Nitrogen mineralization: a review and meta-analysis of the predictive value of soil tests

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Accurate estimation of mineralizable nitrogen (N) from soil organic matter is essential to improve fertilizer management in agricultural systems. Mineralizable N refers to the amount of N in soil that is released during a certain period (ranging from 1 week to the length of a growing season). It has been estimated from increases in inorganic N during incubation or from N uptake by plants grown in a greenhouse or field. Many chemical soil tests measuring extractable organic N (EON) fractions have been proposed to predict mineralizable N. We evaluated the predictive value of these soil tests, using 2068 observations from 218 papers. Meta-analysis was used to find the best soil test, to analyse differences between field and laboratory experiments, and to determine whether their predictive value is affected by extraction intensity (% of total soil N that is extracted). The concentration of EON was positively related to mineralizable N, explaining on average 47% of the variation. It did not, however, explain more of the variation than total N. Best predictions ($57\% < R2 < 74\%$) were obtained when EON was extracted with hot $CaCl_2$, acid $KMnO_4$, acid $K_2Cr_2O_7$, hot water or hot KCl. Extraction intensity was not related to the strength of the above-mentioned relationship. Predictions of mineralizable N were significantly worse when mineralization was measured in the field compared with measurements under controlled conditions. We found no evidence of a causal and direct relationship between EON and mineralizable N. Accuracy of soil testing may improve when the current 'single soil test approach' changes to a more complex approach, which includes different soil tests, soil properties and environmental conditions.