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# The legacy effect of synthetic N fertiliser

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Cumulative crop recovery of synthetic fertiliser nitrogen (N) over several cropping seasons (legacy effect) generally receives limited attention. The increment in crop N uptake after the first-season uptake from fertiliser can be expressed as a fraction (ΔRE) of annual N application rate. This study aims to quantify ΔRE using data from nine long-term experiments (LTEs). As such, ΔRE is the difference between first season (RE1st) and long-term (RELT) recovery of synthetic fertiliser N.

In this study, RE1st was assessed either by the 15N isotope method, or by a zero-N subplot freshly superimposed on a long-term fertilised LTE treatment plot. RELT was calculated by comparing N uptake in the total aboveground crop biomass between a long-term fertilised and long-term control (zero-N) treatment. Using a mixed linear effect model, the effects of climate, crop type, experiment duration, average N rate, and soil clay content on ΔRE were evaluated.

Because the experimental setup required for calculation of ΔRE is relatively rare, only nine suitable LTEs were found. Across these nine LTEs in Europe and North America, mean ΔRE was 24.4% (±12.0%, 95% CI) of annual N application, with higher values for winter wheat than for maize. This result shows that fertiliser-N retained in the soil and stubble may contribute substantially to crop N uptake in subsequent years. Our results suggest that an initial recovery of 43.8% (±11%, 95% CI) of N application may increase to around 66.0% (±15%, 95% CI) on average over time. Furthermore, we found that ΔRE was not clearly related to long-term changes in topsoil total N stock. Our findings show that the - often used - first year recovery of synthetic fertiliser N application does not express the full effect of fertiliser application on crop nutrition. The fertiliser contribution to soil N supply should be accounted for when exploring future scenarios on N cycling, including crop N requirements and N balance schemes.

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