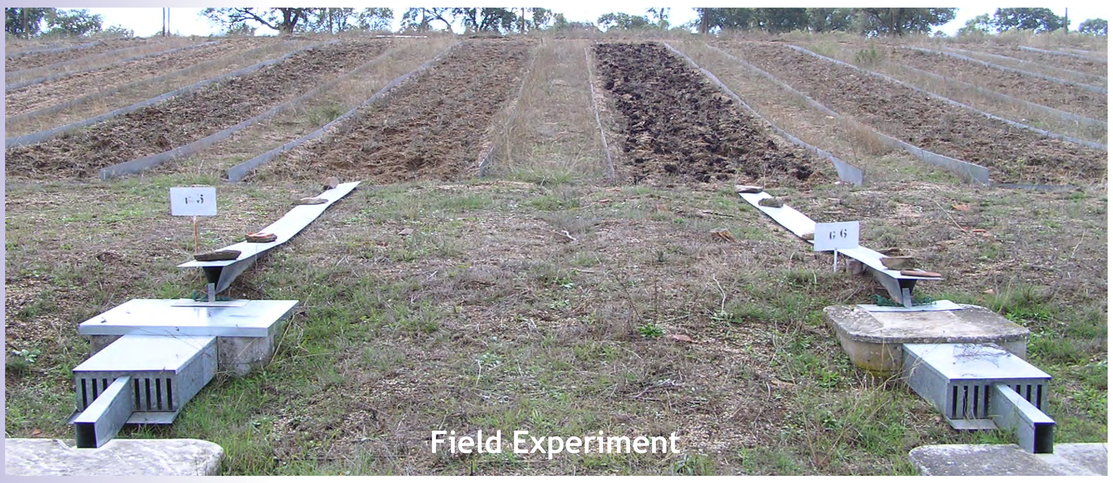
Potential soil P transfer to runoff water in areas fertilized with organic residues*

Carmo Horta[1], João Paulo Carneiro[1], António Canatário Duarte[1], Paulo Ribeiro[1], Marta Roboredo[2] and José Torrent[3]

[1]Instituto Politécnico de Castelo Branco, Escola Superior Agrária, CERNAS, Quinta Sra. de Mércoles, 6001-909 Castelo Branco, Portugal. E-mail: carmoh@ipcb.pt
[2]Universidade de Trás-os-Montes e Alto Douro, Quinta dos Prados, 5001-801Vila Real, Portugal
[3]Universidad de Córdoba, Campus de Rabanales, Edificio C4, 14071 Córdoba, Spain
*Project founding by FCT: PTDC/AGR-PRO/112127/2009 "Assessment of phosphorus bioavailability from animal manures applied to Portuguese soils and site vulnerability to phosphorus losses"

Objectives

1- Evaluate P losses from soils fertilized with organic residues and with commercial fertilizers by: A - runoff waters and B - laboratory desorption experiments.
2- Evaluate the relationship between soil P tests and P losses to runoff waters.
3- Compare the results of P losses obtained by field experiment and by laboratory desorption experiments.



Materials and Methods

1- The field experiment, was performed in a Dystric Regosol with 9% slope; This area has18 plots each with 42 m^2 equipped with a runoff water collection box. The experimental design consists of 6 treatments according with fertilizer P origin with three repetitions per treatment. The amount of P added to soil was 50 kg P ha^{-1}. Treatments were: control, no P added (C); mineral fertilization (F); cattle manure (M); dry fraction of pig effluent (P); dry fraction of duck effluent (D); dry fraction of pig effluent on bare soil (BP).

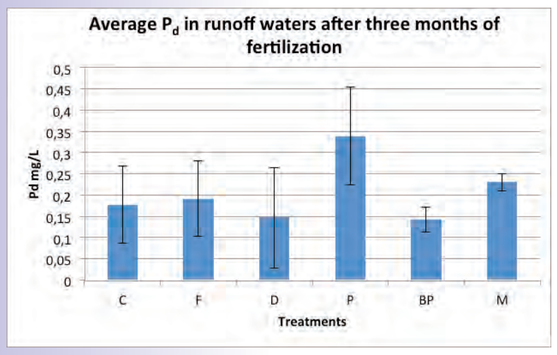
2- Ryegrass was sown in November 2012 one month after P fertilization.

3- Runoff water was collected when precipitation events originates runoff.

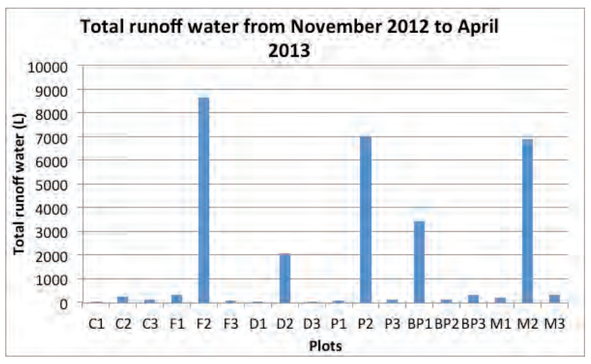
4- A P desorption experiment to a dilute electrolyte (0.002 M $CaCl_2$) in the laboratory was carried out. Fertilized soil samples of each plot were incubated during 90 days at 24ºC. A soil:solution ratio 1:1000 was used to mimick runoff conditions and the dissolved reactive orthophosphate (Pd) in the supernatant after centrifugation (13 000 rpm) was determined.

5- Ammonium lactate-P (Al-P) and Olsen P were determined in the soil every 3 months.

