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Long-term effects of phosphate fertilization

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Introduction

In agriculture there is a growing need to use phosphorus fertilizer more efficiently because of P related environmental problems and diminishing P reserves. Legislation in the Netherlands restricted the maximum supply of phosphate on agricultural soils to minimize losses to the environment. Concerns about soil fertility and yield losses arose. A long-term phosphate trial was initiated and preserved to quantify the effects of P-fertilization levels on crop growth as well as on soil phosphate levels and phosphate losses.

Methods

The experiment on a marine light clay soil started in 1990 with four levels of P- fertilization. In 2005 each treatment was split: fertilization was continued in one part and discontinued in the other. Resulting in these treatments and fertilization (kg P_2O_5 ha^{-1} yr^{-1}):

	1990-2004	2005-2022
P1-0	0	0
P1-70	0	70
P2-0	70	0
P2-70	70	70
P3-0	140	0
P3-140	140	140
P4-0	280	0
P4-280	280	280

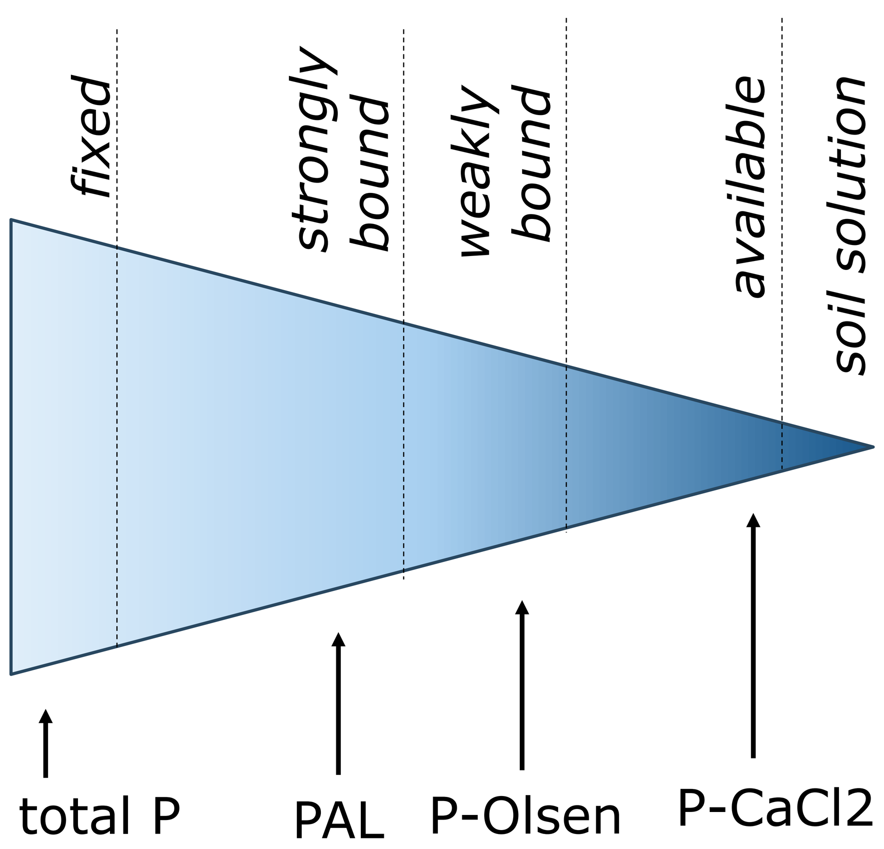

Figure 1. Phosphate fractions in the soil.

Crop yiels were monitored and phosphate fractions (P-$CaCl_2$, Pw, P-AL and total P) were determined in the soil (0-30cm and 30-60cm).

Effects on yields

- An optimum yield was obtained by 70 kg P_2O_5 ha^{-1} yr^{-1} at a soil phosphate level that is considered as optimal.
- Yield losses occurred at fertilized and unfertilized plots with lower soil phosphate levels.
- Higher soil phosphate levels in combination with and without fertilization did not affect yields.

