Vermicompost as potting amendment for the growth of different progenies of pine seedlings (*Pinus pinaster*)

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Key words: Vermicompost, forest nursery, *Pinus pinaster*, plant growth, amendment x plant genotype interaction.

Abstract

We investigated the effect of vermicompost on pine seedling growth independently of nutrient mediated effects, and the influence of plant genotype on the response to the addition to this kind of organic amendment. Vermicompost was incorporated, either solid or liquid, at several doses into the potting media of five selected pine progenies. Growth and maturation of the seedlings were evaluated 20 weeks after sowing.

Introduction

Conventional forestry breeding entails the use of big amounts of mineral fertilizers and peat. Environmentally-friendly alternatives contemplate the incorporation of organic fertilizers as a partial substitution of peat, a non-renewable resource, and substitute of the expensive mineral fertilizers. Several benefits of the use of vermicomposts as organic amendments in agriculture, ranging from their physical to their biological properties, have been described. Vermicompost constitutes a slow release source of nutrients that provides the plants with the nutrients when they are needed (Chaoui et al., 2003); in addition, several studies have shown that vermicompost performed better than the equivalent mineral fertilization when it constituted a relatively low proportion (10-20%) of the growing media of various plant species either in greenhouse or field trials (Atiyeh et al., 2000; Arancon et al., 2005). Furthermore, biologically active metabolites such as plant growth regulators (El Harti et al., 2001) and humates (Canellas et al. 2002) have been discovered in vermicomposted materials. Nevertheless, the effects of vermicompost have been described mainly on horticultural and ornamental plants and to a lower extent in forestry species. In addition, contradictory results are found in the literature concerning vermicompost effects on plant growth which might depend to a great extent on the plant species assayed. Besides, vermicompost effects might vary between genotypes of the same species. In this study, small proportions of vermicompost -either solid or liquid- were added to the potting media of different progenies of pine seedlings and without nutrient limitations, in order to investigate the existence of possible biological growth promotion effects, and the influence of plant genotype.

Materials and methods

Seeds with different genotypes belonging to five open-pollinated progenies of P. pinaster selected for superior growth stem form and branch characteristics were collected from an experimental orchard in Sergude (Galicia, NW Spain). Additionally a commercial mixture of seeds from different progenies was included for comparison. Five seeds belonging to the same progeny were sown in 4 L plastic pots. The basic potting mixture consisted on peat and perlite (1:1 v:v) where the following treatments where applied: (i) 0% substitution of peat by vermicompost (ii) 2.5 % substitution of peat by vermicompost; (iii) 5% substitution of peat by vermicompost; (iv) 10% substitution of peat by vermicompost; (v) 25% substitution of peat by vermicompost; (vi) vermicompost tea, in a dose equivalent to 2.5% of peat substitution by vermicompost; (vii) vermicompost tea in a dose equivalent to 25% of peat substitution by vermicompost. A slow-release mineral fertilizer was added to all the treatments and controls to avoid nutrient limitations. Pots were located in a greenhouse with controlled temperature and moisture following a randomized block design. After 20 weeks, the pine seedlings where harvested and their growth was assessed by measuring shoot height and diameter and biomass of shoots, leaves, and roots. The early ontogenic development of the plants was evaluated through the number of lateral branches and the amount of mature needles formed. Data were analyzed using GLM, with genotype and treatment as main factors. Seed weight and date of germination were introduced as covariables. Significant differences were further analysed with Tukey HSD test.

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Results

Most of the parameters measured were under a strong genetic control. Nevertheless the effect of the treatments was observed in most of the parameters measured. Both aerial and root biomass of the pine seedlings were significantly influenced by the treatments applied in the potting medium (aerial biomass: $F_{6, 751}$: 2.9962, P< 0.05; root biomass: $F_{6, 103}$: 2.87081, P< 0.05) (Figure 1). Whilst the lowest doses resulted in similar yields than the control (0% substitution), substitutions of 25% of the peat by solid vermicompost produced significant reductions of shoot and root biomass. Decreases in aerial biomass were due to significant reductions in needle biomass ($F_{6, 746}$= 3.2216, P<0.05), diameter $F_{6, 751}$= 5.8835, P<0.01) and height $F_{6,744}$= 4.392, P< 0.01) of the shoot in seedlings with 25% of peat substitution. These reductions were similar for all the genotypes, significant interactions between treatment and genotype were only observed in shoot height ($F_{30,744}$= 1.882, P<0.01). Similarly, reductions in root biomass were attributable to the decrease in the abundance of fine roots ($F_{6, 103}$= 3.20522, P<0.05) while thick roots were unaffected. The substitution of peat by vermicompost influenced as well the early ontogenic development of the seedlings as showed by the number of mature needles ($F_{6, 746}$= 2.5900, P< 0.05). This effect was also independent of plant genotype.

