THE IMPACT OF ARBUSCULAR MYCORRHIZAL FUNGAL (AMF) MYCELIUM UPON THE GROWTH OF *SINAPIDENDRON GYMNOCALIX* (LOWE) RUSTAN (BRASSICACEAE)

By M.I. BATISTA-MARQUES [1] & D.J. READ [2]

With 2 figures and 1 diagram

ABSTRACT. Arbuscular mycorrhizal fungi (AMF) occur in the majority of the plant families and their presence influences plant community structure. It is recognised that these fungi have the ability to increase the growth of plants named as 'hosts', a feature which is usually associated with increases of nutrient contents in plant tissues, in particular, phosphorus. However, such colonisation is not normally present in some plant families, notably, Caryophyllaceae, Chenopodiaceae, Cruciferae, Polygonaceae, Resedaceae, though in some instances there are reports of mycorrhizal structures presence in their roots. In disturbed habitats, these plants are usually the most sucessful ones, being known as ruderals; they are the first to colonise in a successional sequence. The impact of AMF upon plants of uncertain mycorrhizal status was examined here.

In this work, we quantified the influence of the AM mycelium upon the growth and development of *Sinapidendron gymnocalix* (LOWE) Rustan, an endemic Cruciferae from Madeira, growing in combination with a 'host' plant (*Plantago lanceolata* L.), colonised or uncolonised by mycorrhizal fungi.

The response of *S. gymnocalix* to the presence of AMF was determined. The results were discussed in relation to the management and conservation of the natural flora of Madeira.

INTRODUCTION

Roots as major vegetative organs have an important role in absorption, anchorage, storage, transport and propagation; to the symbiotic fungi usually associated with them are acknowledged functions that are essential for plant growth and development. Despite these

[1] Secretaria Regional da Educação, Região Autónoma da Madeira, Av.Arriaga, 9000 Funchal- Madeira, Portugal
[2] Department of Animal and Plant Sciences, University of Sheffield, Sheffield S10 2UQ, U.Kingdom

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vital contributions they are often, probably too often taken for granted because they are not visible, usually they are not taken into account by ecologists.

Traditionally, arbuscular mycorrhizal associations are seen as a mutualistic relationship between arbuscular mycorrhizal fungi (AMF) and plants, in which the fungal system contributes positively to the development of plants mainly through the increased uptake of nutrients (e.g. phosphorus (JOHANSEN et al., 1993) and water, as well as a defence against pathogenic microorganisms and the fungus obtains in return photosynthates (SMITH and GIANINAZZI-PEARSON, 1988; SMITH and READ, 1997).

Arbuscular mycorrhizal fungi are found in the majority of plant families influencing the plant community composition (NEWMAN and REDELL, 1987; READ, 1993). The best documented effect of these Zygomycetous fungi is the enhancement of growth of 'host' plants (Read et al., 1976; ABBOTT and ROBSON, 1984; Birch, 1986).

However, some plants belonging to families such as Caryophyllaceae, Brassicaceae, Chenopodiaceae, Polygonaceae, Resedaceae are not extensively colonised by AMF, being traditionally called 'non-hosts', though associations with these fungi are reported in the literature. These species occur usually as ruderals. They are common in disturbed habitats (MILLER, 1979), being the first to colonise bare soil, in the successional sequence (ALLEN and ALLEN, 1988, ALLEN et al., 1989). Almost no studies have been carried on the effect of AM mycelium upon plants of uncertain mycorrhizal status.

In this paper, we quantified the influence of the AM mycelium upon the growth and development of an endemic Brassicaceae from Madeira, *Sinapidendron gymnocalix* (LOWE) Rustan.