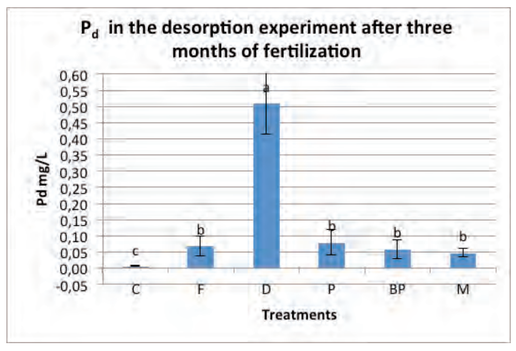
Results



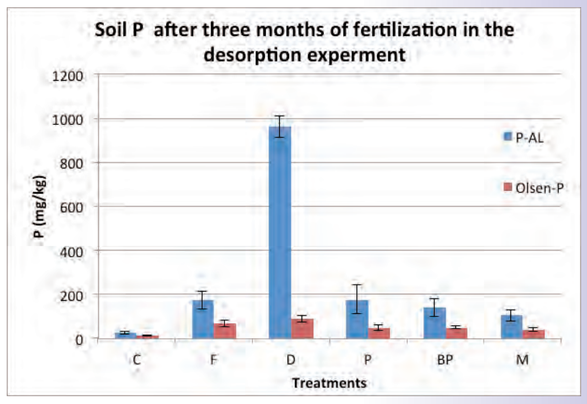
Pd in runoff water samples showed no significant differences between treatments. The average value of Pd in all treatments (including C) was > 0.15 mg L^{-1}



A high variability in the volume of runoff water was observed (CV from 82% in C to 170% in D treatments), which can be partly attributed to differences in solum depth and preferential flow pathways.



In the laboratory desorption experiment, all P-fertilized samples had significantly higher ($p < 0.001$) Pd levels than control samples. The D treatment resulted in significant higher levels of Pd (0.50 mg L^{-1}) than the P, BP, F (0.05 - 0.1 mg L^{-1}) or M (0.03 mg L^{-1}), with no significant differences between the latter.



After three months Olsen P increased significantly from 10 ± 3 mg kg^{-1} (at the beginning of the experiment) to 34 ± 18 mg kg^{-1} with the addition of fertilizers. Considering the effect of fertilizers the D treatment resulted in significant higher ($p < 0.001$) soil P levels while there were no significant differences between P, BP, M or F. The large difference between P-AL and Olsen P in the D treatment suggests the presence of P forms more soluble in acid extractants.

Conclusions

1- P losses from soil to runoff waters

Field experiment

P fertilization with organic residues or commercial fertilizers originates levels of Pd in runoff waters always higher than 0.05 mg P L^{-1} the critical level to prevent eutrophication of water bodies.

No significant differences of Pd in runoff water were observed between treatments even between fertilized and the control plots.

Laboratory desorption experiment

D treatment shows significant higher potential to desorb P from soil to runoff water than the other organic residues or the commercial fertilizer. Phosphorus fertilization increases significantly P losses to water.

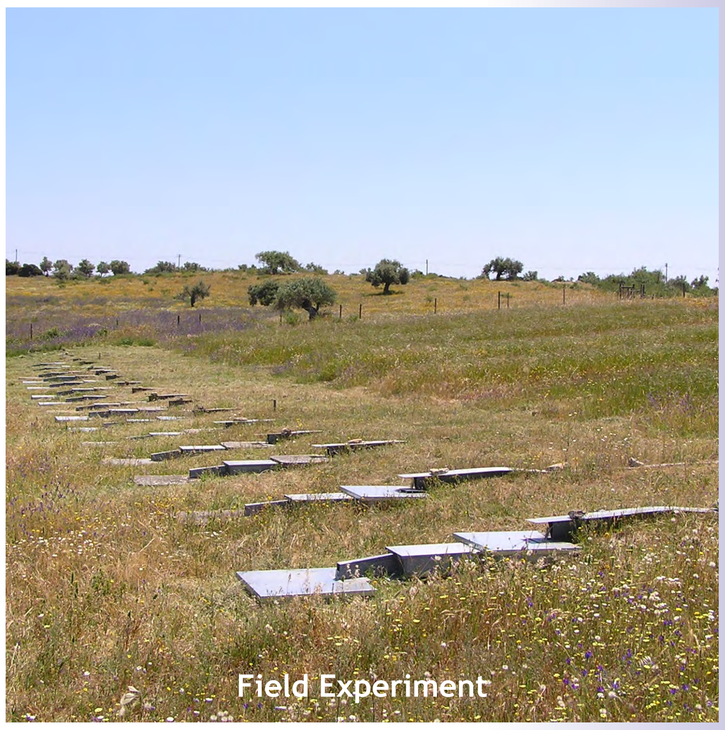
2- Relationship between soil P tests and P losses to runoff waters

Results of soil P tests and of Pd in the desorption experiment are significantly correlated (R= 0.99) but are not with Pd in runoff waters.

3- Compare P losses evaluated by two different procedures

No correlation between the Pd values found in the desorption experiment and the corresponding ones in runoff water was found.

Both P sources and soil profile features play an important role in soil P transfer to runoff waters, which is difficult to assess by laboratory experiments.



7th Phosphorus International Workshop 9-13 september 2013, Uppsala, Sweden.

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA
COMPETE
PROGRAMA OPERACIONAL FACTORES DE COMPETITIVIDADE
QREN QUADRO DE REFERÊNCIA ESTRATÉGICO NACIONAL
UNIÃO EUROPEIA
Fundo Europeu de Desenvolvimento Regional
UNIVERSIDADE DE TRÁS-OS-MONTES E ALTO DOURO utad
Instituto Politécnico de Castelo Branco
UNIVERSIDAD DE CÓRDOBA