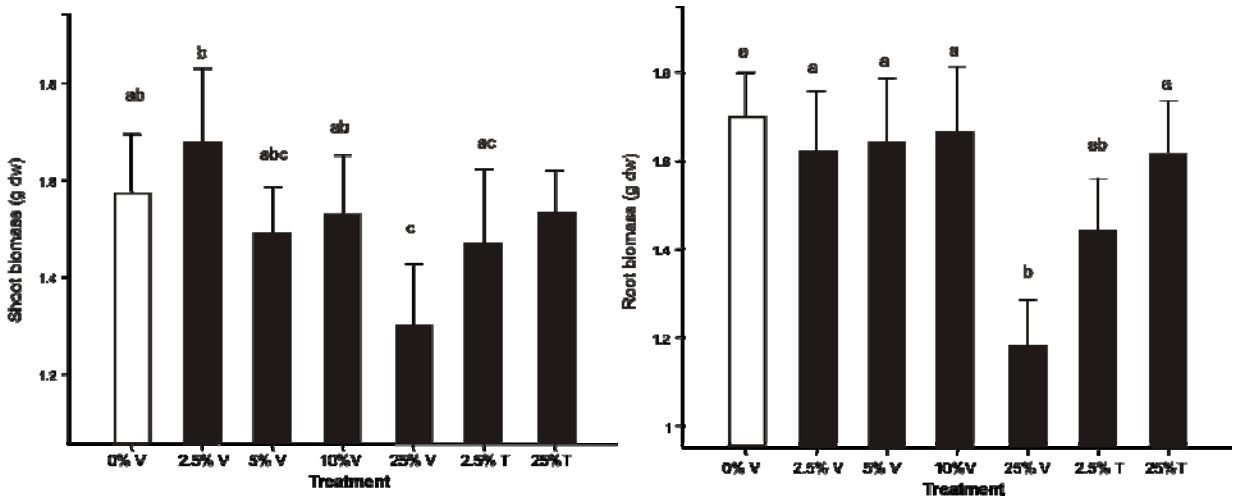

Figure 1: Effects of the treatments (0, 2.5, 5, 10 and 25% of peat substitution by vermicompost (V); and addition of vermicompost tea in doses equivalent to 2.5 and 25% of peat substitution (T)) on shoot and root biomass of the different progenies of pine seedlings.

Discussion

Although genetics have a strong influence on seedling growth during the first growing season of pine trees, nursery management practices are critical for an optimal post-transplant adaptation and field yield. Incorporation of vermicompost into the potting media could report beneficial effects derived from its biological properties. However, in contrast to previous studies, where vermicompost addition produced substantial increases in plant growth when enough fertilizers were provided as compared to mineral fertilization alone, in our study, even thought the pine seedlings were grown under optimal nursery conditions, the substitution of peat by vermicompost did not produce any further beneficial effects in seedling growth and maturing as compared to peat with mineral fertilizer alone. Moreover, the highest dose of solid vermicompost produced significant decreases in seedling biomass. Generally all the progenies responded similarly to the treatments showing the strength of the effect.

Conclusions

In order to incorporate environmentally-friendly practices into pine seedling nursery, vermicompost can be introduced successfully in pine seedling growing media at low doses without detrimentally affecting plant growth. Higher doses could affect seedling growth influencing future field performance.

The results of this experiment provide one of the first approaches to the use of vermicompost as pot amendment in forest nursery as well as a clue for a better management of this kind of organic amendments by studying their interaction with the genotype of the plants.

Acknowledgments

Cristina Lazcano is financially supported by a fellowship from “Fundación la Caixa”.

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