Annex 8:

Field evaluation of N losses associated with organic inputs

NMI Protocol

Spring 2020

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1. Introduction

Within the scope of soil quality and climate change, the attention for the increase of organic matter contents in soil is receiving a lot of attention. One of the methods to increase organic matter contents in soil, is to increase inputs of organic RDF's. However, this should not lead to adverse effects to the environment, e.g. by an increase in nitrate leaching.

For that reason, the potential nitrate leaching losses that were associated with different organic matter inputs via RDF's were studied in field experiments in the Netherlands in the period 2018-2019. The set up of the field experiments are described in the forelying protocol.

2. Set up and execution of the field experiment

2.1. Principle

The effect of different organic fertilisers or soil improvers on soil organic matter contents and potential nitrate leaching can be studied in a field experiment. The inputs of organic matter and total N will differ between the treatments with organic fertilisers, but the input of effective nitrogen should be the same in all treatments. The potential nitrate leaching can be investigated by the determination of the mineral N in soil (0-90 cm) at harvest.

2.2. Selection of soil and crop type

With respect to the selection of the soil and crop type for the experiment, it is of importance to choose a soil and crop that are sensitive to nitrate leaching. This can be maize on sandy soils, because maize as well as sandy soils are known for its' high risk for nitrate leaching.

2.3. Set-up of the experiment

2.3.1. Treatments

Treatments with different inputs of organic matter should be compared, and in addition a control (no organic matter input) and reference fertiliser (e.g. animal manure) should be included. In the field experiments that were performed in the Netherlands, the following treatments were compared:

1. Control treatment without organic matter; only mineral fertilisers used for N, P and K input according to fertiliser recommendation, respecting legal application limits;
2. Cattle slurry (reference organic fertiliser) applied at a level of 50 kg P_2O_5/ha (maximum, legal application limit), which is supplied with additional nutrients via mineral fertilisers to a recommended level with mineral fertilisers, respecting legal application limits;
3. Household waste compost applied at a level of 50 kg P_2O_5/ha, which is supplied with additional nutrients via mineral fertilisers to a recommended level with mineral fertilisers, respecting legal application limits;
4. Household waste compost (double dose) applied at a level of 100 kg P_2O_5/ha (P added with HHW compost only counts for 50% within the scope of legal application limits), which is supplied with additional nutrients via mineral fertilisers to a recommended level with mineral fertilisers, respecting legal application limits;
5. Verge grass applied at a level of 50 kg P_2O_5/ha, which is supplied with additional nutrients via mineral fertilisers to a recommended level with mineral fertilisers, respecting legal application limits;
6. Combined application of cattle slurry and verge grass, both at a level of 50 kg P_2O_5/ha (verge grass is not taken into account for legal application limits). If necessary, this is supplied with additional nutrients via mineral fertilisers to a recommended level with mineral fertilisers, respecting legal application limits.

After application of the fertiliser products to the field, they are plowed into the soil (with a cultivator; Figure 1).

Figure 1. Pictures of the preparation of the field experiment on sandy soil in the Netherlands, where RDF's are applied to the field in spring 2018.

A qualitative overview of the amounts of inputs of nutrients and organic matter is given in table 1.

Table 1. Qualitative overview of input of organic matter (OM), N (total and effective), P (expressed as P2O5) and K (expressed as K2O).

Trt	Description	OM input	Input total N	Input effective N	Input P_2O_5	Input K_2O
1	Reference / control	--	+	+	+	+
2	Cattle slurry	+	++	+	+	+
3	HHW compost	+	++	+	+	+
4	2x HHW compost	++	+++	+	+	+
5	Verge grass	++	++++	+	+	+
6	Cattle slurry+verge grass	+++	+++++	+	+	+

2.3.2. Replicates

At least 3-4 replicates will be necessary, to be able to investigate whether observed differences between treatments are statistically significant or not.

2.3.3. Field and plot size

The required plot size depends on the crop. For maize, we used gross plots of 10 x 10 m^2 and net plots of 1.50 x 2.5 m^2.

2.3.4. Monitoring: analyses of soil, plant and RDF's

Samples of the RDF's should be analysed (preferably before fertilizer application and seeding) as soon as possible and the following parameters are analysed: total nutrient contents (in any case N, P, K, Ca, Mg, S), ammonium (NH4), nitrate (NO3), dry matter content, organic matter content. Sometimes, the information of the composition of the RDF's is not available at the time of fertilizer application. In that case, the fertilizer dose will be based on an average composition and the supplemental application with mineral fertilisers will be adjusted to the known composition, as soon as that composition is available.

The following soil analyses should be performed:

- In early spring (several weeks before fertilizer application), a soil sample is taken from the 0-30 cm of the field (composed from 20 subsamples taken 'at random' from the field) and analysed for available nutrients (mineral N, P, K, Ca, Mg and S), organic matter content (OM %) and pH, so that the required nutrient dose according to the fertilizer recommendation can be determined.

- About one week before the fertilizer application, three soil layers (0-30, 30-60 and 60-90 cm) should be sampled and analysed for mineral N (ammonium and nitrate).
- At harvest of several days thereafter, three soil layers (0-30, 30-60 and 60-90 cm) should be sampled and analysed for mineral N (ammonium and nitrate).

At harvest, plants from the net plots are harvested and weighed in the field. Subsequently the plants are cut/ milled and a subsample is taken and brought to the lab for analyses (Figure 2). The parameters that should be determined are at least dry matter content and total N content.

Figure 2. Pictures of the harvest, the weighing and sample preparation of the maize in a field experiment on sandy soil in the Netherlands, summer 2018.