Benefits of Ectomycorrhizal inoculation of *Tilia tomentosa* seedlings on plant growth and vigor depends on substrate pH

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Introduction

Urban trees provide many ecosystem services to the urban population, including biodiversity protection, carbon sequestration, air quality improvement and mitigation of the *heat-island* phenomenon. These trees, however, are often exposed to adverse environmental conditions that may diminish their health and jeopardize the delivery of ecosystem services. One of this conditions can be the soil pH. In this context, EcM fungi have emerged as a helpful tool to improve the health status and performance of plants under different stress scenarios, such as those faced by plants in urban environments. This study hypothesized that inoculation of seedlings of *Tilia tomentosa* with EcM fungi promotes plant growth and vigor, and that the benefits of inoculation depend on the soil pH.

Methods

Ectomycorrhizal fungi

Lactarius deliciosus

Paxillus involutus

Substrate pH

Acid pH ~5.8

Alkaline pH ~7.5

Parameters analyzed

Aerial part

Biometrics;
Biomass;
Photosynthetic pigments content;
Nutritional content.

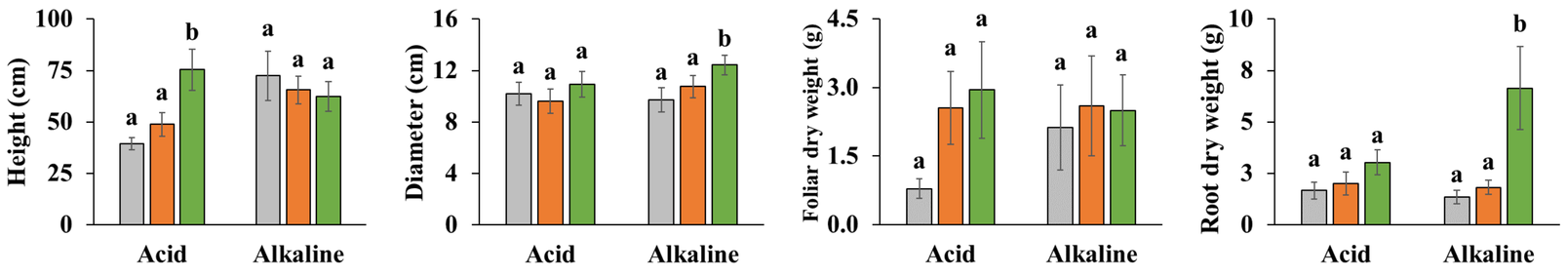
Root part

Biomass;
Mycorrhization rate;
Expansion rate;
Secondary roots;
Nutritional content.

Statistical analysis

One-way ANOVA with Duncan test ($p<0.05$) for multiple comparisons was applied after normality and homogeneity of variance were verified. Each column in the graphs represents the mean ± SE and different letters represent statistically significant results. No statistical analysis was performed for differences between substrates.

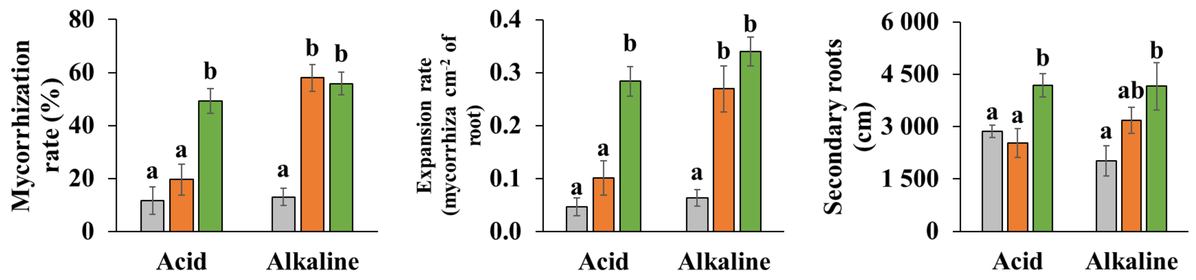
Results



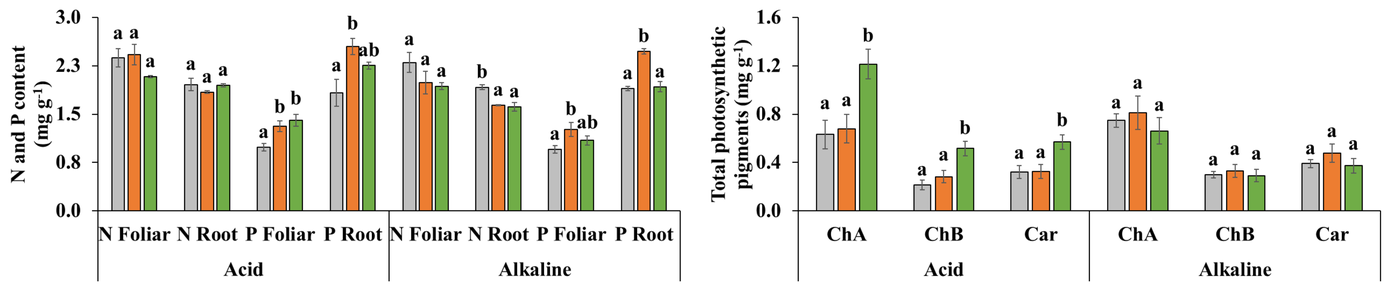
Biometric (height and diameter) and biomass (foliar dry weight and root dry weight) parameters of the control group (grey bars), and plants inoculated with *L. deliciosus* (orange bars) and *P. involutus* (green bars) on acid and alkaline substrates.

Inoculation with *P. involutus* increased the height in acid substrate and diameter and root dry weight in alkaline substrate.

Inoculation, particularly with *P. involutus,* improved the mycorrhization status in both substrates.



Mycorrhization status (mycorrhization rate, expansion rate and secondary roots) of the control group (grey bars), plants inoculated with *L. deliciosus* (orange bars) and *P. involutus* (green bars) on acid and alkaline substrates.



Nitrogen (N) and Phosphorus (P) content of leaves and roots and photosynthetic pigments (Chlorophyll a (ChA), chlorophyll b (ChB) and carotenoids (Car)) of the control group (grey bars), plants inoculated with *L. deliciosus* (orange bars) and *P. involutus* (green bars) on acid and alkaline substrates.

Inoculation, particularly with *L. deliciosus*, improved the P content of leaves and roots in both substrates.

Inoculation with *P. involutus* increased the total content of photosynthetic pigments in acid substrate.

Conclusions

Inoculation of *Tilia* seedlings with the EcM fungi *L. deliciosus* and *P. involutus* impacted plants growing in the acid substrate, which translated in higher rate of mycorrhization, improved the height of the plant, enhanced formation of secondary roots and root expansion rate, higher content of photosynthetic pigments and better plant nutrition (leaf and root phosphorus content). In alkaline substrate, inoculation promoted the diameter, production of root biomass, nutrition and mycorrhization status. The inoculation had a more notorious impact in the plants growing in acid substrate because it is a more stressful pH for *Tilia tomentosa* species.

The introduction of EcM in the young stages of *Tilia* plantlets in a nursery context improved the growth and vigor of the plants in stressed scenarios of pH. Such approach can help the municipality nurseries to improve their techniques for enhancing the growth and resilience of seedlings growing in nurseries until its future transplantation to the urban environment.

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