Assessment of phosphorus bioavailability from animal manures applied to Portuguese soils and site vulnerability to phosphorus losses

Marta Roboredo[1] and Carmo Horta[2]
[1]Centro de Química de Vila Real, Departamento de Biologia e Ambiente, Escola de Ciências da Vida e do Ambiente, Universidade de Trás-os-Montes e Alto Douro, Apartado 1013, 5000-913 Vila Real, Portugal, roboredo@utad.pt
[2]Escola Superior Agrária, Instituto Politécnico de Castelo Branco, Quinta da Sra. De Mércules, 6001-909, Castelo Branco, Portugal, carmoh@ipcb.pt

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Participating institutions and research team

Universidade de Trás-os-Montes e Alto Douro/ Centro de Química de Vila Real
Marta Roboredo
João Coutinho
Fernando Nunes
Sandra Lage

Instituto Superior de Agronomia/ Química Ambiental
David Fangueiro
Fernanda Cabral
Henrique Ribeiro

Instituto Politécnico de Castelo Branco
Carmo Horta
António Duarte
João Paulo Carneiro

Universidade dos Açores/ Centro de Investigação e Tecnologia Agrária dos Açores
Jorge Pinheiro

North Wyke Research
David Chadwick

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, NO_3^-, NH_4^+
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 40ºC 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 40ºC 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 25ºC 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 desoption experiment

Field trial to evaluate P losses under field conditions

- 18 plots of 42m^2 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)

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