Genetic variation and phenotypic plasticity of nutrient re-allocation and increased fine root production as putative tolerance mechanisms inducible by methyl-jasmonate in pine trees

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Plants have evolved two kinds of defensive strategies against their enemies: those based on resistance and avoidance, aimed to deter, reduce or delay current and subsequent attacks, and those based on tolerance, that is, the ability to maintain the performance irrespective from the damage inflicted by the herbivores. The ability of plants for increase their resistance in response to damage signalling (known as induced resistance) has been broadly studied across the plant kingdom. However, less attention has been focused on identifying specific mechanisms of plant tolerance. Just recently, researchers have found that perception and signalling of damage also involves quick changes in primary metabolism such as preferential re-allocation of biomass or nutrients towards specific storage tissues, which could be putatively aimed to tolerate herbivory damage. Here we showed that damage signalling in young pine trees involves two quick and strong tolerance mechanisms: an intense preferential allocation of biomass to the fine roots system (induced plants increased nearly 2-fold their fine root biomass in just 15 days), and a marked increase in the concentration of nutrients in the stem. Interestingly, we observed that boosting of fine roots appeared to be a generalized strategy, with no genetic variation and weak environmental modulation, whereas induced shifts in nutrients to the shoots were strongly affected by soil phosphorus availability. These tolerance responses could putatively improve the plant ability for absorption of water and nutrients from the soil, favouring a quick recovering after damage. We also suggest that these kinds of responses could require a greater energy investment that those allotted to the synthesis of induced chemical defences.