



Annex 2:

Field evaluation of N mineralization kinetics of recycling-derived fertilisers (RDF) on bare ground

Arvalis Protocol

November 2018 to November 2019

Authors: BOUTHIER Alain, LAGRANGE H el ene
Arvalis Institut du v eg etal

ARVALIS
Institut du v eg etal

Table of contents

Table of contents	2
1. Context, and objectives	3
2. Studied factors.....	3
2.1. Products in French trial in 2018-2019	3
2.2. Product spreading	4
3. Experimental design	4
3.1. Trial duration.....	4
3.2. Type of design	4
3.3. Size of elementary (individual) plots	4
3.4. Trial plan	5
.....	5
4. Initial characterization of the trial site.....	5
4.1. Location.....	5
4.2. Soil	5
4.3. Farming history	5
4.4. Agricultural practices on the field during the trial	6
5. Observations and measurements	6
5.1. Soil measurements.....	6
5.1.1. Site characterization.....	6
5.1.2. Monthly N mineral stocks, soil humidity.....	7
5.1.3. Measurement on organic products	7
6. Data analysis.....	8

1. Context, and objectives

With the evolution in the European regulations, more products could cross the border from BeNeLux to France. For now, these products are not well known in France. It is then essential to characterize them and to give farmers advises on how to use them.

This protocol aims to better know one of these product characteristic: the organic N mineralization kinetic. Indeed, part of the N from this product is organic and has to be mineralized by microorganism to be available for crops. The knowledge on these kinetics is essential to determine the favorable spreading period and the complementation needed.

2. Studied factors

Organic products and a blank treatment are compared.

The blank treatment is a plot without neither organic nor mineral fertilizers. The blank plot will be used to calculate the natural soil mineralization kinetics.

Treatment number	product	Dose of organic N (kg/m ²)	Dose of product (tons of raw product/ha)*	Spreading order
1	Blank	0	0	-
2	Product 1	200	19,417 (116.50 kg/plot of 60m ²)	2
3	Product 2	250	33.784 (202.7 kg/plot of 60m ²)	1
4	Etc...			

Example of doses applied.

*For convenient reasons, the amount can be rounded. The most important is to register the amount of product spread on each plot.

2.1. Products in French trial in 2018-2019

Compost: solid fraction of pig slurry (30%) and hen droppings (70%) - from Belgium, imported to France
Compost: solid fraction of pig slurry (70%) and hen droppings (30%) - from Belgium, imported to France
Compost: from solid fraction of pig slurry after anaerobic digestion

2.2. Product spreading

All products are brought at the same date on the field. The field will be previously ploughed and flattened. The products will be spread on bare ground.

Solid organic fertilizers (RDF) will be spread by hand, consistency on the soil surface.

The products that are the most prone to N volatilization will be spread at the end. (see “Spreading order” in table above).

The same day, after spreading, products will be buried at 8-10cm depth to avoid NH₃ volatilization. Indeed volatilization would deteriorate results analyses.

3. Experimental design

3.1. Trial duration

The trial will last 12 months.

LIXIM model* will be used during the trial to estimate the N mineralization kinetics. If the mineralization stops, the trial could be stopped before the end of the 12 months. On the other hand, if the mineralization is still on going at the 12th month, the trial will last longer.

*see § 7

3.2. Type of design

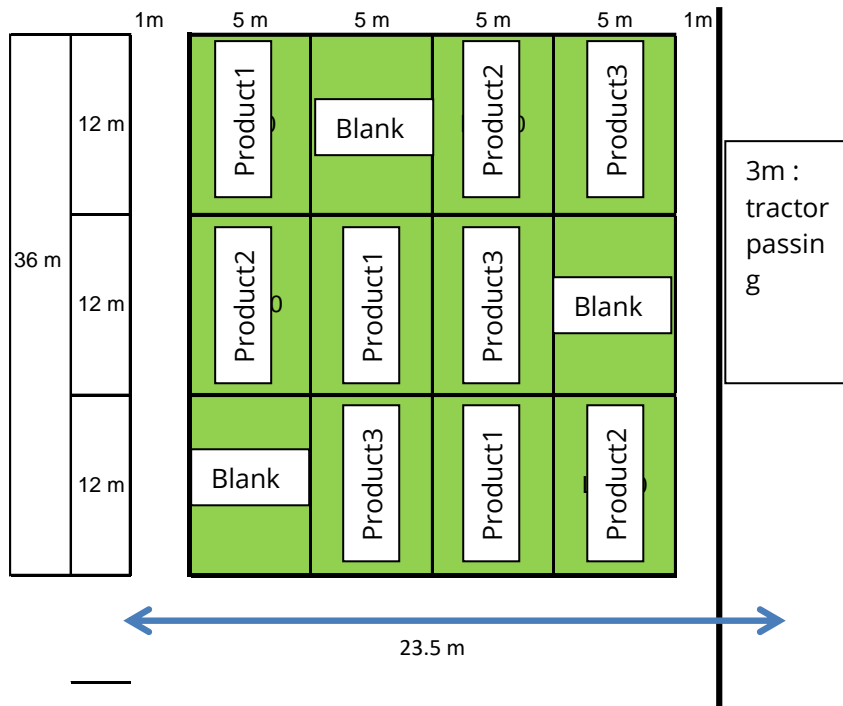
Statistic blocks with 3 replications.

3.3. Size of elementary (individual) plots

The plot size is chosen to contain monthly soil sampling and to minimize amount of product to be applied.

Therefore, each plot will measure 4.8m*12m = 57.6m²

3.4. Trial plan



4. Initial characterization of the trial site

4.1. Location

The field will be georeferenced (GPS, latitude, longitude, altitude).

