

Role of AMF in enhancing the growth of *Cenchrus ciliaris* under different field capacities.

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Abstract: Plants in their natural environment are exposed to various abiotic stresses such as drought, salinity, extreme temperatures. Drought severely impairs plant growth and development and hampers performance of plants. It inhibits many metabolic processes and eventually constraints plant growth. We investigated whether the role of AMF can be major factor in improving the efficiency of *Cenchrus ciliaris* growth under different field capacities. Results showed that AMF inoculated seedlings of *C. ciliaris* had significantly higher growth at low field capacities than those of Non-AMF inoculated plants. It is concluded that AMF fungi may play a positive role under drought conditions and helps in improving the efficiency of the *C. ciliaris* to grown under drastic adverse abiotic drought conditions.

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Introduction

Plants in their natural environment are exposed to many biotic and abiotic stresses. Abiotic stresses, such as drought, salinity, extreme temperatures, and metal and chemical toxicity are serious threats to vegetation (Audet and Charest, 2009; Rabia et al., 2016). These stresses lead to a series of morphological and physiological changes that adversely affect plant growth and productivity (Wang et al., 2000).

Drought, being the most important environmental stress, severely impairs plant growth and development, limits plant production and the performance of plants, more than any other environmental factor (Shao et al., 2009). It is a natural phenomenon that occurs when water availability is significantly below normal levels over a long period and the supply cannot meet the existing demand. It's one of the major environmental factors that inhibits many metabolic processes and eventually constrains plant growth (Pustovoitova et al. 1992; Chaves et al. 2004).

The harsh and stressful conditions like drought, salinity, low nutrients, high temperature etc. are common in the rangelands of Saudi Arabia. The biomass production of most of the grasses in such conditions is generally low which could be enhanced by application of Arbuscular Mycorrhizal Fungi (AMF). Belowground diversity of AMF may be a major factor contributing to the adaptation and maintenance of plant biodiversity and to ecosystem functioning (Requena et al., 2001; van der Heijden et al., 1998).

Buffelgrass (*Cenchrus ciliaris* L.) is drought-tolerant bunch grass that produces forage for the

livestock industry (Burton et al., 1993). It is native to dry sandy areas, and is widely spread in Saudi Arabia and many other arid and semi-arid zones. It can be found naturally in rangelands, along roadsides and in the agricultural lands of Saudi Arabia (Chaudhary, 1989). It has been observed that Buffelgrass has grown drastically around the natural areas of King Saud University, Riyadh, Saudi Arabia replacing native vegetation inspite of heavy drought conditions. The main objective of this study was that: Does AMF play any role in improving the efficiency of the *C. ciliaris* to withstand the harsh water scarce environmental condition?

Materials and Methods

Source of Seeds and Soil:

Seeds of range plant, *Cenchrus ciliaris*, were collected from Plants growing naturally around King Saud University (KSU) Campus, Riyadh, Saudi Arabia. The seeds were surface sterilised with sodium hypochlorite, washed thoroughly with distilled water, and healthy seeds were selected for the experiments.

The experiment was carried out in plastic pots with 1kg of soil capacity. Soil used in the experiment was a sandy-loam and was collected from Agricultural Research Station of the College of Food and Agricultural Sciences, King Saud University in Dirab near Riyadh.

Inoculum Application

Soil based inoculum (soil containing spores, AM colonized roots and extraradical mycelium) obtained from the trap-culture pots was mixed with the sand-loam soil before filling the pots. The non-mycorrhizal

treatment got the same inoculum but autoclaved for 1hr at 121°C.

Experimental Design

The experiment was a (5 x 2 x 4) complete factorial design comprising four treatments (100%, 75%, 50% and 25%) of Field Capacity (FC) and two inoculation (Mycorrhizal and Non-mycorrhizal) treatments with five replications for each treatment. Pots were arranged in a randomized manner.

The experiment was carried out in a Green House of Plant Production Department, College of Food and Agricultural Sciences, King Saud University, Al-Riyadh. The day and night temperatures were maintained at 30°C and 24°C, respectively, with 12 hours of photoperiod.

Growth parameters

Plants from all the treatments were harvested after growth period of 100 days. The harvested

samples were the separated into leaves, stems and roots. Leaf area was measured using a portable leaf area meter (*Li-Cor*, Lincoln, NE, USA). Dry weights were recorded after drying the samples at 70°C for 48 hours.

Mychorrizal colonization

The experimental soil of each treatment was processed and the AMF spores were extracted by the already established wet sieving and decanting method (Gerdemann and Nicolson, 1963) with some modifications (Al-Qarawi et al., 2012). The intensity of structural root colonization was estimated as described in details by (Al-Qarawi et al., 2012; Dhar and Mridha, 2006).

