Mining soil phosphorus by zero P application; an effective method to reduce P loading to surface water ?

Caroline van der Salm, Wim J. Chardon, and Gerwin F. Koopmans

To reduce leaching of phosphorus (P) from agricultural soils and to stop the ongoing enrichment of the soil with P, the application standard of P in the Netherlands will be gradually decreased, until equilibrium between P application and plant uptake (equilibrium fertilization) will be reached in 2015. However, these reductions in P application rates are not sufficient to reach surface water quality standards of the European WFD in 2015 in all sensitive areas. Accordingly, additional measures have to be considered to further reduce P loading to surface water. Mining of soil phosphorus by zero P application is a promising method.

Mining of soil phosphorus

Idea: Growing and harvesting a crop without P application will lead to a rapid decline in P concentrations

Why: Sharp decline in P concentrations due to non-linear sorption (fig. 1)

But: what about feed-back mechanisms (mineralization, slow desorption)

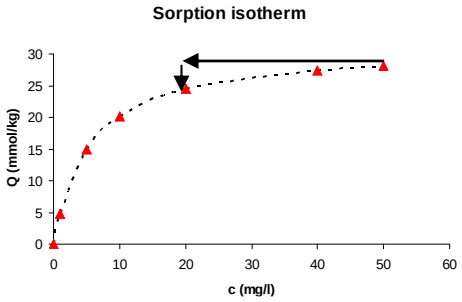

figure 1: Adsorption isotherm indicating a strong decline in P concentration with small changes in adsorbed amounts

Field experiment

In 1997 a study was started on 4 experimental dairy farms (2 sandy soils, 1 clay soil, 1 peat soil)

- At each site 6 plots were established with 3 different P surpluses (0, 20 and 40 kg P_2O_5 ha^{-1} jr^{-1}) and 2 N surpluses (180 and 300 kg N ha^{-1} jr^{-1})
- In 2002 a mining plot was added that received no P and 300 kg mineral N ha^{-1} jr^{-1}

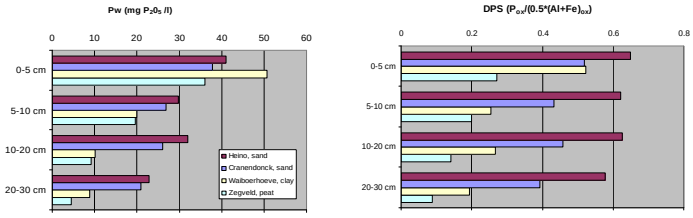

figure 2: Water extractable P and DPS at the mining plots in 2002

Results

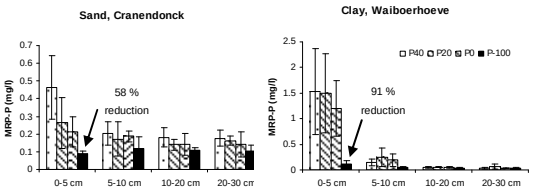

figure 3 : Average MRP-P concentrations at a sand and clay site over the period 2002-2005

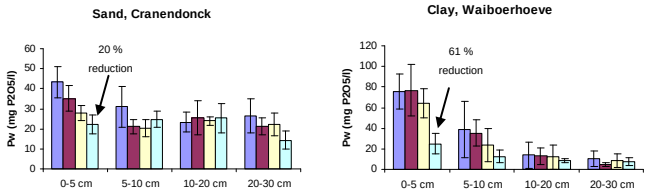

figure 4: Average water extractable P at a sand and clay site over the period 2002-2005

Conclusions

Field experiments showed a:

- Rapid decline in MRP-P concentrations (40-90% in 4 yr)
- Decline in MUP-P concentrations (30-60%)
- Moderate decline in Pw (11- 61%)
- No significant effect on average Pox in the first 4 years

→ Mining quickly reduces P concentrations in upper soil layers. This means that we can reduce P emission in shallow drained soils by mining

Remaining questions

- Reduction of P concentrations in deeper soil layers (time span, max. depth)
- Impact of feed-back mechanisms in the forthcoming years

Alterra, Wageningen UR, Wageningen, The Netherlands
Corresponding author. e-mail: Caroline.vanderSalm@wur.nl