P mining on grassland soils: Long-term effects on nutrient uptake, soil P status and P leaching

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Abstract for the webinar on 'Legacy P in agricultural soils' organised by the European Sustainable Phosphorus Platform (ESPP) on 2 February 2022.

Excessive P fertilisation has led to accumulation of P in grassland soils in the Netherlands which, in turn, enhanced risks for leaching and surface runoff of P to surface waters. Here, the effectiveness of P mining in terms of reducing levels of soil fertility P indicators and levels of ortho-P in soil porewater as an indicator for P leaching as well as its consequences for grass yield are assessed based on monitoring data from a long-term field trial on permanent grassland (Middelkoop et al., 2016, Regelink et al., 2021, Van der Salm et al., 2017).

The field trial includes four grassland locations covering three soil types: Marine calcareous clay, peat and non-calcareous sandy soil. Grass was mowed and the mining plots received sufficient N fertiliser but no P fertiliser. Other plots received P fertilisation at a level equal to P uptake. At the start the P profiles in the soil differed between the soil types. On clay and peat, P contents were high in the 0-5 cm soil layer but strongly decreased with increasing depth whereas P was uniformly distributed over the upper 0-30 cm in the sandy soils. This difference is due to the far higher historical P inputs on sandy soils and ploughing of sandy soils as part of grassland renewal in the decades before field trial started.

Mining of P led to a decrease in P-Al-values in the 0-5 and 5-10 cm whereas these indicators remained unchanged in the lower soil layers. On sand, mining led to a reversal of the soil P profiles meaning that, after ten years of mining, P-Al-values were lower in the 0-5 cm as compared to the deeper soil layers. Mining also reduced levels of ortho-P in soil porewater but this effect was restricted to the upper soil layers 0-5 and 5-10 cm where also the decline in soil P indicators was observed. Hence, on the sandy soil, leaching of ortho-P from the root zone i.e. deeper than 10 cm still continued during the ten-year monitoring period.

Though soil P status in 0-10 cm soil samples declined on all sites, response of grass yield differed between the locations. Yield losses, expressed as the difference in P uptake as compared to P fertilised plots, were smaller on the on the sandy soils (17-30%) as compared to the clay and peat soil (48 and 56%, respectively) averaged over the period of 5 to 10 years after the start of the experiment. The smaller yield losses on sand are attributed to the high soil P status in the soil layers below 10 cm. To conclude, the overall P stock in the rooting zone has to be taken into account when assessing effectiveness of mining as a large part of the P stock may be overlooked when only the upper five or ten cm soil samples are being assessed.

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