Annex 5a:

Pot trial: evaluation of the short-term P effect of recycling-derived fertilisers (RDF) in laboratory

This pot trial was carried out by the Celesta Lab at the request of Arvalis

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1. Context, State of art

Phosphorus from mineral fertilizers is mainly a mined resource. Even if the timeframe of its non-availability remains uncertain it requires to be managed from the point of view of its scarcity. In this context, it is desirable to develop RDF use as an alternative resource. To develop them efficiently, it is necessary to quantify the biodisponibility of the phosphorus of these products. The references on P availability of RDF are less numerous than for N availability. Speciation of P in RDF can be very variable.

The phosphorus of the RDF can be of mineral or organic forms. In most cases the mineral form is predominant. The chemical form depends on the origin of the product (animal species and way of feeding them…), as well as possible treatments applied (composting, liming, heat treatments…). The origin and the treatments before spreading can influence the short-term availability of phosphorus. For example, in ashes, part of phosphorus can be phosphate-calcic which is insoluble.

Measurements of short-term or mid or long term availability is a challenge in fertilization planning. This different times availability answer different issues:

- The evaluation of short-term availability is useful to predict the ability of the RDF to provide sufficient phosphorus to the current crop in a field with low availability of P in soil.
- The evaluation of mid or long-term RDF P availability in the soil is relevant for soils where P bioavailability is correct.

In all cases, it is necessary to quantify a fertilizing value in reference to a P mineral fertilizer with a high solubility in water (ie: triple superphosphate, or TSP). This can be done thanks to field trial or pot trail conducted in laboratory.

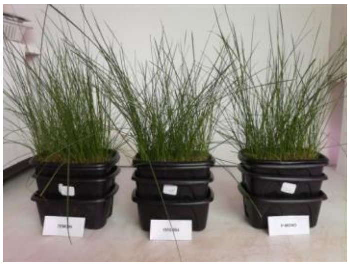
This protocol refers to the short-term effect, studied on a P pot trial under controlled condition on ray-grass.

2. Trial objectives

The objective of this protocol is to determine the Phosphorus bioavailability when it's brought to plants through a RDF. It is done thanks to the Chaminade method on a pot trial in a phytotron. The organic fertilizers are compared to monocalcic phosphorus.

3. Experimental design

- Pots: specific containers: described by Standford and De Ment pots; 2L



- Controlled conditions:
  - mean temperature during days: 21.5°C; mean temperature during nights: 18.3°C
  - light: pots are placed under homogeneous light: 7000 lux/m² at 60cm above pots. 16h light per day and 8h night per day.
  - Humidity: 100% of the field capacity
- Soil: the laboratory chooses and provides the soil. It's a sandy-loam soil, low P rate soil.
- Plant: Hybrid Ray-Grass, certified seeds
- Treatments: 5 pots per treatment
  - 1 blank control treatment = soil only
  - 4 organic products tested: Soil + organic fertilizer (repeated for each product)
  - 1 positive control: Soil + monocalcic phosphorus

Organic products were dried at 40°C and milled at 1mm.
The products (organic fertilizer and monocalcic phosphorus) are incorporated to the soil such as bringing 0.01% of P_2O_5 per mass of dry soil. This is equivalent to 300 kg of P_2O_5/ha.

- Trial duration: 12 to 14 weeks = 3 ray-grass cuts (1 cut every 4 weeks)
- Fertilization: a nutritional solution is brought on every pots during the whole trial, it is P deprived. 60mL per pot at sowing date, then every 7days 60 mL.
  Within the 3 months the major elements where brought, per pot, at
  91 mg og Mg
  380 mg of N
  215 mg of Ca
  217 mg of K

4. Measurements

After each harvest (Ray-Grass cut), for each pot and each treatment, the dry matter quantity (for the aerial part of the plant) is determined and the P concentration in those organs is dosed. So we can determine, for each pot and each treatment, the P quantity in aerial part of Ray-Grass: these are the exportations.

5. Data analyses and evaluation

5.1. Calculated indicators

The Apparent P Recovery and the P fertiliser replacement value of the tested products are calculated and compared to the values calculated for the mineral fertilizer. It is done for every treatment which is statistically significantly different to the control treatment.

$$\text{Apparent P recovery} = \frac{100\text{x}[(\text{exported P in the studied product}) - (\text{exported P in the control treatment})]}{\text{P brought by the treatment}}$$

P fertiliser replacement value = Apparent P Recovery of the tested product / Apparent P Recovery of the mineral fertilizer CAU

These results are related to the use of phosphorus by aerial part of the plant (use by roots is not included)

5.2. Statistical analyses

For each harvest and for the cumulated results a statistical analysis is done on dry matter production and phosphorus exportation.
After checking the normality of residues (Shapiro test), homogeneity of variances (Levène test), an ANOVA has been done. When a statistical difference is proved, a test of mean comparison is done (Tukey test).
In some case the hypotheses of normality of residues and homogeneity of variances were not validated, the ANOVA could not be processed. Then a non-parametric test is done (Kruskal-Wallis). When a statistical difference is proved, a test of mean comparison is done (Dunn test).

6. Products tested

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