Effects of arbuscular mycorrhizal symbiosis on growth and N_2 fixation of *Trifolium alexandrinum* under late drought-stress conditions

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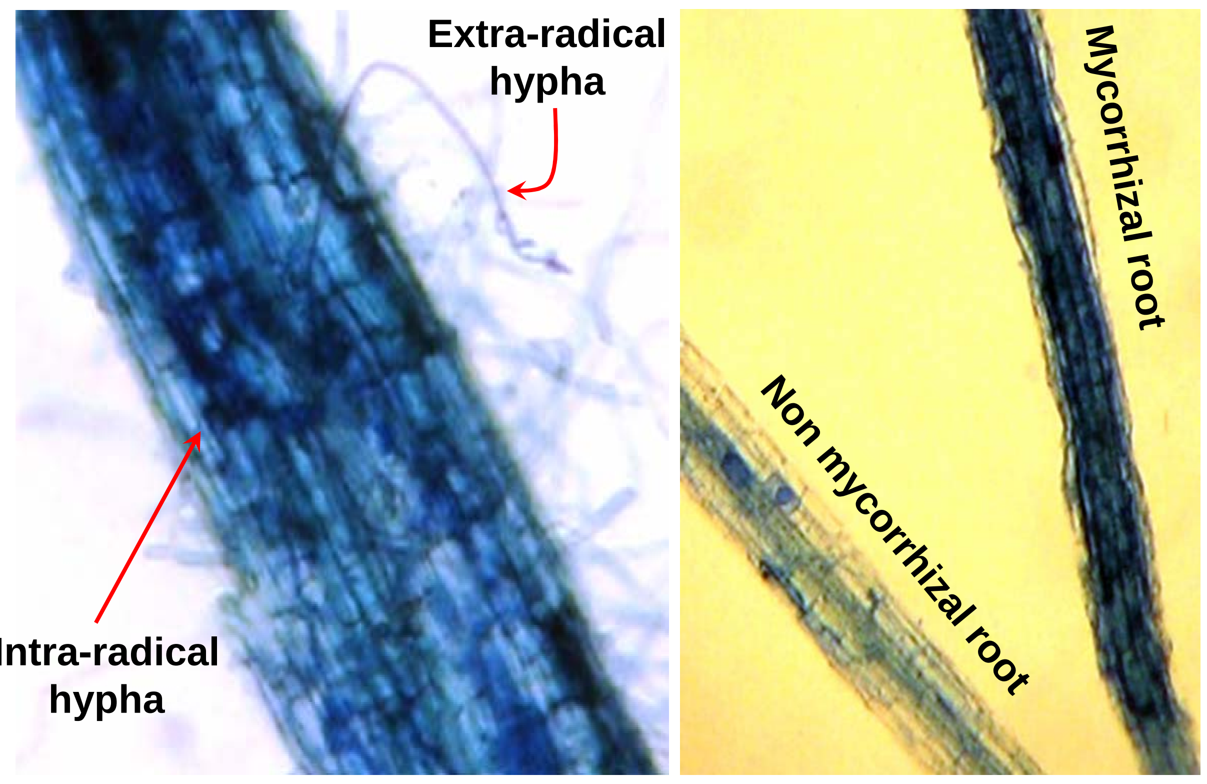
Several experiments, mostly carried out under controlled conditions, have shown that arbuscular mycorrhizal (AM) symbiosis enhances nutrient uptake and improves drought tolerance of host plants.