MATERIALS AND METHODS

For this purpose, a specialised experimental system was designed (Diagram 1, modified from FRANCIS and READ, 1995). The chamber was filled with sterilised dune sand. Each of the chambers contained 4 sections (A, B, C and D). In section A, they were placed pre-infected seedlings of the mycorrhizal 'host' plant (*Plantago lanceolata* L.) and, in section D, uninfected seedlings of the same species. These plants were allowed to grow so that the AM mycelium from the section A colonise the sand in section B. When the colonisation had occurred, six pre-germinated seeds of *S.gymnocalix* were sown into the sections B and C. The experimental design corresponds to 5 pots x 6 seedlings (M/NM) x 3 harvests. Harvests were carried out every 4 weeks. The dry weights of roots and shoots were determined.

Statistical analysis

The data obtained were submited to a One-way ANOVA in which the data was the response variable and mycorrhizal status was the factor (in Minitab), a Tukey's test being, used at a significance of $p>0.05$.

RESULTS

Growth responses

This preliminary results indicate a differential growth of *S.gymnocalix* observed when the seedlings were grown with or without the presence of AM mycelium. *S.gymnocalix* produced a better growth in the non-mycorrhizal (NM) than in the mycorrhizal (M) compartments of the chambers, just four weeks after sowing the pre-germinated seeds (Fig. 1). This effect was maintained and enhanced throughout all the experiment.

The dry weight of the seedlings showed a significantly greater dry weight in the NM than in M conditions, at harvests 2 and 3 (Fig. 2a). At harvest 3, the dry weight of the seedlings was 4-fold greater in NM than in M compartments (Fig. 2a).

The shoots (Fig. 2b) and roots (Fig. 2c) of the seedlings showed a significantly reduced growth in M than in NM compartments, at harvests 2 and 3, these results reflecting the negative effect of the presence of AM mycelium upon the biomass of the seedlings.

DISCUSSION

The strong negative relationship between the presence of AM mycelium and the growth of *S. gymnocalix* defies the general concept of a mutualistic relationship attributable to these fungi. It is widely recognised that, in closed and undisturbed plant communities, mycorrhizal plant species at the stage of young seedlings (e.g. *Plantago lanceolata*) are connected by the AM mycelium network; therefore, a seendling that is compatible with mycorrhizal fungi will be integrated in this network). Quite the opposite, as shown in this work, will happen with plant species of uncertain mycorrhizal status which will be excluded of these plant communities by the mycelial network. Therefore, the ecological niche occupied by plant species in a natural plant community could be explained, if not totally, at least partially, by this phenomenon.

CONCLUSION

The importance of the mycorrhizal symbiosis in ecosystems has been much understimated. Many studies have been carried out on the positive impact of AMF upon 'host' plants, e.g. uptake of phosphorus, water, as well on the resistance to pathogenic microorganisms.

The knowledge of the mechanism that regulates the impact of the fungus on 'non-host' plants, plants of uncertain mycorrhizal status is poorly understood. This work supports the existence of a negative effect of AM mycelia upon the growth and development of

Sinapidendron gymnocalix, which is likely to determine the ecological niche occupied by this plant species. Because of the susceptibility to the presence of AMF, the plant is unlikely to succeed in closed communities of mycorrhizal plants. Recognition of the fact must be an essential prerequisite for any programme designed to manage populations of these plants.

