

Nitrogen isotope analysis to trace sources and degradation of glyphosate and its metabolite AMPA

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To assess sources and degradation of the herbicide glyphosate (*N*-phosphonomethyl glycine) and its metabolite AMPA (aminomethylphosphonic acid) in the environment, concentration measurements alone are often inconclusive [1]. To advance an alternative approach, we present compound-specific nitrogen isotope analysis (¹⁵N/¹⁴N) of glyphosate and its metabolite AMPA by derivatization-gas chromatography/isotope ratio mass spectrometry (GC/IRMS). In the first step the N-H group was derivatized with isopropyl chloroformate (iso-PCF). In the second step, remaining acidic groups were methylated with trimethylsilyldiazomethane (TMSD) [2]. Accurate δ¹⁵N values were obtained (deviation from elemental analyzer-IRMS): 0.23‰ ± 0.88‰ for glyphosate and 0.37‰ ± 0.70‰ for AMPA with a limit of precise δ¹⁵N measurements of 150 ng (glyphosate) and 250 ng (AMPA), respectively. Isotope values in commercial products ranged from +3.3‰ to -1.9‰ for δ¹⁵N and from -24.6‰ to -33.7‰ for δ¹³C (measured with liquid chromatography-IRMS) [3]. Nitrogen isotope fractionation during abiotic degradation of glyphosate with manganese dioxide (MnO₂) were as high as ε_N = -17‰ ± 0.5‰ indicating that AMPA formation by C-N bond cleavage rather than sarcosine formation by C-P bond cleavage [4] was the dominant initial step. Dual element isotope plots illustrate the potential of combined carbon and nitrogen isotopes analysis to trace sources and environmental fate of glyphosate and AMPA [5].

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