Percent colonization was calculated by the following formula:

$$\%colonization = \frac{\text{total no. of AMF positive segments}}{\text{total no. of segments studied}} \times 100$$

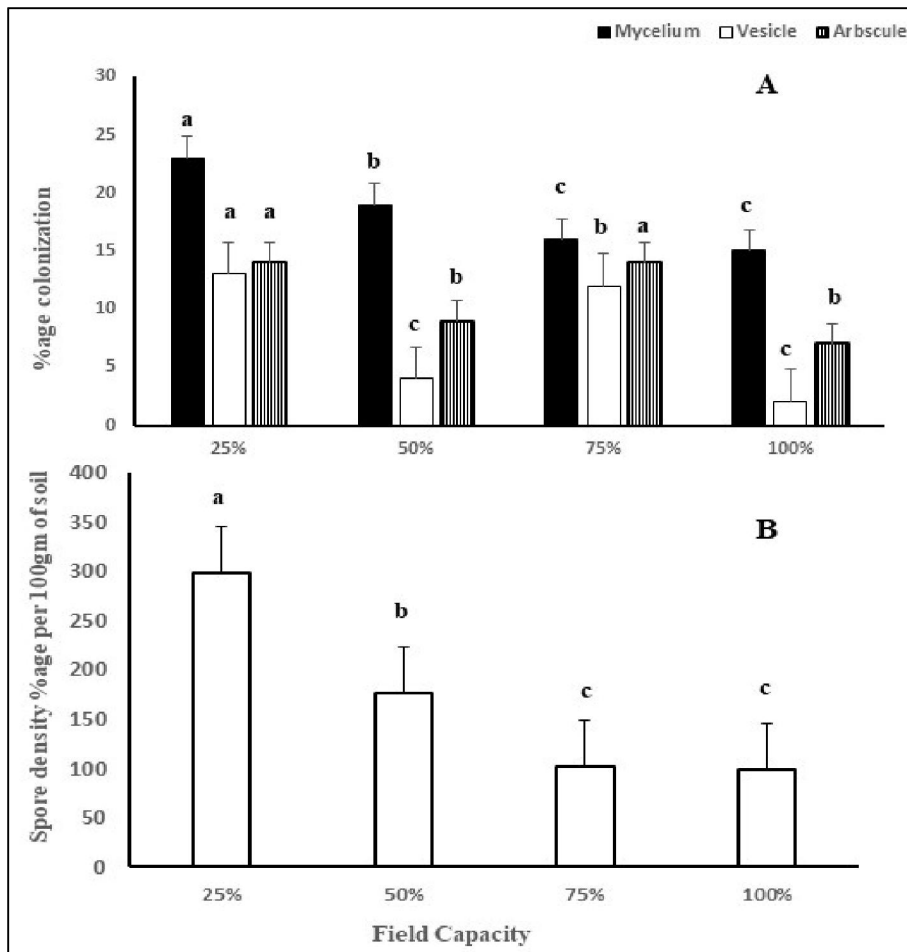


Figure 1:- Showing (A) percent root colonization and (B) spore density in the root and rhizosphere of *C. ciliars* under different field capacity.

Photosynthetic pigments

The photosynthetic pigments (chlorophyll a, b and carotenoids) were extracted from leaves of the experimental plant. The extract was centrifuged 10,000/g for 10 min. the absorbance of the supernatant was estimated spectrophotometrically at 480, 510, 645, 663nm (T80 UV/VIS Spectrometer, PG Instruments Ltd, USA), acetone was used as blank (Arnon, 1949).

Statistical analysis

The data was statistically analyzed using the program SAS (SAS, v.9.1) and the differences in

means was determined by the least significant differences (LSD) ($\alpha=0.05$) test.

Results and Discussion

Results showed that root colonization and spore density of AMF increased significantly in 25% followed by 50% field capacity (Figure 1 A & B & Figure 2). The significantly high percentage of mycelium at 50% and 25% field capacity may have helped plant to withstand drought by increasing root surface area of the target plant. This is in disagreement with the findings of (Al-karaki et al. 2004) which indicated that AMF root colonization was positively correlated with field capacity.

