Mycorrhizal response of halophytes to plant growth in non-saline soil conditions

Hamid R Asghari[A] and Tim R Cavagnaro[B]

[A]Faculty of Agriculture, Shahrood University of Technology, Iran, Email hamidasghari@gmail.com
[B]School of Biological Sciences, Monash University, VIC, Australia, Email tim.cavagnaro@sci.monash.edu.au

Abstract
A glycophyte species and three different halophytes species were examined for colonization and growth response to arbuscular mycorrhizal (AM) fungi under non-saline soil conditions. Roots of *Trifolium alexanderium* as a glycophyte and AM responsive plant highly colonized (more than 85%) and plant growth increased significantly by inoculation with AM fungi. A low level of AM colonization (less than 5%) was found in the roots of *Haloxylon persicum*, *Seidlitzia rosmarinus* and *Salsola sp* as halophytes. Despite low level colonization, AM fungi inoculation increased plant growth of two halophytes species (*Haloxylon persicum and Seidlitzia rosmarinus*). The present study demonstrates that although roots of halophytes have intrinsically low symbiosis with AM fungi, but, even at low level of AM colonization, they show positive growth response to AM fungi inoculation in non-saline soil conditions.

Key Words
Arbuscular fungi, halophytes, soil salinity, response.

Introduction
Among the soil microorganisms, arbuscular mycorrhizal (AM) fungi are ubiquitous and are the most widespread mutualistic symbiosis on earth. Mycorrhizal fungi form a mutually beneficial symbiosis with most terrestrial plants and occur in the soil of most ecosystems (Smith and Read 2008). They play an important role in nutrient cycling and benefit plants in terms of their growth and soil structure development. Arbuscular mycorrhizal fungi occur in many stressful environments. Although relatively large populations of AM fungi spores have been found in saline conditions (Aliasgharzadeh *et al.* 2001; Sengupta and Chaudhuri 1990; Wang *et al.* 2004), increased salinity decreases AM spore population, root colonization and hyphal extension (Juniper and Abbott 2006; Peat and Fitter 1993). Different levels of AM colonization in halophytes have been reported in many field studies in different locations with different soil salinity levels (Asghari *et al.* 2008). Salinity could reduce AM colonization by directly reducing hyphal growth and/or decreasing plant growth (less carbohydrate). But the most important reason of low levels of AM colonization in halophytes is the detrimental effect of salinity on hyphal growth. A recent report indicates that the most important effect of salinity on AM fungi is related to its detrimental effect on spore germination and hyphal production (Juniper and Abbott 2006). It is not clear if reduced soil salinity may develop mycorrhizal benefits in halophytes. The objective of this study was to evaluate AM colonization of halophytes and mycorrhizal response of halophytes to plant growth under non-saline conditions.

Material and methods
An experiment was carried out to investigate the effects of AM fungi on plant growth under non saline soil conditions in four different plant species. Plants were *Trifolium alexanderium* as a mycorrhizal responsive species, *Haloxylon persicum*, *Seidlitzia rosmarinus* and *Salsola sp* as halophytes and non mycorrhizal responsive species. Plants were grown in a soil with low level of salinity (0.4 dS/m) under green house conditions for 12 weeks. The soil was autoclaved (110 ˚C, 1 h, twice at 48 h intervals) to remove indigenous AM fungal propagules. Pots (2 kg) were inoculated with *Glomus intraradices* Schenk and Smith (DAOM 181602) or not inoculated. Pots containing sterilized soil received a filtrate from 5 g of original non-sterile soil, to reintroduce a soil microflora (without AM fungi). Long Ashton nutrient solution without P was added (10 mL per pot) to the pots once per week for 8 weeks. The experiment had a randomized complete block design with 2 treatments (AM inoculated and non AM inoculated). There were six replicates per treatment. Data were analyzed by T-Test.

