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Effect of water supply on the tree biodiversity - soil nutrient availability relationship in forests along the soil profile

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An increasing number of studies demonstrate that tree species biodiversity affects primary productivity and nutrient cycling in forests due to several factors, such as complementarity, facilitation or selection effects. For instance, resource partitioning in soils has been found to allow a more optimized nutrient uptake in mixed species plots compared with monocultures. However, how these effects will be modified by climate change (e.g. water supply) is not as well understood, especially in deep soil layers.

Therefore, we specifically asked how water supply may influence the effect of tree diversity on soil microorganism activity by measuring nutrients along the soil profile. This study was conducted on a 10-year-old plantation in southwestern France which manipulates tree biodiversity (Pinus pinaster and Betula pendula, in monocultures and in mixed plots) and water resource, simulating drought effects through irrigation. We sampled soil at five different depths (0-5, 5-15, 15-30, 30-60, 60-90 cm) and measured bioavailable nitrogen and phosphorus.

We found a decoupling of nitrogen and phosphorus availability when studying the water supply and tree biodiversity interaction. Bioavailable nitrogen was affected by the interaction between irrigation and the soil profile similarly in both monoculture and mixed plots. This effect was strongest in the lower layers, due to an increase in nitrate, a mobile form of nitrogen, which allowed a trickle-down effect to deeper layers in the irrigated plots. Phosphorus bioavailability was highest in the 5-15cm layer for all plots, but varied along the profile differently in monocultures and mixed plots. This may be due to an increase in microbial activity in mixed plots, which we will further investigate with upcoming enzymatic assays.

Our results show that irrigation increased bioavailable nitrogen and that tree species diversity affected bioavailable phosphorus, but that these effects varied along the soil profile for both nutrients in our forest soils. These differences along the soil profile highlight the importance to look at different soil depths to better understand how climate change may influence biodiversity effects on nutrient cycling.