

Mycorrhizal inoculation of grapevines in replant soils: improved field application and plant performance

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Introduction

Soilborne plant pathogens and abiotic stress factors, such as bad drainage, toxic metabolites or extreme pH are causal agents that contribute to the severity of the vineyard's replant disease. Several species of fungi are associated with the syndrome and among them, the root rot fungus *Armillaria mellea* (Vahl ex Fr.) Kummer is considered the principal cause of soil fatigue in Spanish vineyards.

Considering the fact that there are no commercial rootstocks conferring protection in replant situations, few control measures are available. Soil fumigation is banned due to high cost and environmental concerns and long term fallow is strongly recommended before planting, but growers are not willing to wait in intensive production areas.

The mycorrhizal inoculation of grapevines under controlled conditions has been achieved by many authors and the beneficial effects on plant growth promotion proved (Linderman and Davis, 2001; Aguin et al, 2004), thus, the use of arbuscular mycorrhizal fungi (AMF) to obtain plants with increased capacity to withstand replant stress has been proposed as a biotechnological alternative.

Two consecutive applied research projects, starting in 2000, have been conducted at IRTA, Barcelona, involving growers of several wine production areas in Northeastern Spain. The final purpose was to evaluate mycorrhizal inoculation in replant vineyards by using several inoculation methods, by comparing different AMF isolates, by testing the agronomic response of commercial vine rootstocks of different genetic origin, and by establishing the field performance of mycorrhizal grapevines in replant vineyards with identified replant contributing factors or pathological causal agents. Some of the results obtained are summarized in this presentation, focused on rootstock screening and field growth performance of inoculated mycorrhizal vines.

Mycorrhizal inoculation of grapevine rootstocks suitable for mediterranean soils: evaluation of their growth response

Five commercial rootstocks tolerant to high lime soil contents and commonly used in mediterranean production areas were inoculated with three *Glomus intraradices* isolates, two of them obtained from vineyard soils and the registered BEG 72 isolated from similar edaphic and climatic conditions. Hardwood cuttings from Richter 110 (*Vitis berlandieri* Planch. x *Vitis rupestris* Scheele), SO4 (*V. berlandieri* x *Vitis riparia* Mich.), 41B (*V. berlandieri* x *Vitis vinifera* L.), 140 Ruggeri (*V. berlandieri* x *V. rupestris*), and 1103 Paulsen (*V. berlandieri* x *V. rupestris*), were rooted in perlite beds (Figure 1) and 15 plants per treatment were either individually inoculated with the mycorrhizal fungi or fertilized with P (0,035 g KH₂PO₄/Kg substrate) once transplanted to 2 L volume containers filled with a pasteurized substrate mixture (sandy soil, quartz sand and sphagnum peat; 3:2:1, v/v).

After six months growth under greenhouse and shadowhouse conditions, plants were harvested and growth parameters measured, and the mycorrhizal colonization achieved was estimated in their root systems.

Figure 1

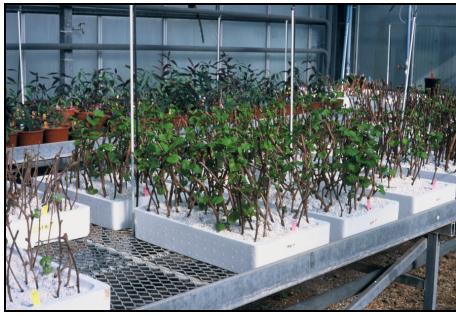
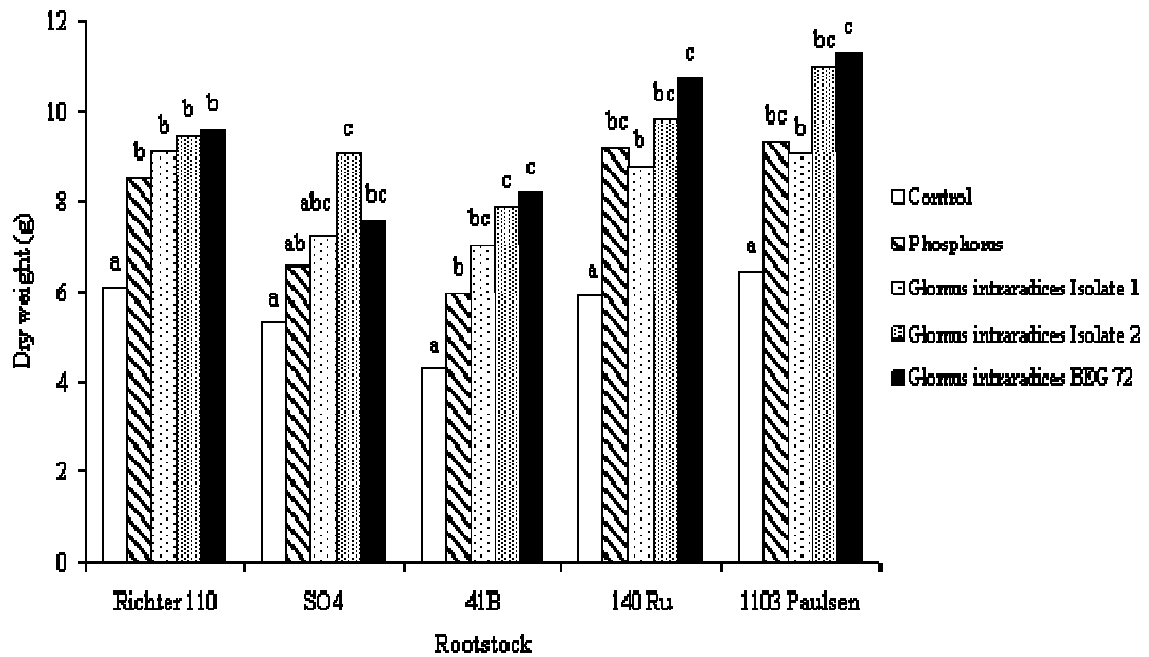


