Putting a young forest under a microscope – and seeing fungi

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It is predicted that the amount of precipitation will increase in the near future in northern temperate and boreal forest bioregions. More frequent precipitation will be concomitant with a rise in air humidity, especially within forest canopies. This future climate change scenario is simulated in the Free Air Humidity Manipulation experiment in South-East Estonia, where there are plots of forests growing under increased relative air humidity (RH) and soil moisture treatments compared to ambient conditions. Along with tree physiology, foliar fungi are also influenced by changes in environmental conditions. We investigated what effect these changes have on the density of Norway spruce needle colonization by fungi.

Norway spruce needles were sampled for scanning electron microscope imaging in winter of 2023. Two machine learning models were trained to recognise fungal hyphae, one in interstomatal areas and the other in epistomatal areas of the needle. The resulting datasets were then used to calculate various traits of fungal hyphae (diameters, coverage area, and length) on spruce needles and relate them to environmental conditions.

We found that elevated RH significantly reduces hyphal coverage of spruce needles in interstomatal areas, but not in epistomatal areas. Hyphal diameters were also reduced under higher RH. This has some implications for forest fungal biology. It appears that increased precipitation may make it more difficult for fungi to survive on the surface of the needles. However, since fungi often use stomata as a gateway to colonize the interior of the leaf, we can conclude that detrimental effects that increasing air humidity has on foliar fungi may be confined to outer surfaces of leaves.

Reduction of hyphal coverage of interstomatal areas coincided with a change in structures of cuticular wax, while structures of stomatal waxes remained uninfluenced by a change in RH. From this we concluded that the decline in hyphal colonization density observed under elevated RH was driven by changes in waxes, which consisted mostly of tubular granules and tufts, compared to smoother plate-like and amorphous waxes in ambient conditions.