Results
Roots of *Trifolium alexanderium* plants were highly colonized by AM fungi (more than %85), but less than %5 colonization were found in halophytes. Mycorrhizal inoculation significantly increased shoot dry weight of *Trifolium alexanderium.* Despite low level of AM colonization, *Haloxylon persicum* and *Seidlitzia rosmarinus* shoot dry weights were increased by AM fungi inoculation (Figure 1)

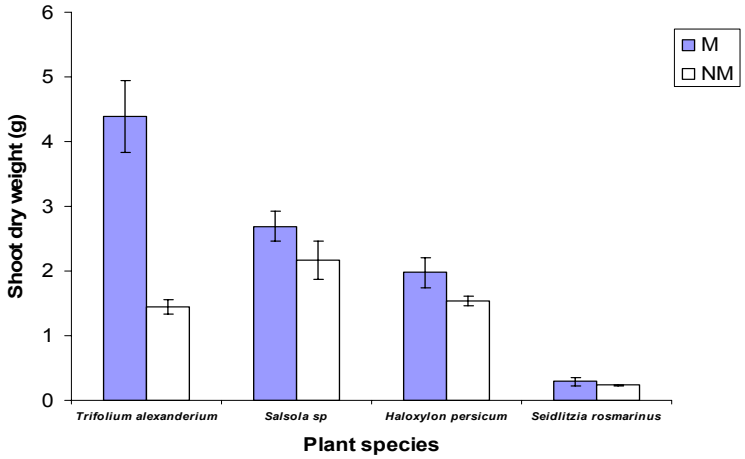

Figure 1. Shoot dry weight of AM fungi inoculated (M) and non-inoculated (NM) *Trifolium alexanderium*, *Salsola sp, Haloxylon persicum* and *Seidlitzia rosmarinus* after 12 weeks. Vertical bars represent standard error of the means, n =6.

Conclusion

The detrimental effects of soil salinity on spore germination and hyphlal growth of AM fungi have been identified in past studies as being the most important reason for the absence of AM fungi colonization in halophytes. In contrast to this, we found that reducing soil salinity did not improve AM colonization in halophytes. Thus, it is likely that other factors such as environmental factors, phenology of host plant (Wilson and Hartnett 1998) and other soil properties (Caroline and Bagyaraj 1995; Mamatha *et al.* 2002) may affect colonization by AM fungi in halophytes. Despite of low level of AM colonization, halophytes show a positive growth response to AM inoculation in non-saline soil conditions. More work to determine factors that promote AM colonization in halophytes is required.

References

Aliasgharzadeh N, Rastin NS, Towfighi H, Alizadeh A (2001) Occurrence of arbuscular mycorrhizal fungi in saline soils of the Tabriz Plain of Iran in relation to some physical and chemical properties of soil. *Mycorrhiza* **11**, 19–122.

Asghari HR, Amerian M, Gorbani H (2008) Soil salinity affects arbuscular mycorrhizal colonization of halophytes. *Pakistan Journal of Biological Science* **11**, 1909-1915.

Caroline M, Bagyaraj D J (1995) Mycorrhization helper bacteria and their influence on growth of cowpea. In 'Mycorrhiza.: Biofertilizers for the Future'. (Eds A Adholeya, S Singh) pp. 192–196. (TERI: New Delhi).

Juniper S, Abbott LK (2006) Soil salinity delays germination and limits growth of hyphae from propagules of arbuscular mycorrhizal fungi. *Mycorrhiza* **16**, 371-379.

Mamatha G, Bagyaraj DJ, Jaganath S (2002) Inoculation of field-established mulberry and papaya with arbuscular mycorrhizal fungi and a mycorrhiza helper bacterium. *Mycorrhiza* **12**, 313–316.

Peat HJ, Fitter AH (1993) The distribution of arbuscular mycorrhizas in British flora. *New Phytologist* **125**, 845-854.

Sengupta A, Chaudhuri S (1990) Vesicular arbuscular mycorrhiza (VAM) in pioneer salt marsh plants of the Ganges river delta in West Bengal (India). *Plant and Soil* **122**, 111–113.

Smith SE, Read DJ (2008) 'Mycorrhizal symbiosis', 3rd edition. (Academic Press: London, UK).

Wang FY, Liu RJ, Lin XG, Zhou JM (2004) Arbuscular mycorrhizal status of wild plants in saline-alkaline soils of the Yellow River Delta. *Mycorrhiza* **14**, 133-137.

Wilson GWT, Hartnett DC (1998) Interspecific variation in plant responses to mycorrhizal colonization in tallgrass prairie. *American Journal of Botany* **85**, 1732–1738.