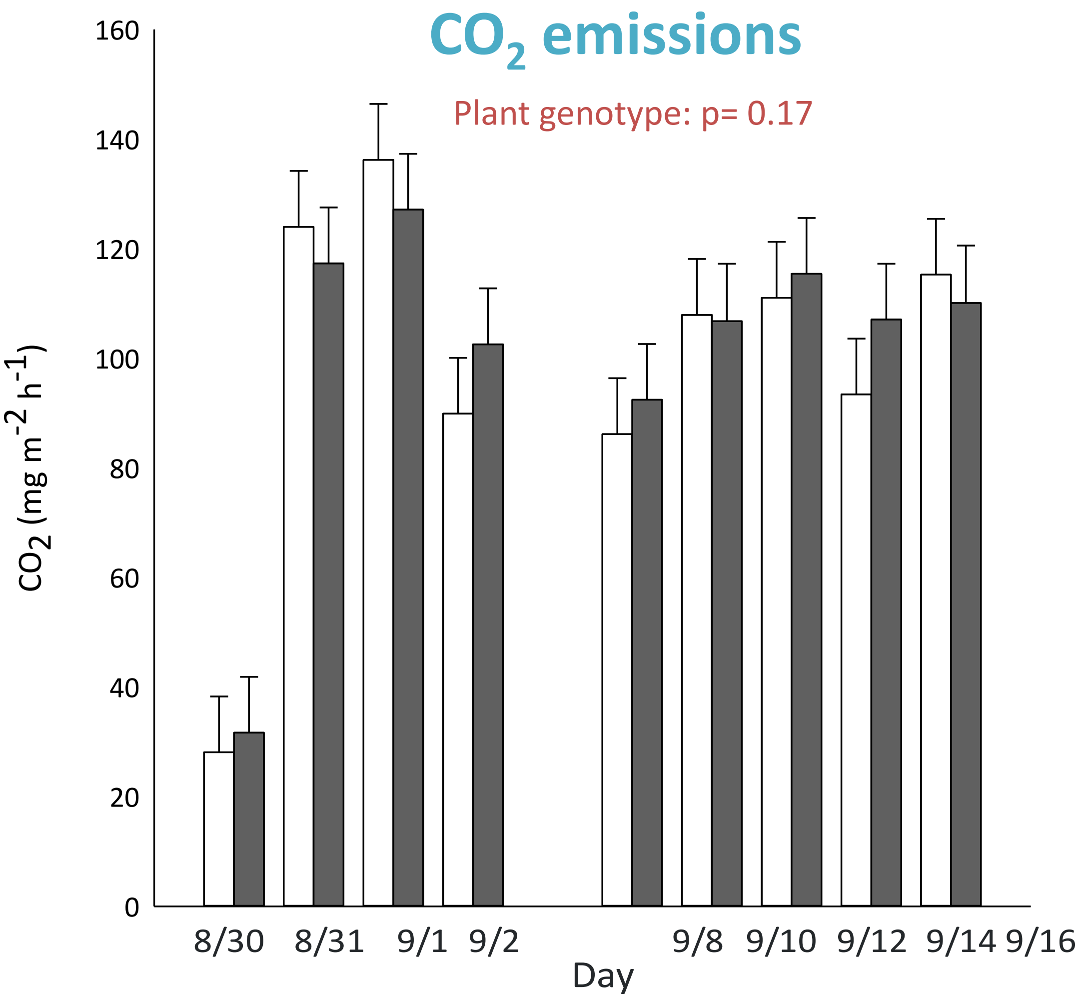
Effects of AM symbiosis on soil biochemistry

AM symbiosis: 10% lower soil WFPS over the first dry down (genotype * date: p= 0.04)

Lower N_2O emissions, depending on soil moisture

Effects of AM plants on N_2O emissions depended on soil moisture

No significant effects in soil CO_2, NH_4, NO_3, DON, MB-C between genotypes or water treatments



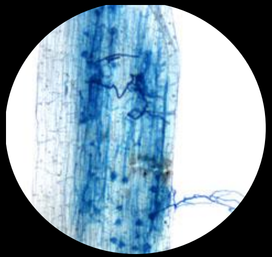
Conclusions

AM symbiosis improved the capacity of the tomato plants to respond to intermittent soil moisture regimes (modulation of photosynthetic rates and stomatal conductance)

Soil N_2O emissions were reduced at high soil moisture with AM colonized plants

Reduction of N_2O emissions related to a higher use of water by AM plants rather that a higher use of N

Soil management that enhances colonization of roots by AM fungi may contribute to a more efficient use of water under changing environmental conditions and the reduction of the GHG emissions from soil




Thank you for your attention!