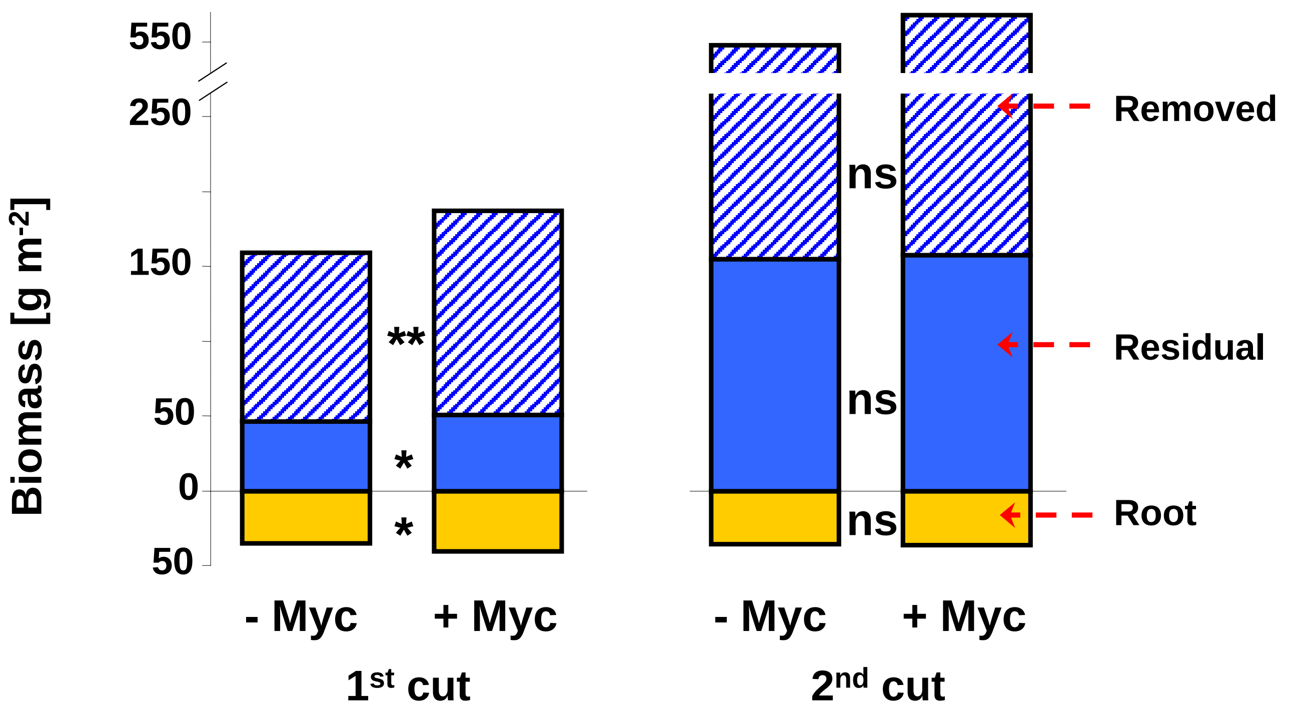
The aim of this field experiment, carried out in a typical Mediterranean environment, was to determine the effect of AM symbiosis on forage yield, quality, and biological N_2 fixation of berseem (*Trifolium alexandrinum* L.) grown under both late drought stress and well-watered conditions.



AM infection at 55 DAS was significantly lower in the –Myc than the +Myc treatment (7.0 and 32.4%, respectively; P < 0.001).

At 76 DAS (1st cut), root dry matter (DM) yield, aboveground biomass (both removed and residual), and respective Leaf Area Indices (LAIs) were significantly higher in the +Myc than the –Myc treatment, whereas at 116 DAS (2nd cut) no significant effects of mycorrhization treatment were observed.

At 144 DAS (3rd cut), AM symbiosis resulted in a significant increase in biomass yield, total N uptake, total amount of N fixed, and proportion of N derived from the atmosphere in the drought-stressed treatment, only.



Removed and Residual above ground and Root biomass of berseem at 1st cut and 2nd cut. Data were analyzed separately per cut. +Myc and –Myc for mycorrhizal inoculated and mycorrhizal depressed crops, respectively.

