Enhancement of pine (*Pinus pinaster*) seed germination by vermicompost and the role of plant genotype

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Abstract

The use of organic fertilizers such as vermicompost has shown to enhance germination and growth of several plant species. Nevertheless effects might vary depending on plant genotype. Here we investigated how the incorporation of vermicompost can affect seed germination in six progenies of pine trees.

Introduction

The use of organic fertilizers such as vermicompost might be considered in forest nursery as a mean to reduce expenses and adopt more environmentally-friendly practices. Genetic improvement programs select genotypes that best meet the requirements for a good adaptation to the environment and optimal yields; nevertheless, given the phenotypic plasticity of the species, their growth and field performance might vary depending on the environment and breeding practices. Several studies have demonstrated that vermicompost can improve germination and enhance growth in some plant species and at very low doses (Edwards et al., 2004; Zaller, 2007); nevertheless, the effects of vermicompost have been described mainly on horticultural and ornamental plants and to a lower extent in forestry species. Besides, vermicompost effects might vary between genotypes of the same species. We therefore investigated the effect of vermicompost, on the germination and early development of six progenies of *Pinus pinaster*.

Materials and methods

Pine seeds from six open-pollinated *P. pinaster* families, selected for superior growth, stem form and branch characteristics, were collected from an experimental orchard in Sergude (Galicia, NW Spain). Eight seeds belonging to the same family were sown in 500 ml pots, filled with perlite and a superficial layer of 3 cm of sand, where the treatments were applied. Treatments consisted in: (i) solid vermicompost incorporated into the sand layer (1:1, v:v), (ii) vermicompost tea administrated once a week. Controls were made with no vermicompost addition. Seedling development was divided in four early developmental stages comprising from emergence to the appearance of the second set of needles and a number (1-4) was assigned to each of them. Seed germination, seedling growth at stage 4 and ontogenic development were evaluated. Data were analyzed using ANOVA with genotype and treatment as main factors and seed weight was introduced as a covariable. Significant differences were further analysed with Tukey HSD test.

Results

As expected, both germination and early development of the seedlings were under a strong genetic control. In addition, the amendment with organic products significantly affected most of the parameters studied. Both solid and liquid vermicompost showed to be suitable amendments for the potting media of pines. The percentage of final germination was increased by vermicompost tea addition (Treatment: $F_{2,61}$= 5.1171, P<0.01; figure 1) and the seeds that germinated with vermicompost tea matured faster that those germinated in vermicompost (Treatment: $F_{2,61}$= 4.197, P<0.05; figure 1). The seedlings amended with vermicompost and the ones with vermicompost tea showed significantly lower root biomass than the controls (Treatment: $F_{2,61}$=5.534, P<0.05). However the treatment factor did not affect the aerial biomass, and the smaller root biomass observed in those treatments did not generated nutrient deficiencies, since nitrogen concentration in the seedlings amended with vermicompost products were significantly greater than in the control plants (Treatment: $F_{2,61}$=7.326, P<0.01). Most of the genotype x treatment interactions were not significant, showing that the vermicompost effects were similar through the six families assayed.

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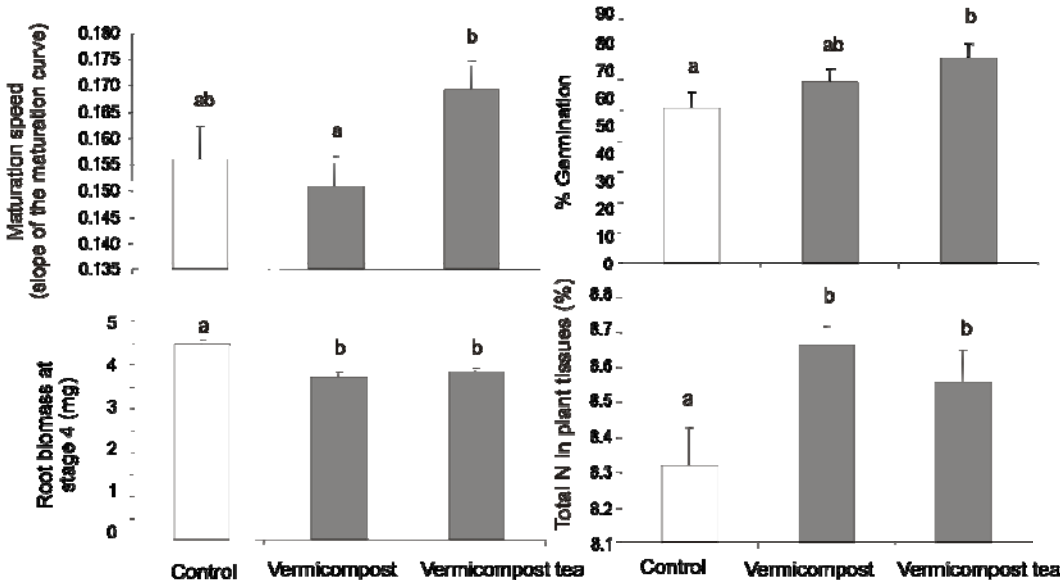

Figure 1: Maturation speed, % of final germination, root biomass at stage 4 and total N in plant tissue, of the pine seedlings germinated in sand (control), sand+ vermicompost (vermicompost), and sand+ vermicompost tea (vermicompost tea). Means ± standard error. Different letters indicate significant differences at P< 0.05.

Discussion

Although germination is an internally regulated process influenced mainly by seed genotype, external factors such as light period, temperature, moisture, and application of certain chemical compounds can also alter this process, either through promotion or inhibition. Generally, the results observed here show that the incorporation of solid vermicompost in the growing media of pine is possible without detrimentally affecting germination of the seeds; moreover, vermicompost can promote germination when it is applied as a tea independently of seed genotype. Incorporation of vermicompost may improve physical properties of the pots such as moisture retention and aeration when compared to sand alone. Nevertheless, percentage of final germination was increased with liquid vermicompost showing that other factors rather than physical were responsible for higher germination. Growth was also influenced by the treatments applied independently of the genotype and the seeds germinated with vermicompost tea grew faster than the ones germinated in vermicompost or the control medium. Furthermore, seedling biomass, which was under strong genetic control, was decreased by vermicompost addition (either solid or liquid) due to the decrease of root biomass. However, this decrease was not attributable to a nutrient deficit, since seedlings with vermicompost and vermicompost tea had significantly higher N content, or to the physical features of the growing media, since the effects were observed both in solid and liquid vermicompost. Probably the higher nutrient availability in the vermicompost treatments made unnecessary the root development observed in the control.

Conclusions

Vermicompost, either solid or liquid, seemed to be an adequate amendment for pine seed germination increasing the number of seeds germinated and accelerating seedling development. The higher nutrient content seems to be responsible for decreased growth and faster maturation, but other mechanisms which still need to be investigated, might be involved in the promotion of germination.

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References

Zaller, Johann G. (2007). Vermicompost as a substitute for peat in potting media: Effects on germination, biomass allocation, yields and fruit quality of three tomato varieties. Scientia Horticulturae. 112, 2: 191-199.

Edwards, C.A. Domínguez, J. and Arancon, N.Q. (2004). The influence of vermicomposts on plant growth and pest incidence. In: S.H. Shakir and W.Z.A. Mikhail, (eds.), Soil Zoology for Sustainable Development in the 21st Century, Self-Publisher, Cairo, Egypt, pp. 397–420.