

# The Potential of Breeding for Enhanced Inducibility in *Pinus pinaster* and *Pinus radiata*

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## Abstract

Most resistance mechanisms against pests and pathogens in pine trees involve the production of chemical defenses. These defenses are not cost free and the production of secondary metabolisms is generally inversely related with other plant fitness correlates, such as growth. The existence of these negative genetic correlations imposes an important obstacle for breeding for resistance and productivity simultaneously. Increased susceptibility to pests and diseases is, indeed, a common side-effect of enhancing productivity in many tree breeding programs. In a companion communication (Sampedro et al., these proceedings), we have reported negative correlation between constitutive resistance and growth potential of pine trees.

Pines are able to respond to insect and fungus attacks eliciting a wide array of responses. Induced defenses, i.e., those that are activated after biotic damage, are assumed to have evolved as a cost-saving strategy, as costs of induced resistance materialize only when strictly necessary. Despite the fact that breeding for resistance is emerging as an important tool to diminish the impact of forest pests and diseases on managed forests, to date no attention has been paid to the possibility of improving forest resistance through breeding for improving inducibility, i.e., the ability to respond to biotic damage eliciting induced defenses. Such a breeding strategy could likely integrate the benefits of both resistance and productivity, as inducible defensive strategies are cost saving. The very first step to explore whether inducibility can be increased through breeding is to determine whether these phenotypically plastic responses are under genetic control. Here we show that inducibility of chemical defenses in *Pinus pinaster* Aiton and *P. radiata* D. Don, two main forest tree species in southwestern Europe and other temperate regions, is genetically variable within populations.

We performed two greenhouse experiments with half-sib families of the two pine species. Plant material was a random selection of the actual breeding populations of these species in northwest Spain. We simulated biotic damage by spraying a solution of methyl jasmonate (MJ), a plant phytohormone that is known to be involved in the signalling and triggering of induced defenses, and when exogenously applied, elicit similar responses as real herbivory. Fifteen days after MJ application, we measured the concentration of diterpenes in the stem, total polyphenolics, and condensed tannins in the needles as measures of quantitative chemical defenses.

We found large genetic variation in all the defensive traits studied, but more interestingly, we also found additive genetic variation in the inducibility of the stem diterpenes in both species, as revealed by the significant family  $\times$  MJ interaction. Although family  $\times$  MJ interaction was not significant for phenolics, the different levels of genetic variation observed in control and MJ-induced plants, with significant differences among families found only in the MJ-induced treatment, does show the existence of genetic variation in the inducibility in this trait, too. Results indicate the existence of additive genetic variation for the inducibility of the three studied defensive traits in the two pine species, and the possibility of improving resistance of managed forests by artificially selecting for high inducibility potential, thus minimizing the possible undesired side-effects of enhancing productivity.

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