The Effect of a Reduction in Phosphate Application on Soil Phosphate Pools

C. van der Salm
Wageningen University and Research Centre, The Netherlands

J. van Middelkoop
Animal Science Group, The Netherlands

P. A. I. Ehlert
Wageningen University and Research Centre, The Netherlands

The XX International Grassland Congress took place in Ireland and the UK in June-July 2005. The main congress took place in Dublin from 26 June to 1 July and was followed by post congress satellite workshops in Aberystwyth, Belfast, Cork, Glasgow and Oxford. The meeting was hosted by the Irish Grassland Association and the British Grassland Society.

Proceedings Editor: D. A. McGilloway

Publisher: Wageningen Academic Publishers, The Netherlands

Section 2

Chemical controls over soil quality and nutrient turnover

The effect of a reduction in phosphate application on soil phosphate pools

C. van der Salm[1], J. van Middelkoop[2] and P.A.I. Ehlert[1]
[1]*Alterra, Wageningen University and Research Centre, P.O. Box 47, 6700 AA Wageningen, The Netherlands, Email: caroline.vandersalm@wur.nl,* [2]*Animal Science Group, P.O. Box 2176, 8203 AD Lelystad, The Netherlands*

Keywords: phosphate pools, environmental P losses, dairy farms

Introduction Excessive use of manure and fertilisers in western Europe has led to high phosphorus (P) contents in many agricultural soils leading to environmental P losses by overland flow, subsurface drainage and leaching to groundwater. To stop phosphate build up in the soil and leaching to surface and ground waters, the Dutch government is gradually reducing allowable phosphate application on grassland from 130 kg/ha per year in 2005 to 90 kg/ha per year in 2015. This will lead to a reduction of the phosphate surplus from 40 in 2005 to 0 kg/ha per year. To investigate the impact of reductions in application rates on soil phosphate, leaching and grass production, a field experiment was started in 1997 on four dairy farms on two sandy soils, a peat and a clay soil.

Materials and methods At each dairy farm, six plots were established receiving a yearly N surplus of 180 and 300 kg/ha per year and P surpluses of 0, 20 and 40 kg P_2O_5/ha per year. The grass was alternately harvested and grazed. Fertiliser and manure inputs and grass production were measured regularly. Changes in P pools were monitored yearly in the topsoil (0-5, 5-10, 10-20 and 20-30 cm). Pw was measured in a 1:60 extraction with water, and P-Al by extraction with a 0.1 N ammonium lactate/0.4 N acetic acid solution. Changes in Pw and P-Al pools were assessed by multiple linear regression.

Results All sites had relatively high phosphate contents at the beginning. In the peat and clay soils, phosphate contents declined with depth, whereas contents were high throughout the topsoil (0-30 cm) of the sandy soils (Table 1). Phosphate losses from by leaching and drainage ranged from 1- 11 kg P_2O_5/ha per year total –P and 1-4 kg P_2O_5/ha per year MRP-P. These data indicate that a decline in P pools may be expected at a P surplus of 0 kg P_2O_5 ha per year and a rise in P pools will occur at P surpluses of 20 and 40 kg P_2O_5 ha per year. Changes in P pools in the different layers will be governed by the P surplus and the P losses to greater depth.

Table 1 Phosphate pools[1] in the topsoil of four farms in 1997

Site	Texture	Pw	P-Al	DPS[2]	P losses by leaching/drainage[3]	
					MRP-P	Total-P
		mg P_2O_5/ l	mg P_2O_5 /100 g	(-)	kg P_2O_5/ ha per year	
Cr	Sand	40-17	40-28	0.44-0.39	3	6
Hn	Sand	39-24	50-38	0.59-0.58	4	11
Wb	Clay	56-8	58-12	0.46-0.18	0.7	1.3
Zg	Peat	31-4	42-5	0.36-0.16	1.2	3

[1] Contents in the 0-5 cm layer and the 20-30 cm layer resp. [2] $P_{ox}/0.5(Al+Fe)_{ox}$ [3] Average values 1997-2001

Multiple linear regression analysis confirmed this hypothesis. The change in Pw and P-Al was described by: $\Delta P = C_{soil} + \alpha\ P_{initial} + \beta\ P_{surplus}$ in the upper soil layer (0-5 cm) and by $\Delta P = C_{soil} + \alpha\ P_{initial} + \beta\ Pw_{x-1}$ in the deeper layers where ΔP represents the yearly change in P pool, C_{soil} a constant depending on the soil type, $P_{initial}$ the P pool in the previous year and Pw_{x-1} is the Pw of the overlying horizon. Pw_{x-1} is included as a measure for the P leaching from the overlying horizon (Schoumans & Groenendijk, 2000). The explained variance was 54.3 and 54.1 for ΔPw and 46.8 and 45.9 for ΔP-Al in topsoil and deeper layers, respectively. ΔP strongly increased with a decline in $P_{initial}$ (α: -0.9/-1.0 and -0.6/-0.7 for Pw and P-Al in top- and subsoil, respectively). ΔP increases with an increase in $P_{surplus}$ in the topsoil (β: 0.16 for Pw and P-Al).

Conclusions Regression equation indicated that Pw and P-Al values (0-5 cm) can be kept at a value of 35 at a P_2O_5 surplus of 0 kg/ha per year in sand and peat soils. To retain higher P levels (40), a P_2O_5 surplus of 20 kg/ha per year is required. In the clay soil, Pw and P-Al pools can be kept 20 units higher at the same P_2O_5 surplus. In the deeper soil layers, changes in P pools were independent of the surplus and remained stable over 7 years. Despite declines in Pw and P-Al in the topsoil at the lowest surpluses, grass production remained stable at 11 ton dry matter/ha per year. However, P content in the grass showed a slight decline on the sand and peat soils.

References

Schoumans, O. F. & P. Groenendijk (2000). Modelling soil phosphorus levels and phosphorus leaching from agricultural land in the Netherlands. *Journal of Environmental Quality*, 29, 111-116