***,** significant at P<0.05 and P<0.01, respectively; ns , not significant.**

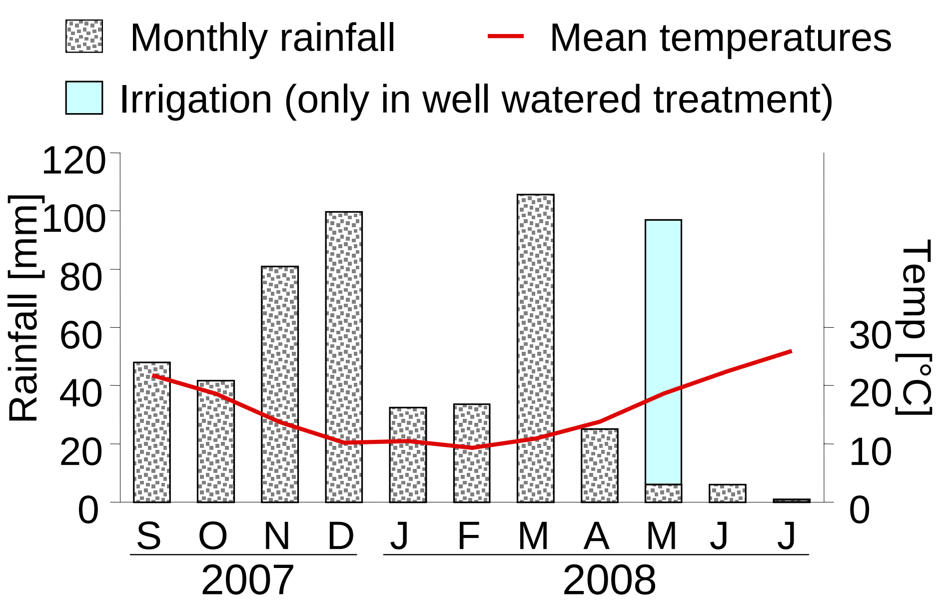
The results suggest that AM symbiosis could play a key role in alleviating the stress effects of late drought on forage production and N_2 fixation of berseem grown in semiarid areas.

Effects of mycorrhization (M) and water availability (W) on berseem at 3rd cut. +Myc, and –Myc for mycorrhizal inoculated and mycorrhizal depressed crops, respectively.

		Drought stress		Well-watered		W	M	W*M
		- Myc	+ Myc	- Myc	+ Myc			
Above-ground								
Biomass	g DM m^{-2}	501	567	667	657	*	*	**
LAI		1.99	2.12	3.98	4.22	***	ns	ns
N uptake	g N m^{-2}	12.3	13.7	16.9	16.2	*	ns	*
Below-ground								
Biomass	g DM m^{-2}	38.7	40.5	40.2	38.1	ns	ns	ns
N uptake	g N m^{-2}	0.7	0.7	0.7	0.7	ns	ns	ns
Mycorrhizal infection	%	8.9	66.0	8.5	52.4	*	***	**
Whole plant								
Ndfa	%	40.4	52.9	50.3	52.7	*	ns	*
	g N m^{-2}	5.2	7.6	8.9	8.9	*	*	*

*, **, *** significant at P<0.05, P<0.01 and P<0.001, respectively; ns, not significant

Sample area after root harvesting (by removing the top 20 cm of soil).



Materials and Methods

Treatments were: **1)** ***soil moisture regime****: rainfed (drought stress) or well-watered during regrowth*; **2)** ***crop mycorrhization****: AM inoculation (+Myc) or AM suppression (–Myc).* AM suppression was achieved by spraying plots with systemic fungicides once per month starting from sowing. AM inoculation involved the application of a commercial AM inoculum (*Glomus intraradices* and *G. mosseae*) to berseem seed. Minimal rainfall occurred during the spring (61 mm, 55% below long-term average), resulting in late drought stress conditions for crops in the rainfed treatments. Well-watered crop received sprinkle irrigation (total of 90 mm, starting at 116 days after sowing [DAS]). A split-plot experimental design (4 replicates) was used. Berseem was hand-sown on 3 Jan. 2008. Plots were cut at 5 cm stubble height at 76 (1st cut), 116 (2nd cut), and 144 (3rd cut) DAS. The ^{15}N isotope dilution technique was used to estimate N_2 fixation by berseem, using annual ryegrass as the reference crop.