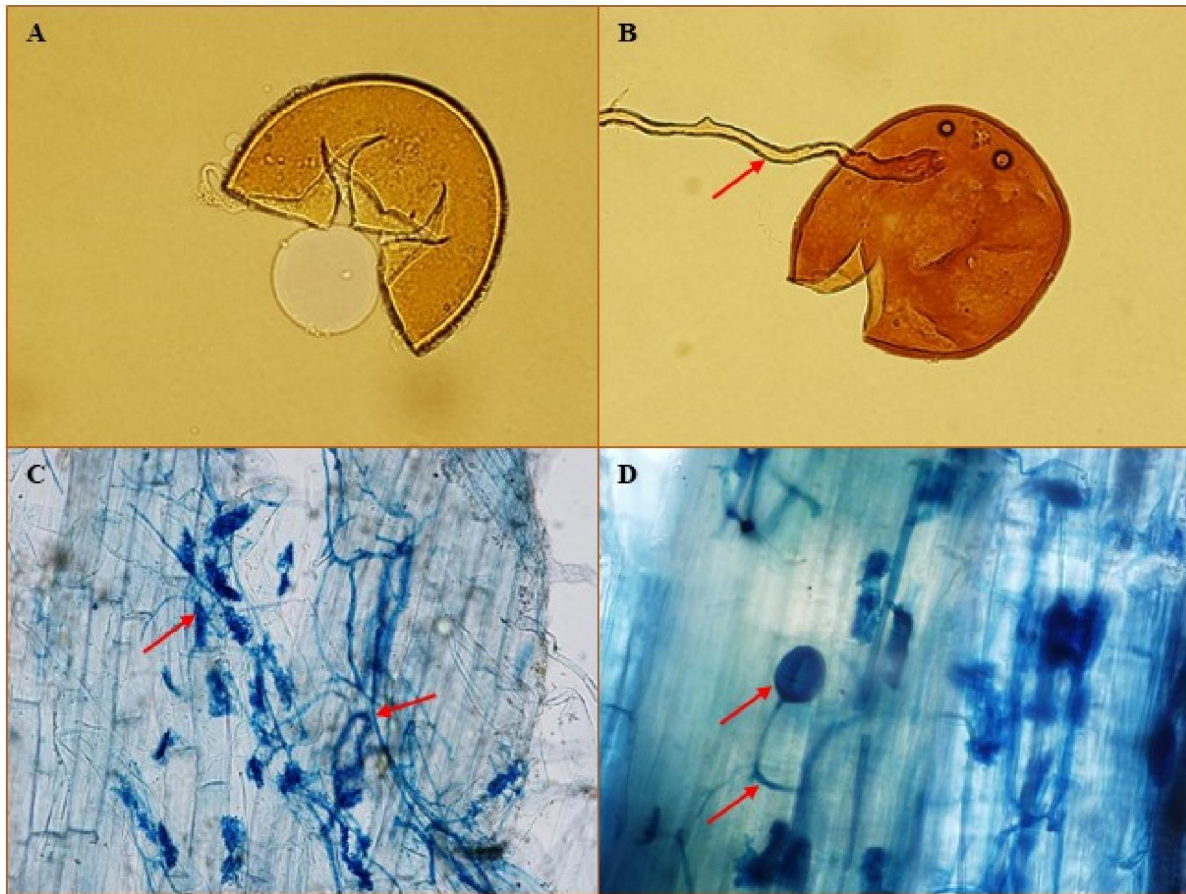


Figure 2:- showing (A & B) crushed spore AMF, (C & D) AMF fungal structures viz: arbuscules, coiled hyphae and vesicles in the roots of *C. ciliaris* grown under different 25% field capacity.

Results generally showed that seedling with higher field capacity had higher above ground biomass content, root biomass and leaf area index (Figure 3, A). But, the AMF inoculated seedling showed higher biomass content compared to Non-AMF inoculated seedlings at their respective field capacities (Figure 3, B & C) especially at 25% field capacity, AMF inoculated seedling showed significant increase in aboveground biomass. Also, with respect to root

biomass and leaf area index, the AMF inoculated seedlings showed higher root biomass and leaf area index compared to Non-AMF induced seedlings at their respective field capacities (Figure 3 B & C). The same had been reported by (Gong et al. 2013 & Liu et al. 2015) which showed that biomass of host plants inoculated with AMF fungi was higher than that of Non-AMF plants under drought conditions.

