RELACS
IMPROVING INPUTS FOR ORGANIC FARMING

UNIVERSITY OF HOHENHEIM

Nitrogen efficiency of organic fertilisers

Problem

A high share of the nitrogen (N) in recycled and other organic fertilisers is not in a form available to plants and needs to be mineralized before plant uptake. This makes the effect on yields less predictable.

Solution

Evaluating recycled fertilisers regarding their nitrogen efficiency compared to mineral fertilisers can help estimate the amount of N they supply to the plants and, therefore, their effect on yields.

Outcome

Experiments showed higher N efficiencies for stored human urine, digestates and sewage sludge than compost. Additionally, higher contents of ammonium-nitrogen (NH_4^+-N) and a lower C/N ratio increase the nitrogen efficiency of recycled fertilisers.

Applicability box

Input used

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

Geographical coverage
Global

Application time
Best when applied at the beginning of growing season

Period of impact
Mainly in the year of application, with possible carry-over effects

Equipment
Best when incorporated into the soil immediately after field application

Best in
Fertilisers with a strong N release are best for high N demanding, non-legume crops and cropping systems with a high external N fertilisers demand. Fertilisers with a weak N effect are best applied to legumes and cropping systems with a high share of legumes.

Practical recommendations

In organic fertilisers, the total nitrogen content is not always the best indicator of the amount of nitrogen that is available to the plants. Indicators that estimate how much of the total nitrogen will be available for plants can help plan the nitrogen supply to crops more accurately.

One indicator is the long-term N transfer rate (Table 1), which determines how much of the total nitrogen applied to the field will be taken up by the plants. Liquid animal manure and digestates show a relatively high transfer rate comparable to mineral fertilization, while solid manure, especially composts, show lower rates. Experiments within RELACS supported these findings.

The mineral fertiliser equivalent (MFE) compares the nitrogen efficiency of an organic fertiliser to a mineral fertiliser in a given year of application. This indicator shows a similar pattern (Figure 1) as the long-term N transfer rate. Additionally, sewage sludge and human urine have a high MFE. In general, fertilisers with a lower C/N ratio and a higher proportion of N as ammonium (NH_4^+) show higher nitrogen transfer to the plant in the year of application as well as in the long term.

Organic fertiliser	N-transfer rate
Urban and biomass waste compost	0.25-0.35
Solid animal manure (dairy/pig)	0.50-0.70
Liquid animal manure	0.70-0.80
Digestates	0.70-0.80
Mineral N-fertiliser	0.80-0.90

Table 1: Long-term N transfer rate of different organic fertilisers (Source: Kurt Möller, University of Hohenheim).

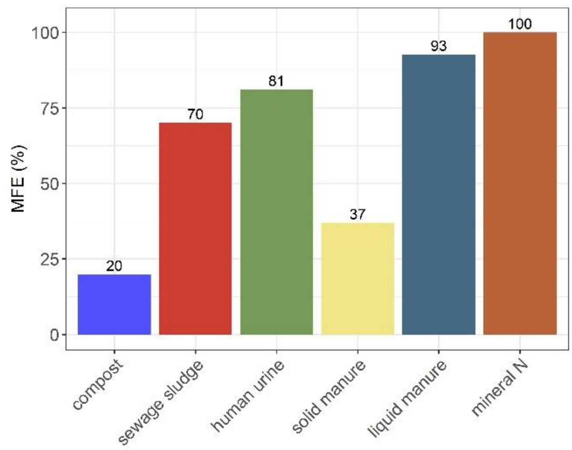

Figure 1: Mineral fertiliser equivalent (MFE) in % for recycled fertilisers and animal manures (Source: Marie Reimer, University of Hohenheim)

The residual nitrogen that is not taken up is either lost or is stored in the soil's organic matter. Of the total losses (~40% of applied N), leaching losses represent 20%-25% of applied N. Human urine also has high losses (~11%) through ammonia volatilization. However, these volatile ammonia losses can be minimized by avoiding surface applications. Fertilisers with low efficiency often show the highest increase of organic nitrogen storage in the organic matter. For compost and solid animal manure, around 25% of applied N is stored in the soil and results in an increase of organic matter, while the effect of fertilisers with high N efficiency on soil organic matter varies greatly depending on the specific conditions.

On-farm application

System approach

- Fertilisers should be chosen based on the desired effect. If the pure plant fertilisation effect is desired, fertilisers with a narrow C/N ratio and high contents of ammonium (NH_4^+), such as liquid manures, human urine or sewage sludge, might be advantageous. However, additional sources of organic matter would be needed to avoid possible declines in soil organic matter (e.g. green manure crops).
- If the effects on soil and soil organic matter are the main focus, then other sources with a weak N effect can be chosen. However, the maximum amounts that can be applied are limited by the P inputs, which should not exceed the average P offtakes by the cropping system, to avoid creating a P surplus. Therefore, other sources of nitrogen low in phosphorus (e.g. biological nitrogen fixation, keratins) are needed to balance out the system.
- The positive effect of fertilisers with a high C/N ratio on soil organic matter is often the result of high nitrogen losses during storage or processing of the fertilisers. Theses nitrogen losses have to be taken into account when looking at the whole system.
- Besides nitrogen, the other nutrients contained in organic fertilisers should also be considered to avoid nutrient imbalances, mainly of phosphorus and potassium.

Further information

Further readings

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

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

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.

Project website: www.relacs-project.eu

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