Figure 2



Results obtained for shoot dry weight (Figure 3) after the rootstocks screening defined the high mycorrhizal aptitude of the most commonly used vine rootstocks in commercial mediterranean vineyards and the effectivity of the mycorrhizal fungi used as inoculum source.

Figure 3



Field experiments

*Nursery Inoculation of Merlot plants with *Glomus intraradices* BEG 72 and post transplant growth response in a high lime content replant soil (Calvet et al., 2007)*

Plants from the cultivar Merlot grafted on the rootstock SO4 were grown in forest pots filled with a sphagnum peat-perlite mixture (1:1,v/v) and inoculated with *G. intraradices* BEG 72 (Figure 4). Two months later, when 15 plants per treatment were transplanted at random to the field, the mycorrhizal inoculation had caused a significant growth depression in plant shoots, but only five months after the plants establishment in the high lime content replant soil, mycorrhizal plants (Figure 5) outgrew the noninoculated control plants (Figure 6) and their biomass was significantly higher, despite the container's volume used in the nursery.

Figure 4



One year later, the difference in shoot biomass was still significant between treatments, and moreover, the foliar relative chlorophyll content recorded demonstrated the presence of a higher pigment concentration in plants previously inoculated with *G. intraradices*.

Figure 5



Figure 6

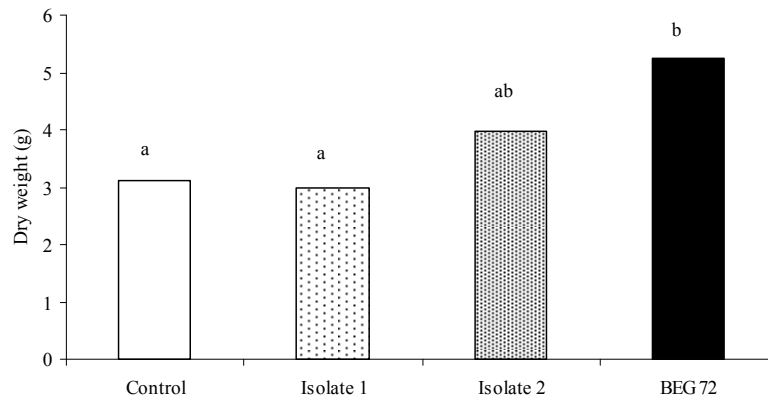


Field inoculation of grapevines in a replanted vineyard soil infested by *A. mellea* (Camprubí et al., 2008)

Cabernet Sauvignon plants grafted on Richter 110 were planted in a high pH replant soil heavily infested by the root-rot fungus *A. mellea* and with an estimated number of mycorrhizal propagules of 114 in 100 ml. Seventy-five grapevines per treatment were established in the field empty loci left by dead plants previously removed. Four treatments were considered: non inoculated plants, and inoculation with one of the isolates tested in rootstock evaluation (Figure 3), *G. intraradices* BEG 72 and two native *G. intraradices* referred as isolate 1 and isolate 2. One hundred grams of fungal inocula developed on “Terragreen®” were placed under the plants, but the traditional planting method involving water flooding around the plants was modified in order to avoid the inocula dispersion and plants were only watered after planting.

After 8 months growth, vines were pruned and their shoot biomass recorded. Despite the presence of mycorrhizal propagules in the field soil, *G. intraradices* BEG 72 significantly increased the growth of plants (Figure 7), while the other two introduced AM fungi did not. The results demonstrated that in the field not all the AMF are equally efficient at increasing plant growth, even if they belong to the same species, and despite their identical performance when they colonized the same rootstock, Richter 110, under controlled conditions (Figure 3).

Figure 7



Development of new inoculum formulations

The implementation of mycorrhizae into the vineyard agronomical practices pointed out the need to adapt the inoculation method to the traditional mechanized planting system. Experimental research has been undertaken to obtain solid formulated products based on the use of biodegradable organic polymers including mycorrhizal propagules which can be easily delivered in the water hole when planting grapevines (Figure 8).

Figure 8



Acknowledgements

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