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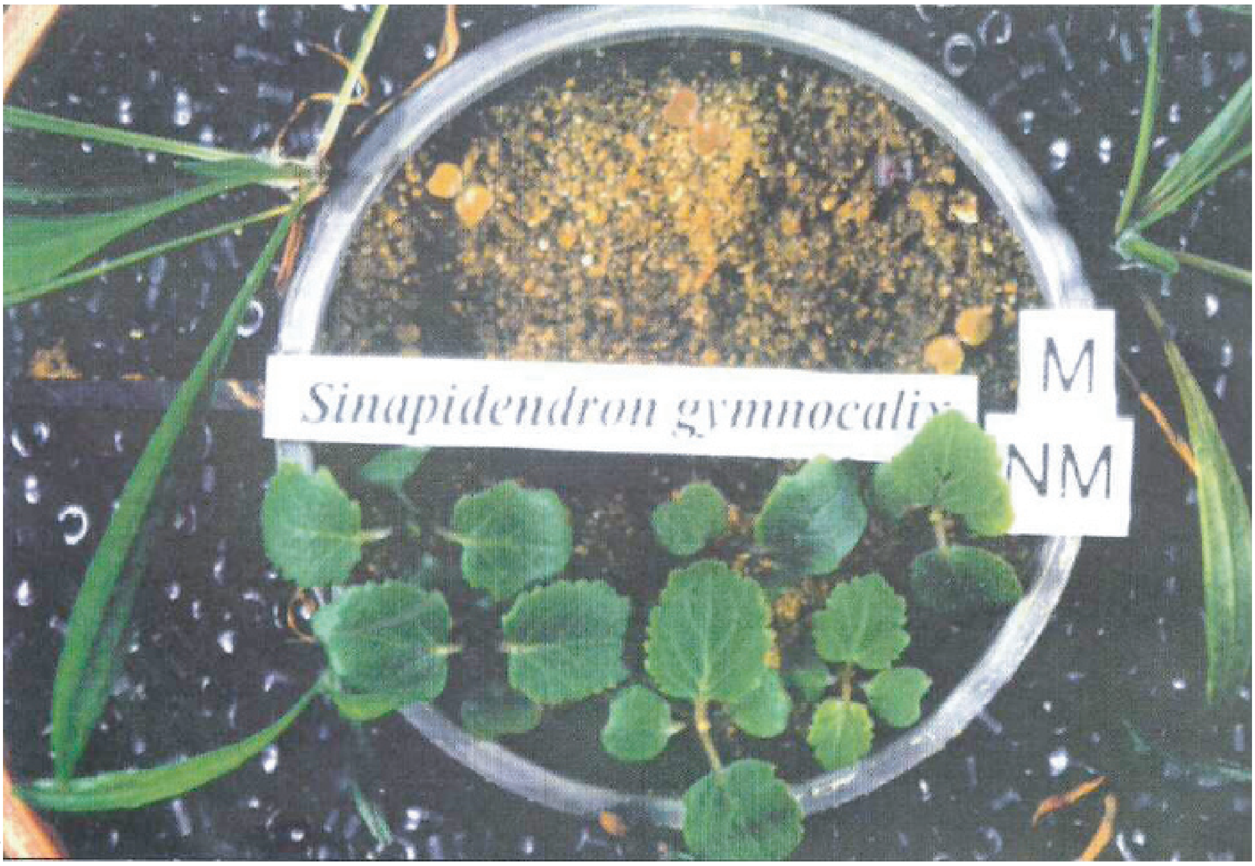

Fig. 1 - Growth of *S. gymnocalix* (LOWE) Rustan, 4 weeks after sowing, in the presence (M) and absence (NM) of arbuscular mycorrhizal mycelium.

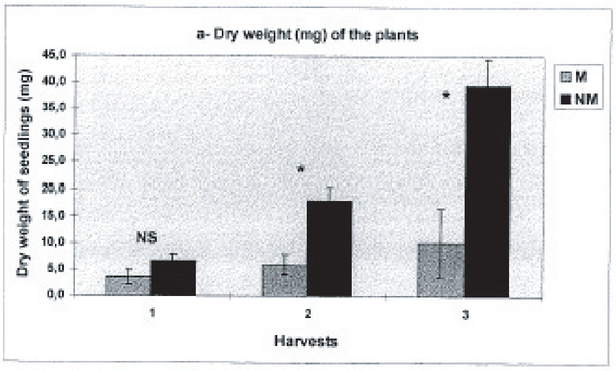

Fig. 2a - Dry weight (mg) of the seedlings of *S. gymnocalix*, at the time of the 3 harvests (4,8 and 12 weeks after sowing). Each value represents a mean of 5 replicates. The figures in brackets represent the standard error of the mean [* indicate a significant difference at $p<0.001$; ns- differences were not significant, $p>0.05$, Tukey's test).

