Testing and evaluation of laboratory methods for the assessment of mineralizable nitrogen from bio-based fertilizers

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Introduction

Bio-based fertilizers (BBFs) are an increasingly popular source of nutrients in agriculture which enables to close nutrient cycles on the regional scale. The recently reinforced European Fertilizer Regulation (Fertilizing Products Regulation (EU) 2019/1009) represents the legal basis to facilitate the international commerce of BBFs by laying the foundation for a BBF categorization approach. However, a more refined categorization reflecting the mineralization-dependent nutrient release of BBFs is key for the appropriate use of these fertilizers.

Methodology

In this study we assessed mineralizable nitrogen (N) and carbon (C) of a representative selection of 32 BBFs with biological mineralization assays (84-day incubations). Based on mineralizable N and C we grouped BBFs using the hierarchical clustering approach proposed by Parnaudeau et al. (2004). Tested chemical predictors for mineralizable N of BBFs were CN ratio, cold water extractable mineral N, hot water extractable N (adapted from Curtin et al. 2006a), hot potassium chloride extractable N (adapted from Chadwick et al. 2000) and sulfuric acid extractable N (adapted from Martínez & Galantini 2017). The suitability of chemical predictors was evaluated based on correlation coefficients between chemically extractable N and mineralizable N at different stages of incubation. A potential reconstruction of the mineralizable N and C based BBF grouping using multiple suitable chemical predictors was evaluated based on analyses of variance.

Results and discussion

In 84-day aerobic incubations, cumulative mineral N release from -134 (net immobilization) to 1056 mg Nmin-N g-1 amended N was achieved. Mineralized C ranged between 14% and 112% of amended C. Based on the results of the biological mineralization assays, BBFs were classified into five significantly different groups which did not reflect the categories specified by the European Fertilizer Regulation. Hot water extractions presented the lowest extraction intensities, followed by hot potassium chloride and hot sulfuric acid extractions. Cold water extractable N was most strongly correlated to mineralizable N at the start of incubation ($r = 0.99$), while hot sulfuric acid extractable N was correlated to mineralizable N after the first month of incubation ($0.73 < r < 0.85$). The CN ratios showed highest correlations to mineralizable N at the end of the incubation ($-0.83 > r > -0.86$). However, the combination of those three indicators could not discriminate BBFs into the five mineralizable N and C based groups without ambiguity.

Conclusion

The categories specified in the current European Fertilizer Regulation are not sufficient to characterize the N release of BBFs. A multiple-predictor approach exclusively based on chemical indicators targeting differently labile organic N pools of BBFs is regarded as a realistic alternative to biological characterization methods, provided that a sufficient number of suitable predictors is available.

Acknowledgements

This study was financially supported by the EU Horizon 2020 project "LEX4BIO".

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