

Behind (and below) the growth rate of Norway spruce

As plant-associated microbes are suggested to largely determine the competitive success of their hosts, we have tried to estimate the role of belowground fungal communities for variation in long-term growth rate of Norway spruce. We explored the possible mechanistic role of symbiotic ectomycorrhizal fungi on the development of Norway spruce seedlings by utilizing tree breeding material, spruce families verified to differ in their long-term growth rate.



Photo: Metla/ Erkki Oksanen

Fast growing spruce trees possessed a diverse mycorrhizal community

Our results from a clonal field trial demonstrated that diversity of symbiotic mycorrhizal fungal correlates positively with the long-term growth rate of host trees. 14-yrs-old, fast-growing spruce clones had almost double the number of ectomycorrhizal fungal taxa associated to their roots compared to the slow-growing spruce clones of equal age. This observation made us to ask if a mechanistic link between fast growth and mycorrhizal fungal diversity of spruce exist, ie. is high diversity of mycorrhizal fungal community in fast-growing spruce genotypes reason or result of their good growth?

In the early stage of tree development the richness of mycorrhizal fungi was equal

Thereafter we studied the susceptibility of spruce seedlings of fast- and slow-growing origins to fungal infections before the differences in the growth rates appear. It was found out that Norway spruce does not show a strong genetic selection of its fungal populations (mycorrhizas or needle endophytic fungi) and that the mycorrhizal richness of young seedlings does not correlate with later growth performance of Norway spruce. However, the mycorrhizal short root architecture was under a strong genetic control of the host tree, even more strongly than growth of the stem. It seems that the superior growth rate is correlated to characteristic resource allocation and root architecture in the juvenile stage: as young seedlings, fast-growing families allocated resources to belowground root growth and the slow-growing ones invested more into aboveground growth. Also under attack of pathogenic fungi these spruce origins showed similar variation in their resource allocation patterns.

Different response to fungal infections

Taken together, these observations indicate that the belowground investment of host photosynthesized carbon might occur primarily via host genotypic control over root growth and subsequent ECM fungal colonization and nutrient uptake in the early stage of development. Furthermore, our key finding was that in terms of resource allocation, fast- and slow-growing spruce families responded differently to both mutualistic and pathogenic fungal associations. This could be one of the mechanisms behind the suggested influence of fungi on the competitive status of their hosts.



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