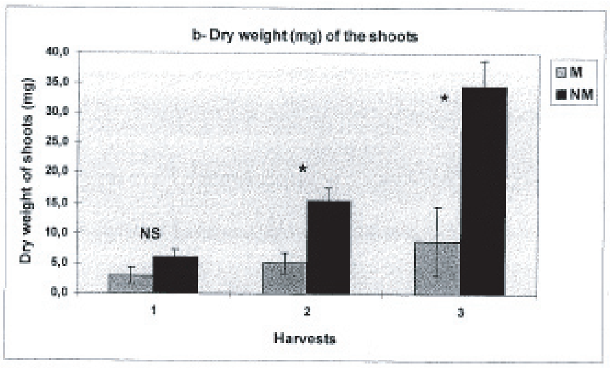

Fig. 2b - Dry weight (mg) of the shoots of *S. gymnocalix*, at the time of the 3 harvests (4,8 and 12 weeks after sowing). Each value represents a mean of 5 replicates. The figures in brackets represent the standard error of the mean [* indicate a significant difference at $p<0.001$; ns- differences were not significant, $p>0.05$, Tukey's test).

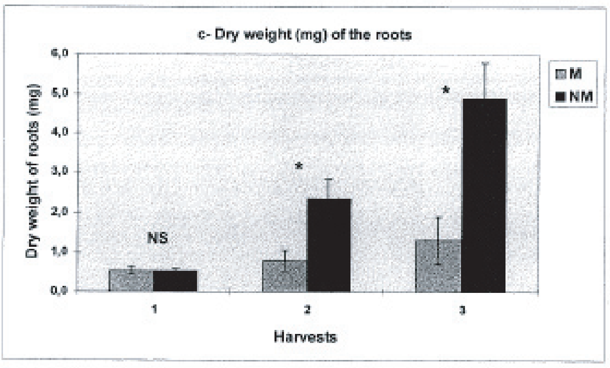

Fig. 2c - Dry weight (mg) of the roots of *S. gymnocalix*, at the time of the 3 harvests (4,8 and 12 weeks after sowing). Each value represents a mean of 5 replicates. The figures in brackets represent the standard error of the mean [* indicate a significant difference at $p<0.001$; ns- differences were not significant, $p>0.05$, Tukey's test).

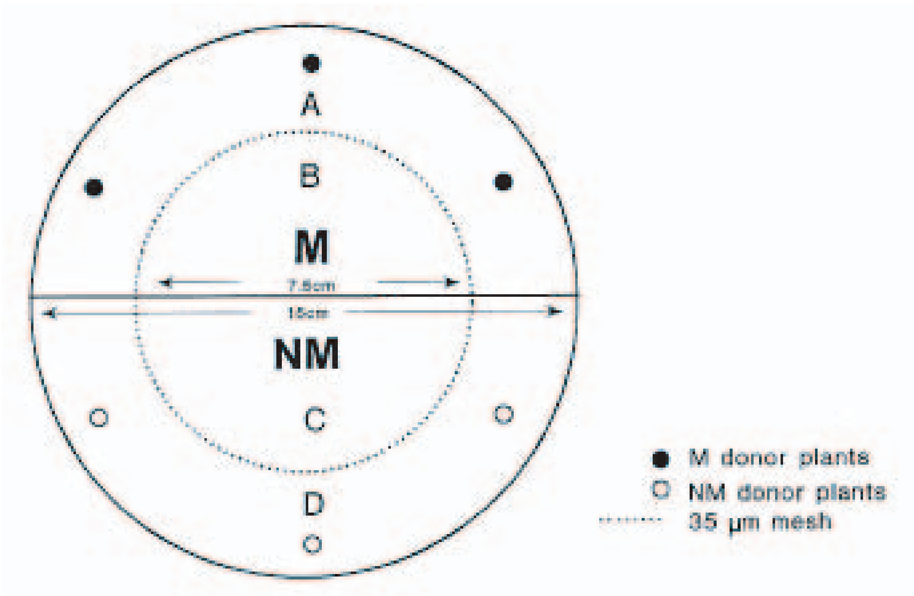

Diagram 1 - Design of the experimental system used to study the effect of AMF mycelium upon *S. gymnocalix* (LOWE) Rustan.

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