The closest weather station will register daily rainfall, minimum and maximum temperature each day, and PET.

4.2. Soil

Soil has been ploughed and flattened before the first sampling date.

The first sampling date is 2 weeks before spreading (see § 5.1.1)

4.3. Farming history

No organic fertilizers in the previous 3 years.

Register the past 5 to 10 years: crops, yield, destination of the crops residues, mineral and organic fertilization (products, doses, spreading dates), cover crops.

4.4. Agricultural practices on the field during the trial

The soil has to be kept without crops or weeds. This is to avoid N absorption by plant that would deteriorate results.

Use hand weeding or chemical products.

No fertilizers applied on the field during the trial.

5. Observations and measurements

5.1. Soil measurements

5.1.1. Site characterization

- **Chemical analysis:** total N, Organic C, water pH, CEC Metson, P₂O₅ Olsen, K₂O, CaO, MgO

2 weeks before spreading the products, sample 12 cores at 0-20cm depth in the whole trial (a gouge will be better than an auger to control the depth). Mix the 12 cores to send one sample to the lab.

In the meantime, take one sample per plot. These samples will be kept during the trial in case we need additional analysis.

- **Physical analysis** for each plot : 5 decarbonated fractions (clay, fine silt, rough silt, fine sand, rough sand); carbonates

2 weeks before spreading the products, sample 12 cores at 3 different depth: 0-30cm; 30-60cm; 60-90cm in the whole trial. Mix the 12 cores for each depth to send one sample per depth to the lab.

- Measure **apparent density** for the 3 depth (0-30cm; 30-60cm; 60-90cm).

During the trial, in spring, a profile will be dig at 90cm depth. It will be done close to the trial. Soil samples will be taken according to the ring method. 6 rings will be taken at each depth. The soil sampled for each ring will be dried at 105°C during 24hours. Then they will be weight to calculate apparent density.

- **Soil profile description:** the profile will be described to estimate the soil horizons, especially the mineralization depth.

- Measure **pF4.2** and **pF2.5**: take 1kg of clumps for each 3 soil depths (0-30cm, 30-60cm, 60-90cm). They will be sent to the lab for soil wilting point and field capacity measurements.

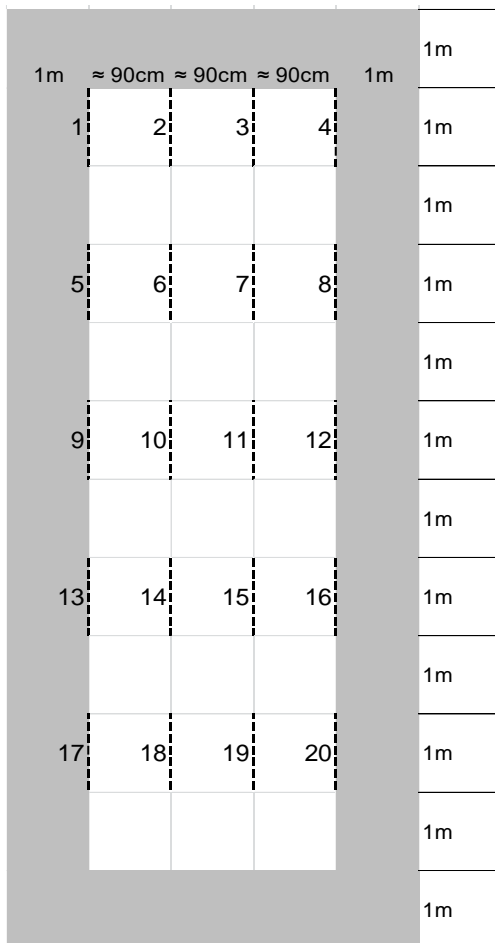
5.1.2. Monthly N mineral stocks, soil humidity

First sampling date: 15 days before spreading the products

2nd sampling date: 1 week after spreading the products

Then: every month

For each sampling dates, each plots and each soil depths, take 10 samples along a 1m line. This organization will help to keep space for each sampling date in the plot and will avoid soil packing. See plan below as an example:



This plan represents one plot.

Each numbered dotted line represents one sampling date.

5.1.3. Measurement on organic products

At the spreading date take 3 samples of each products:

- One sample is sent to the lab for analysis. (Dry matter, pH, organic C, N total, N-NH₄, N-NO₃, P, K, Ca, Mg; N mineralization in lab)
- One sample is sent to U-Ghent for ReNu2Farm analysis

- One sample is kept until the end of the trial.

6. Data analysis

The data will be used through the LIXIM Model (INRA - Mary et al, 1999).

This model simulates water and mineral N transportation.

To use this model, we need data from trials: each month, for a year, we are measuring soil humidity and N. We need soil characteristics and climatic data.

During a year, between each sampling dates, LIXIM calculates drainage, N mineralization and N leaching. First it calculates the water progression in the soil profile; then it estimates water drainage and N leaching between two dates. Then, it calculates N mineralization.

This will be used for our N mineralization trial on bare ground for the 3 composts.

	Data	Unity	When and where
Climatic data	Rainfall	mm	Each day, From the beginning to the end of the trial
	Potential Evapo Transpiration	mm	Each day, From the beginning to the end of the trial
	Mean Temperature	°C	Each day, From the beginning to the end of the trial
Soil data	Soil bulk density	g/cm ³	For each soil sampling thickness
	Soil humidity at permanent wilting point	% of dry soil	For each soil sampling thickness
	Soil humidity at field capacity	% of dry soil	For each soil sampling thickness

Example of LIXIM results

