

Assessment of phosphorus bioavailability from animal manures applied to

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Research project PTDCAGR-PRO/112127/2009

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Objective

To assess phosphorus (P) dynamics and provide scientific knowledge to create an evaluation tool to identify the risk of P loss to surface water bodies in soil amended with animal manures.

⇒ Plan and Methods

Starting date: March 2011

Duration: 36 months

A. To determine variations in manure bioavailable P

- (i) Resulting from P transformations during short term incubations
- (ii) Resulting from soil microorganisms

B. To promptly determine the effect of applying animal manures to soils on soil bioavailable P and to evaluate the consequent changes in soil P pools.

C. To establish comparisons between animal manures and inorganic P sources and to determine their effect on :

(i) Bioavailable P

(i) Soil P pools

(ii) P loss susceptibility

⇒ Soils

- Agricultural soil low P content and no pH limitations
- Soil from the erosion field trial
- Agricultural soil derived from calcareous material
- Soil with high P sorption capacity from Lagoa das Sete Cidades, S. Miguel, Açores, an eutrophysed zone

characterization

basic physical and chemical properties

bioavailable P: water, Olsen, Égner, anion exchange resin extractable P

Hedley fractionation

P adsorption isotherms

oxalate extractable Al, Fe and P

⇒ Animal Manures

- ◆ Separate dairy faeces and urine to simulate a grazing system
- ◆ Dairy manures
- ◆ Swine manures
- ◆ Duck manure

characterization

nutrient quantification: C, N, P, K, Ca, Na, Cl, NO₃⁻, NH₄⁺

soluble inorganic C, N

soluble total C, N

soluble total C, N

Hedley fractionation

Po characterization: HPLC, AEC with conductivity detection, GC-MS

bioavailable P: water and anion exchange resin extractable P

Laboratory incubations

1. Anaerobic short term incubation of animal manures

- * Incubation of manures in anaerobic conditions at 40°C during 7 days
- * Follow up of Pi transformations through anion exchange resins (AER) extractions:
 - (i) AER remaining in contact for 7 days with the manure suspension
 - (ii) AER 16h extraction at the end of the incubation period
 - (iii) AER 1h extraction each day of the incubation period

2. Anaerobic short term incubation of soil/manure mixtures

- * Incubation of soil/manure mixtures (75 mg P kg⁻¹) in anaerobic conditions at 40°C during 7 days
- * Follow up of inorganic P transformations: AER, CAER, Olsen, Égner
- * Hedley fractionation

3. Aerobic long term incubation of soil/manure mixtures

- * Incubation of soil/manure mixtures (0, 75, 150 mg P kg⁻¹) in aerobic conditions at 25°C during 120 days with 5 sampling dates
- * Follow up of inorganic P transformations: AER, CAER, Olsen, Égner
- * Follow up of inorganic/organic P transformations: Hedley fractionation
- * Long term P desorption experiment

Field trial to evaluate P losses under field conditions

- * 18 plots of 42m² will be submitted to the application of 6 treatments:
 - (i) 4 manures: swine, dairy (solid and liquid), duck
 - (ii) control
 - (iii) superphosphate
- * Sediment mass quantification
- * Percolation water P analysis: Pi, Po
- * Soil P analysis: Pi, Po, WEP, Olsen, Égner

Two year greenhouse biological experiment

- * 4 replicates of 5 treatments applied to 4 soils
 - (i) 3 manures: swine, dairy, duck
 - (ii) control
 - (iii) superphosphate
- * Growth of crop rotation in lysimeter pots: ryegrass/wheat/ryegrass/wheat
- * Soil and leachates analysis for P (AER, CAER, Hedley, Égner, Olsen)
- * Determinations of crop yields nutrient content (N, P, K, Ca, Mg)