P SOURCES FOR ORGANIC

RELACS
IMPROVING INPUTS FOR ORGANIC FARMING

FiBL

Phosphorus sources for organic agriculture

Problem

On many organic farms, especially those without livestock, phosphorus (P) exports through the sale of produce is greater than P imports through fertilisers and purchased animal feed. While soil P reserves from residual fertiliser applied before conversion to organic farming can often deliver P for decades, mining of soils is unsustainable in the long term.

Solution

Many bio-resources, such as digestates and composts, contain P from various organic wastes. Wastewater treatment plants are a major sink for P as well. There are many options under development to recycle P from these waste streams. Some are already permitted in organic agriculture.

Outcome

Closing nutrient cycles is at the core of organic agriculture. Replenishing soil P reserves will prevent deterioration of soil fertility and sustain good productivity.

Applicability box

Input used

☐ Copper	☐ Anthelmintics
☐ Mineral oil	☐ Antibiotics
x Fertilisers	☐ Vitamins

Geographical coverage
Global

Application time
Depends on the P source

Period of impact
Mainly in the year of application plus replenishment of soil P reserves

Equipment
Typical farm machinery for spreading and incorporation

Best in
All crops

Practical recommendations

Amounts of P exported through arable crops under temperate conditions are in the order of 10-40 kg P/ha. Soil P stocks in the plough layer typically range between 1000-3000 kg P/ha, and the subsoil often contains a similar amount. If no P fertiliser is applied and plant production relies entirely on soil P mobilisation, these soil P reserves are depleted in 50-300 years, since P release from the bedrock is mostly negligible. Regular soil testing and/or calculation of nutrient budgets can show whether soil P is being depleted.

Manures are an important net input of P if the animal feed is obtained from outside the farm. On stockless farms, other P sources are needed. Rock phosphate mined from finite deposits often contains contaminants such as cadmium and is not effective as a P fertiliser above a soil pH of about 6. Therefore, various recycled P sources are recommended.

- Composts and digestates from urban organic wastes allowed in organic farming contain average P concentrations between 0.2 and 0.7% dry matter. With a typical application dose for composts and solid digestates of 10 t dry matter/ha, 20-70 kg P/ha is applied. This P is partly in inorganic form, replenishing the plant-available P stock on the short-term, and partly in organic form, providing P on the longer term.
- Meat and bone meal is a by-product of meat consumption that can be used as fertiliser after pasteurisation or pressure sterilisation. It often contains about 5% P and is marketed as commercial fertiliser. Meat and bone meal shows an increasing plant P availability with decreasing pH (pH < 6), similar to rock phosphate.
- Since direct use of sewage sludge on agricultural land is currently not permitted in organic farming, alternatives to recover P from wastewater and sewage sludge are under development. Struvite is granular magnesium ammonium phosphate with very low levels of contaminants produced by precipitation and crystallisation from wastewater and sewage sludge. P in struvite is not soluble in water, yet available to plants independently from soil pH. The overall recovery of P from the initial material is low and therefore struvite production needs to be combined with other approaches to recover P from wastewater treatment plants. Struvite is not yet permitted for use in organic agriculture, but likely will be soon.

Picture: Struvite granules (Photo: Else Bünemann, FiBL)

- In the AshDec® process, a fertiliser similar to Rhenania phosphate ($CaNaPO_4$) is produced via thermal oxidation of sewage sludge ash. The P content of the final granular product is about 9%. Rhenania phosphate is not water soluble, but plant available in acidic, neutral and alkaline soils. The process recovers almost all P from the sewage sludge and requires no hazardous input materials. This P fertiliser made from sewage sludge is not yet permitted for use in organic agriculture, but will likely be soon.
- Other technologies under development likewise result in non-water-soluble P sources that may be permitted for organic farming in the future.

On-farm application

System approach

- Struvite and Rhenania phosphate are mainly sources of P, while manure, compost and digestates contain all macro- and micronutrients. Meat and bone meal is a source of N and P.
- Manure, compost and digestates contain carbon and hence contribute to maintaining soil organic matter, while struvite, Rhenania phosphate and meat and bone meal are inorganic nutrient sources.
- High reliance on biological nitrogen fixation through legumes creates a need for targeted P and K inputs. Here, struvite and Rhenania combined with potassium sulphate can make an important contribution.
- On soils above pH 6, P sources other than meat and bone meal or rock phosphate should be used.
- Care must be taken to avoid ammonia losses when spreading manure and digestates.

Evaluation

- If farm-gate nutrients are negative for P, increased use of P sources is recommended.
- All P sources mentioned in this practice abstract partially contribute to crop P uptake and partially to replenishing soil P reserves.

Further information

Further reading

Further practice abstracts on fertiliser (nutrient budgets in organic farms, digestates, struvites, N efficiency of organic fertilisers) are available online at: https://relacs-project.eu/resources/practical-guidelines/

Detailed information on different P fertilisers in fact sheets can be found here: https://improve-p.uni-hohenheim.de/en

Video

Video Tutorial: Phosphorus recycling for organic agriculture. Available at: https://www.youtube.com/watch?v=LBKmgw5LjLA

Weblinks

Check the Farm Knowledge Platform for more practical recommendations.

About this practice abstract and RELACS

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RELACS: 'Replacement of Contentious Inputs in Organic Farming Systems' (RELACS) builds on results of previous research projects and takes far-advanced solutions forward. As a system approach to sustainable agriculture, organic farming aims to effectively manage ecological processes whilst lowering dependence on off-farm inputs. The RELACS partners will evaluate solutions to further reduce the use of external inputs and, if needed, develop and adopt cost-efficient and environmentally safe tools and technologies.

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