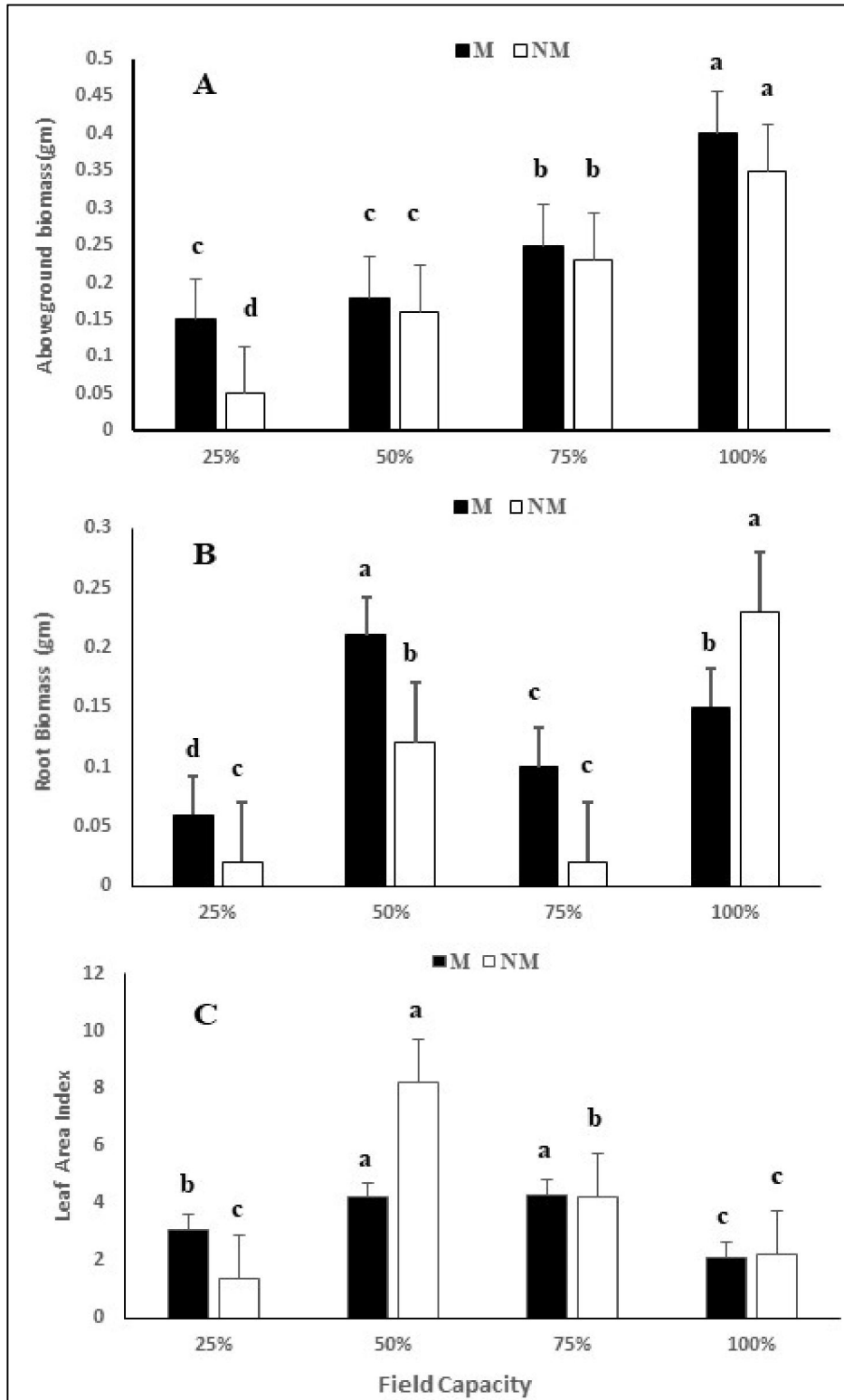


Figure 3:- showing effect of field capacity on (A) above ground biomass, (B) root biomass and (C) leaf area index of *C. ciliaris* in presence and absence of AMF.

The photosynthetic pigments viz; carotenoids and chlorophyll a & b decreased with the increase-in

drought conditions for both mycorrhizal and non-mycorrhizal inoculated seedlings of *C. ciliaris* (Table

1). However, mycorrhizal inoculated seedlings for each treatment had significantly higher photosynthetic pigment content than its related non-mycorrhizal inoculated plants, showing higher significance at 100% field followed by 75% field capacity

respectively. The results of this experiment are consistent with the results of (Barida et al. 2007; Afsaneh et al. 2014) which showed that the amount of chlorophyll decreased with the increase in water stress.

Table 1:- Role of AMF on photosynthetic pigment contents in *C. ciliaris* under different field capacity.

Field Capacity	Carotenoids		Chlorophyll a		Chlorophyll b	
	M	NM	M	NM	N	NM
25%	2.90c + 0.34	2.31c +0.03	0.63f +0.14	0.74f +0.03	0.46d +0.04	0.25e +0.01
50%	3.41b +1.00	2.62c +0.55	2.29d +0.99	1.25e +0.48	1.04c +0.07	0.92d +0.25
75%	4.89a +1.86	1.86c +0.40	4.56b +1.09	2.60d +0.20	1.76b +0.38	0.86d +0.03
100%	5.08a +1.64	2.08c +0.09	7.28a +0.84	3.53c +0.95	2.68a +0.40	1.37b +0.31

In conclusion, results demonstrated that AMF fungi may play a positive role under drought conditions and helps in improving the efficiency of the *C. ciliaris* to grown under drastic adverse abiotic drought conditions.

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