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Tree species effects are amplified by clay content in acidic soils

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The tree species composition of many forests in western and central Europe has changed considerably over the last century, as large areas of mixed deciduous forests were replaced by conifer plantations. In this study, we aim to evaluate whether conversion of mixed broadleaved forest to Norway spruce (Picea abies) on the acidic soils of the Gaume forest (southern Belgium) affected soil quality in terms of soil acidity, exchangeable calcium and aluminium, humus type and earthworm communities, and determine whether this effect is mitigated or amplified by an edaphic gradient in clay content. In this ancient deciduous woodland, stands were partly converted from mixed deciduous forest to Norway spruce monocultures 30 to 60 years ago. A twin-plot setup was established, where we sampled pairs of adjacent deciduous and Norway spruce plots along a gradient in clay content varying between 3 and 34 %. This design allowed to evaluate the effects of soil type and conversion independently. In the deciduous plots, forest type ranged from mixed oak-hornbeam forest to oak-beech forest. The first has a higher clay content, higher exchangeable calcium, mull humus type, low forest floor mass and the presence of burrowing earthworms (endogeics), while the latter is characterised by high forest floor mass and presence of only litter-dwelling earthworms (epigeics), respectively. Our results evidence that the natural biogeochemical gradient converges to a narrow and acid range after conversion. When comparing Norway spruce plots with adjacent broadleaved stands, topsoil pH, calcium concentrations and total earthworm biomass were significantly lower, endogeic and epi-anecic earthworms were mostly absent, and the exchangeable aluminium was significantly higher. Contrary to the current paradigm, the impact of conversion in these acidic soils is largest for the stands with the highest clay content, where the larger exchange capacity allows greater accumulation of exchangeable aluminium when pH becomes sufficiently low. These findings have important implications for forest management: for systems near a threshold in soil process domain, it is important to realise that the sites with the best soils, higher CEC and more favourable pH-values are the ones that will have larger trajectories and deteriorate the most upon acidification, and hence restoring such stands into more natural deciduous or mixed forest may become increasingly difficult.