frontiers | Frontiers in Soil Science

TYPE Editorial
PUBLISHED 13 January 2025
DOI 10.3389/fsoil.2024.1549217

OPEN ACCESS

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RECEIVED 20 December 2024
ACCEPTED 30 December 2024
PUBLISHED 13 January 2025

CITATION
Martínez I, Di Bene C and Sandaña P (2025) Editorial: Strategies to reduce fertilizers: how to maintain crop productivity and profitability in agricultural acidic soils. *Front. Soil Sci.* 4:1549217. doi: 10.3389/fsoil.2024.1549217

Editorial: Strategies to reduce fertilizers: how to maintain crop productivity and profitability in agricultural acidic soils

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KEYWORDS

environmental impact, nutritional disorder, nutritional imbalances, soil health, yield loss

Editorial on the Research Topic

Strategies to reduce fertilizers: how to maintain crop productivity and profitability in agricultural acidic soils

Although the increased use of synthetic fertilizers has improved soil nutrient availability and crop productivity, it has also increased soil acidification which can be harmful to the long-term sustainability of agroecosystems. This is particularly true for the 40% of arable lands worldwide that are naturally acid (1). Soil pH regulates the capacity of soils to store and supply nutrients and thus contributes substantially to the control of productivity. Indeed, small changes in water balance cause a steep transition from alkaline to acidic soils across a natural climate gradient, showing that climate controls many aspects of soil chemistry and thus affects soil acidity (2, 3).

This Research Topic, *Strategies to reduce fertilizers: How to maintain crop productivity and profitability in agricultural acidic soils* aimed to provide a discussion update on new strategies needed to reduce fertilizer use that will help us achieve more sustainable agriculture by promoting crops and varieties that are more resource-efficient (i.e. nutrients) and more able to adapt to specific soil conditions such as low fertility, low pH and associated aluminum and manganese toxicity. This will ensure the continued cultivation of agricultural land, minimize fertilizer inputs, and reduce transport costs - especially in remote areas - promoting organic local amendments and strengthening resource-poor low-income family farming. This Research Topic presents two review papers, namely, a worldwide meta-analysis of 50 years of research and a study of farmers' perception of the environmental impact of chemical fertilizers. Some of the highlights from the six articles published in this Research Topic are summarized below.

The study by Moggia et al. demonstrated that the methodology used to predict early nutritional imbalances in commercial apple orchards grown on acidic soils is essential to understanding the factors that determine Bitter pit (BP), a post-harvest apple disease linked to mineral imbalances like potassium and calcium deficiencies. It is challenging to predict BP, due to the variability in mineral content within and across fruits. X-ray fluorescence

(XRF) spectrometry allows non-destructive analysis of mineral composition in individual apples, aiding prediction. This study tested multivariate modeling with XRF data to improve BP prediction. Using a balanced dataset of BP-affected and healthy apples, four additional elements (Cl, Si, P, S) were identified as predictors alongside K and Ca. Multivariate models outperformed univariate methods, achieving sensitivities and specificities of 0.76–0.92, highlighting XRF's potential for precise BP prediction. This BP prediction could be performed periodically throughout the season, which is of great importance to improve the effectiveness of foliar calcium applications. Dai et al. explored the best fertilization management strategy to obtain high grain yield and N use efficiency in a 41-year long-term experiment in China under a subhumid climate. The authors demonstrated that NPK application plus manure addition in a soybean-maize-maize rotation increased crop yield and decreased fertilizer N losses and thus environmental risks.

Liming acidic soils is generally promoted as an effective management practice to increase soil pH and base cation concentrations and to ameliorate toxicity caused by aluminum and manganese. Enesi et al. reviewed how liming can raise pH and crop yield under different agricultural practices. The meta-analysis showed that the effect of liming on crop yield was greater in no-tillage systems than in conventional tillage systems. Application of organic fertilizer and liming increased yields more than liming and inorganic fertilizer. Xu et al. investigated the yield and nutrient composition of five forage crops and their effects on soil characteristics in the South of China. They were able to design an alternative nutrient management strategy for rice growers. While *Vicia villosa* improved soil characteristics, *Lolium multiflorum* provided higher forage yields. These results provide useful information on how to integrate forage into farming systems. Additionally, the authors found that crop species had a significant effect on the microbial community of soils, which may also affect the nutritional value of crops.

It has been a challenge to reduce the excessive amount of fertilizer for the production of high-yield crops. Although many studies have shown that fertilizer applications in northern China are excessive, Zou et al. investigated an optimal fertilizer rate. They found that a 10-20% reduction in fertilizer application is safe and feasible to maintain maize production in the region. Sande et al. discussed strategies to mitigate the environmental impact of chemical fertilizers. Their systematic review explored the synergies of vermicompost, fertilizer and bio-enriched rock phosphate in nutrient management. They also discussed the importance of farmer education in fostering the adoption of sustainable practices.

Today, as fertilizer prices increase, maintaining crop productivity and profitability is a challenge. This Research Topic will offer valuable insights into strategies that provide recommendations to reduce fertilizer use and sustainably improve soil health.

Author contributions

IM: Conceptualization, Supervision, Writing – original draft, Writing – review & editing. CB: Supervision, Writing – review & editing. PS: Supervision, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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