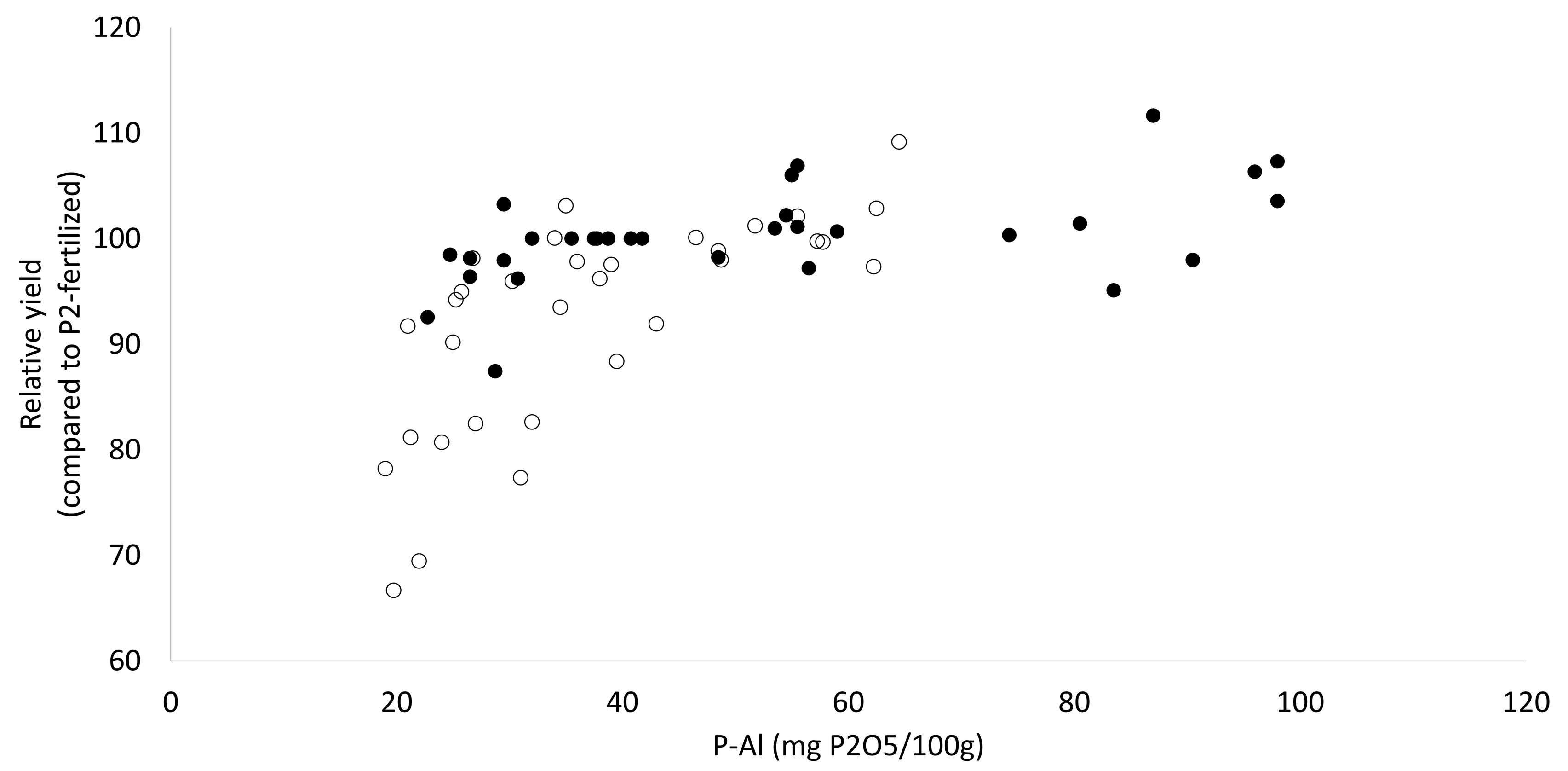

Figure 2. Relative crop yields for fertilized treatments (filled) and not fertilized treatments (open) in the period 2006-2022, for crops with a high P need (potato, onion, maize, beans).

Effects on soil

- Different levels of fertilization led to divergent soil phosphate levels in the soil layers 0-30cm and 30-60cm.
- Discontinuation of fertilization led to sharp decreases in soil phosphate levels.
- The P_2O_5 surpluses did not lead to proportionate changes in the soil P_2O_5 stock at 0-30cm.
- Losses were difficult to quantify.
- At high fertilization rates P-$CaCl_2$ stabilized while the P stock measured with P-Al further increased.

