Long-term P fertilisation experiment on grass – effects on plant and soil

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THE AIM OF THE STUDY

Phosphorus (P) fertilisation has been significantly decreased in Finland in the last 25 years but the long-term effects of reduced P inputs on crop yield and soil P are poorly studied.

MATERIALS AND METHODS

- Sandy loam soils at Site 1 (Maaninka, 63°08' N, 27°19' E,) and Site 2 (Ruukki, 64°44'N, 25°15'E) in Finland.
- Treatments (n=4): mineral P application (PF), average 16 kg ha^{-1} annually, and a control with no added P (P0). A randomized complete block design.
- Four ley rotations from year 2003 to 2020. Mixture of timothy and meadow fescue was sown with barley and harvested for grass for the next three or four years. Dry matter yield (DMY; kg DM ha^{-1}) and grass P concentration (g kg^{-1} DM) were measured.
- Soil P in 0-20 cm (Ammonium acetate extraction, P_{AAC}, mg l^{-1} of soil) was monitored.

RESULTS

- There was no significant difference in cumulative DMY between P0 and PF (Fig. 1).
- The cumulative P yield of P0 was lower than in PF (Fig. 2). P fertilisation increased the P balance of PF, but it still remained negative at both sites (Fig. 3).
- The negative P balances caused a decrease of soil P_{AAC}. In the spring 2003, P_{AAC} was 19.5 and 14.8 mg l^{-1} at Site 1 and 2, respectively. At Site 1, P_{AAC} declined to 9.3 in P0 and to 13.0 mg l^{-1} in PF by 2020. At Site 2, the decline was from 14.8 to 8.4 in P0 and to 10.4 mg l^{-1} in PF by 2020. In earlier studies, yield response has commonly occurred as soon as P_{AAC} has declined below 10 mg l^{-1}.

CONCLUSIONS

- P fertilisation of perennial grasses could be lowered even down to suboptimal soil P_{AAC} level (8 mg l^{-1}).
- Interpretation of soil P test results needs revision.
- Availability of slowly soluble soil P requires further study

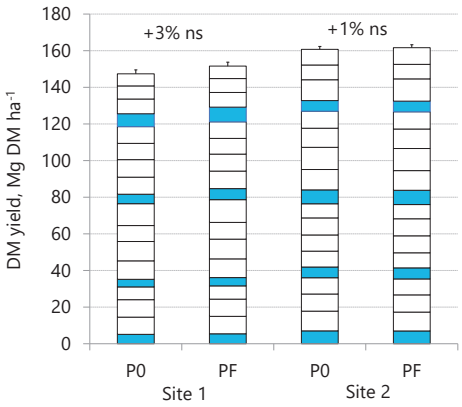

Figure 1. Cumulative dry matter yield (Mg DM ha^{-1}) at Site 1 and Site 2 in 2003–2020. The ley was sown with barley in 2003, 2007, 2012 and 2017, highlighted in blue. Percentages above the bars are differences between P0 and PF. Statistical significances: ns = non-significant. Error bars show the standard error of means (SEM).

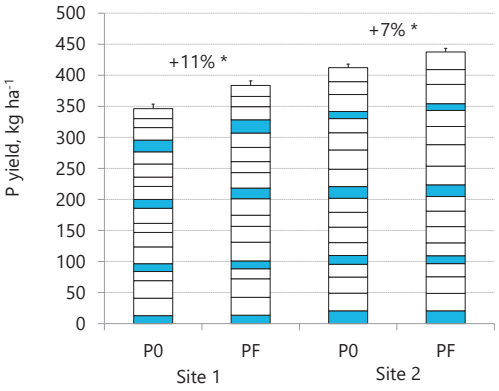

Figure 2. P yield (kg ha^{-1}) at Site 1 and Site 2 in 2003–2020. The ley was sown with barley in 2003, 2007, 2012 and 2017, highlighted in blue. Percentages above the bars are differences between P0 and PF. Statistical significances: * P < 0.05. Error bars show the standard error of means (SEM).

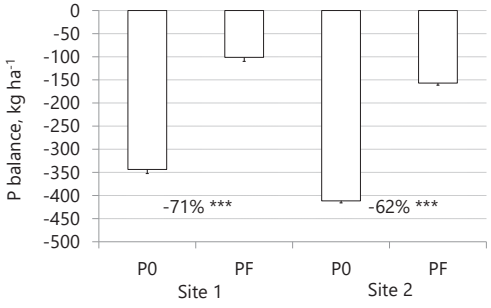

Figure 3. P balance (kg ha^{-1}) at Site 1 and Site 2 in 2003–2020. Percentages below the bars are differences between P0 and PF. Statistical significances: *** P < 0.001. Error bars show the standard error of means (SEM).