Potential of Bio-Based Phosphorus Fertilisers to replace conventional fertilizers in Europe

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Abstract text

Phosphorus (P) is an essential plant nutrient, and mineable P deposits for production of inorganic P fertilisers are finite. Substituting conventional inorganic fertilisers with novel bio-based fertilisers (BBFs) produced from various organic wastes and side streams promotes the circular economy, but the BBFs need to be effective and reliable. Our objectives were i) to evaluate the P fertilisation effect of current and emerging BBFs using pot and field experiments, and ii) to assess the P demand in Europe based on soil P test values. To this end, i) 30 P-BBFs either commercially available or at a high developmental stage were tested in three pot trials conducted under different conditions, and a subset of eight fertilisers was also evaluated at five field sites across Europe, and ii) a prediction of Olsen P threshold values was developed in order to identify P-responsive agricultural soils of the European Union and to estimate the potential of P-BBFs to replace conventional inorganic fertilisers.

The pot experiments revealed that fertilisation efficiency of the P-BBFs depended on their dominant P species. Fertilisers containing ammonium-magnesium phosphate, monoammonium phosphate, monocalcium phosphate or dicalcium phosphate, i.e. struvites and BBFs classified as inorganic soluble (in neutral ammonium citrate, NAC) were as effective as triple superphosphate (TSP), making them highly efficient fertilisers that can be recommended for use in agriculture, as long as they fulfil safety regulations. For pyrolysed

products and organic fertilisers, the mineral replacement value (MRV) averaged 55 % across pot experiments. However, also amongst these fertilisers there were some BBFs that had a good performance in some of the trials, warranting more differentiated evaluation. In the field trials, none of the tested P-BBFs had a significantly lower agronomic efficiency than TSP. As in the pot trials, struvite and inorganic NAC-soluble fertilisers performed best when considering results averaged over field experiments, despite variations in the agronomic performance of the BBFs between the trial sites and years. Generally, the results of the field experiments were in good agreement with those from the pot experiments.

Based on a combination of Olsen P values measured in the LUCAS survey with soil pH, clay content and annual rainfall, only 28% of EU cropland soils and 43% of grassland soils were P-responsive, suggesting that most of the European demand for P fertilisers could be covered by recycling P from manure, wastewater and other organic wastes (Recena *et al*. 2022). From the farmer's perspective, however, a number of trade-offs must be accounted for when choosing between conventional inorganic fertilisers and BBFs, i.e. fertiliser cost, yield expectation, agronomic efficiency, content of other nutrients, soil quality benefits, application costs and logistics. Therefore, other incentives may be needed for farmers to choose the BBF alternative.

References

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