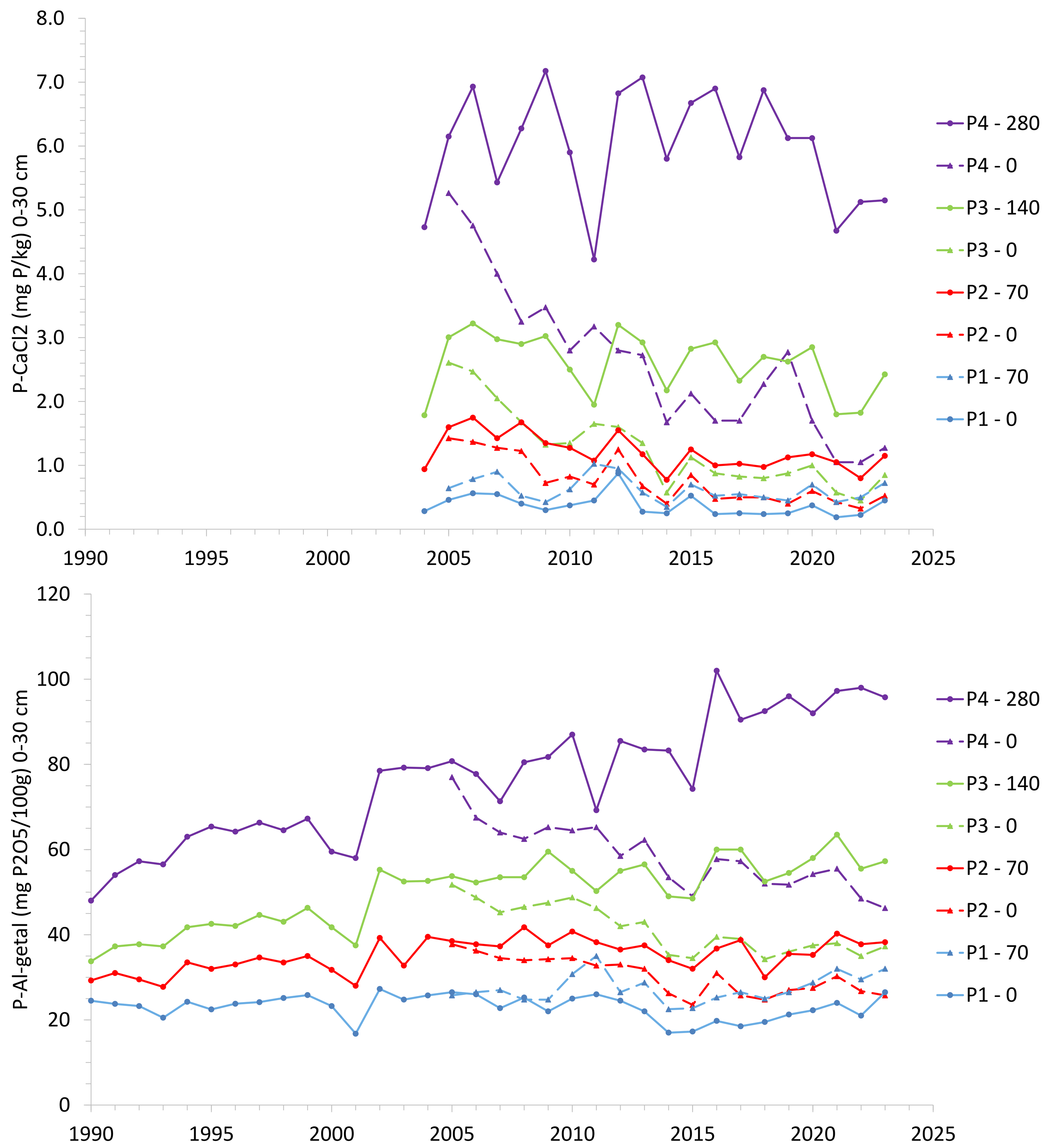

Figure 3. The soil phosphate levels measured as P-CaCl2 (top) and as P-Al (bottom) in the layer 0-30cm.

Conclusions

- At sub optimal soil phosphate levels, fertilization is needed to reach optimal yields and improve the soil phosphate levels.
- At high soil phosphate levels, fertilization is not needed to reach optimal yields. The current limit of 40 kg P_2O_5 ha^{-1} yr^{-1} is sufficient to reach optimal yields at high phosphate levels.
- At low soil phosphorus levels, mining did not lead to a further decrease.
- At high soil phosphorus levels, mining did not lead to stabilized levels after 18 years.

Acknowledgements

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