

Article

Effects of Different Ectomycorrhizal Fungal Inoculates on the Growth of *Pinus tabulaeformis* Seedlings under Greenhouse Conditions

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Abstract: The tree species *Pinus tabulaeformis* Carr. (*P. tabulaeformis*) is commonly planted in China due to its economic and ecological value. In order to identify one or more ectomycorrhizal (ECM) fungal species for future *P. tabulaeformis* afforestation, we investigated the effects of five ECM fungal species: *Laccaria laccata*, *Boletus edulis*, *Gomphidius viscidus*, *Suillus grevillei*, and *Suillus luteus* on the growth of *P. tabulaeformis* seedlings under greenhouse conditions. The growth parameters of *P. tabulaeformis* seedlings were evaluated 90 days following fungal colonisation. The majority of seedlings were significantly affected by ECM inoculation. Mycorrhizal inoculated seedlings were taller, had more lateral roots, and a greater biomass compared with the non-mycorrhizal (CK) seedlings. With the exception of *G. viscidus*, inoculated seedlings exhibited higher phosphorus, potassium, and nitrogen content compared with the CK seedlings. In addition, ECM colonisation increased the enzymatic activity of catalase, acidic phosphatase, protease, and the urease content in the rhizosphere soil. Our study showed that *Laccaria laccata*, *Suillus grevillei*, and *Suillus luteus* may be useful for improving the growth and cultivation of *P. tabulaeformis* seedlings. Furthermore, we observed that *S. luteus* inoculation increased the gas exchange parameters of *P. tabulaeformis* seedlings under field conditions.

Keywords: ecto-mycorrhizal fungi; enzymatic activity; *Pinus tabulaeformis* Carr.; seedling growth

1. Introduction

Pinus tabulaeformis is widely cultivated in arid and semi-arid regions of China and has a strong adaptability to dry and barren habitats. Due to its versatility and resiliency, it is considered an important tree species for forest restoration in Northwestern China. Moreover, it provides other important ecosystem functions, including enrichment of headwaters, soil fertility, and water conservation [1,2].

Reduced amounts of root hairs on the *Pinus* species have contributed to the evolution of mycorrhiza, which are particularly important for the absorption of water and nutrients [3]. Ectomycorrhizal (ECM) fungi can ameliorate the growth of seedlings by improving water and nutrient uptake from the soil [4]. Without ECM fungi, *P. tabulaeformis* seedlings may not develop normally [5]. Ectomycorrhiza also play an important role in protecting plants against environmental stress, such