NUTRIENT RE-ALLOCATION AND INCREASED FINE ROOT PRODUCTION AS PUTATIVE TOLERANCE MECHANISMS INDUCIBLE BY HERBIVORY IN PINE TREES: LOOKING FOR BELOWGROUND MICROBIAL PARTNERS OR MOVING RESOURCES AWAY FROM HERBIVORES?

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Pine trees are big, apparent, long-lived plants that have to cope against a vast array of biological enemies and lots of herbivory events during their lifespan. Pine species usually show large distribution ranges across heterogeneous soil fertility and climatic conditions, and they have to continuously readjust the allocation of the limited resources to their live functions according to the changing environmental circumstances. As other plants, pines 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 by plants 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.

Previous research in pine trees has showed that besides resistance against insect herbivores, tolerance strategies are very important in this conifer group. Both resistance and tolerance are genetically variable at the population and species level, and both depend on nutrient availability. We found that resistance traits are inducible by herbivore signalling, and we studied in more detail whether phenotypic traits putatively related to medium term tolerance could be also inducible by herbivory.

In an experiment with young pine trees, we found that damage signalling with jasmonate 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 (N and P) 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 kinds of responses could require a greater energy investment in terms of carbon that those allotted to the synthesis of induced chemical defences. We found these results in two
relevant forest pine species (Pinus pinaster and P radiata). We found similar results also with real herbivory by a phloem feeder weevil, but we unknown at what extent these responses are extensively to other feeding guilds.

We are now exploring if these responses are aimed to move resources away from herbivores, as proposed by some authors in other systems, or alternatively could be putatively aimed to improve the plant ability for absorption of water and nutrients from the soil, favouring a quick recovering after damage. Pine trees support extensive populations of herbivore insects and also massive micorrhizal communities, however little is know about their interaction. Now we are interested in studying the effect of herbivory on further tolerance at field, and also if carbon derived to fine roots in response to herbivore damage is also involving carbon transfer to rhizosphere microbiota, in particular to ectomicorrhizal fungi.