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Original article

Influence of the fertilisation method in controlled ectomycorrhizal inoculation of two Mediterranean pines

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Abstract – The influence of the fertilisation method: soluble (SF) vs. slow-release fertiliser (SRF) and of inoculation with *Laccaria laccata* (Scop.) Fr., *Pisolithus tinctorius* (Pers.) Coker & Couch and *Melanogaster ambiguus* (Vittad.) Tul & C. Tul. on ectomycorrhizal colonization and growth of *Pinus pinea* L. and *Pinus pinaster* Ait. was evaluated. For both pines, mycorrhization with *L. laccata* was not affected by the fertilisation method. Percentages of ectomycorrhizas (ECM) formed by *P. tinctorius* were dependent on the fertilisation method, the inoculum type (vegetative or spores) and the pine species involved. ECM formed by *M. ambiguus* were increased with fertilisation in both pines. Inoculation significantly improved *P. pinea* biomass when seedlings were fertilised with SRF whereas no effect was found in non-fertilised ones. For non-fertilised *P. pinaster*, inoculation with *L. laccata* and both inocula of *P. tinctorius* increased seedling biomass whereas fertilisation neutralised the fungal effect. Fertilisation increased *P. pinea* and *P. pinaster* biomass, independently of the inoculation treatment.

***Pinus pinea* / *Pinus pinaster* / controlled mycorrhization / ectomycorrhizal fungi / seedling nursery production / fertilisation**

Résumé – Influence de la méthode de fertilisation sur la mycorhization contrôlée de deux espèces de Pins méditerranéens. L'impact sur le degré de mycorhization et la croissance de jeunes plants de *Pinus pinea* L. et de *Pinus pinaster* Ait., de deux méthodes de fertilisation (fertilisant soluble (FS) et fertilisant à libération lente) et d'une inoculation contrôlée avec *Laccaria laccata* (Sco.) Fr., *Pisolithus tinctorius* (Pers.) Coker et Couch et *Melanogaster ambiguus* (Vittad.) Tul et C. Tul. Pour les deux pins, la mycorhization avec *Laccaria laccata* n'a pas été modifiée par la méthode de fertilisation. Le pourcentage d'ectomycorrhizes (ECM) formé by *P. tinctorius* dépendait de la méthode de fertilisation, su type d'inoculum (spores ou inoculum végétatif) et de l'espèce de pin. La fertilisation a augmenté les ECM produites par *Melanogaster ambiguus* chez les deux pins. L'inoculation a augmenté significativement la biomasse des semis de *Pinus pinea* lorsqu'ils ont été fertilisés avec SRF tandis qu'aucun effet n'a été trouvé pour les traitements non fertilisés. Pour les semis non fertilisés de *Pinus pinaster*, l'inoculation avec *Laccaria laccata* et avec les deux inoculums de *Pisolithus tinctorius* a augmenté la biomasse des semis tandis que la fertilisation a neutralisé l'effet de l'inoculation. La fertilisation a augmenté la biomasse de *Pinus pinaster* et de *Pinus pinea* indépendamment du traitement d'inoculation utilisé.

***Pinus pinea* / *Pinus pinaster* / mycorhization contrôlée / champignon ectomycorhizien / pépinière de production de semis / fertilisation**

1. INTRODUCTION

Fertilisation is a key factor for producing high quality nursery stock destined to reforestation [17]. An optimal fertilisation method adjusted to the tree species produced in the nursery will ensure the improvement of physiological traits such as growth, nutrient storage, photosynthetic rates and root growth potential [18]. The application of soluble fertilisers and the addition of slow-release fertilisers to the potting substrate are the two fertilisation methods most commonly used in nurseries [3, 37]. Soluble fertilisers can be more precisely adjusted than slow-release ones for each developmental stage of tree seedlings [28, 30] and they are commonly applied with the nursery irrigation system. On the other hand, slow-release fertilisers are easier to apply providing an important economical advantage for producing nursery tree seedlings at a commercial scale. Additionally, the effect of slow-release fertilisers can persist after outplanting [31].

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Spontaneous mycorrhization of seedling commonly occurs in nursery although usually opportunistic fungi with low host specificity have been reported [11, 16, 19]. Inoculation with selected ectomycorrhizal fungi has been often signalled as a promising practise for improving the quality of nursery seedling stock [4, 11, 21]. Mycorrhization not only improves seedling growth and their photosynthetic capacity [12] but also notably extends the root surface allowing seedlings to a better exploration of soil after out-planting [36]. Obtaining a well-developed root system of seedlings in nursery is important since a vigorous root growth contributes to the ability of seedlings to overcome post transplanting stress [15]. Mycorrhization can be an important advantage for seedlings to surmount transplanting stress [7, 36] especially under unfavourable field conditions such as those imposed by the Mediterranean climate [25, 34]. When nursery production of mycorrhizal plants is desired, an adjustment of the fertilisation regime becomes essential, since high fertilisation inputs usually inhibit the formation of ectomycorrhizas [4, 14, 35].