Effects of different types of fertilizers on phosphorus availability In a soil with low P content

S. Barbieux[1,2], M. Renneson[1], F. Cobert[1] & G. Colinet[1]

[1] University of Liege – Gembloux Agro-Bio Tech – Soil & Water Systems Unit
[2] University of Liege – Gembloux Agro-Bio Tech – AgricultureIsLife
Passage des Déportés, 2. B-5030 Gembloux -sophie.barbieux@ulg.ac.be

CONTEXT & OBJECTIVE

- **In the world**, the use of nitrogen and phosphorus (P) fertilizers has increased at a faster rate than global food production in the last fifty years, resulting in a decrease of efficiency (Rockström et al., 2009). Moreover, world reserves of mineral P are limited and non-renewable at human scale. The disappearance of phosphate rock of high quality is expected in the coming decades (Cordell et al., 2009) (Fig.1).
- In that context, **the objective** of this research is to study the effect of alternative amendments on P availability for plants.

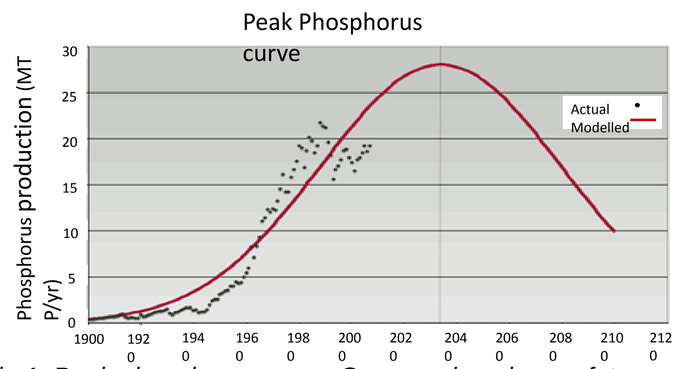


Fig.1. Peak phosphorus curve. Source: phosphorousfutures.org

MATERIAL & METHODS

Micro-culture experiment based on the Stanford & DeMent (1957) procedure

Ryegrass grown without added P in sand until development of roots at the bottom of the container
15 days

Plants were grown under controlled conditions (18-25°C)

470 g of sand
2 g of ryegrass (*Lolium multiforum*) seeds
80% of field capacity
Supply of nutritive solution (free P)

Plants (roots) are then placed in contact with a soil-fertilizer mixture
15 days

500 g of soil (silty, low P) mixed with fertilizer
→ Fertilizer type: manure, struvite (magnesium ammonium phosphate complex from urine) or triple superphosphate (TSP) + a control without fertilizer
→ Fertilizer rate: 50, 100 or 200 kg P /ha

Shoot :

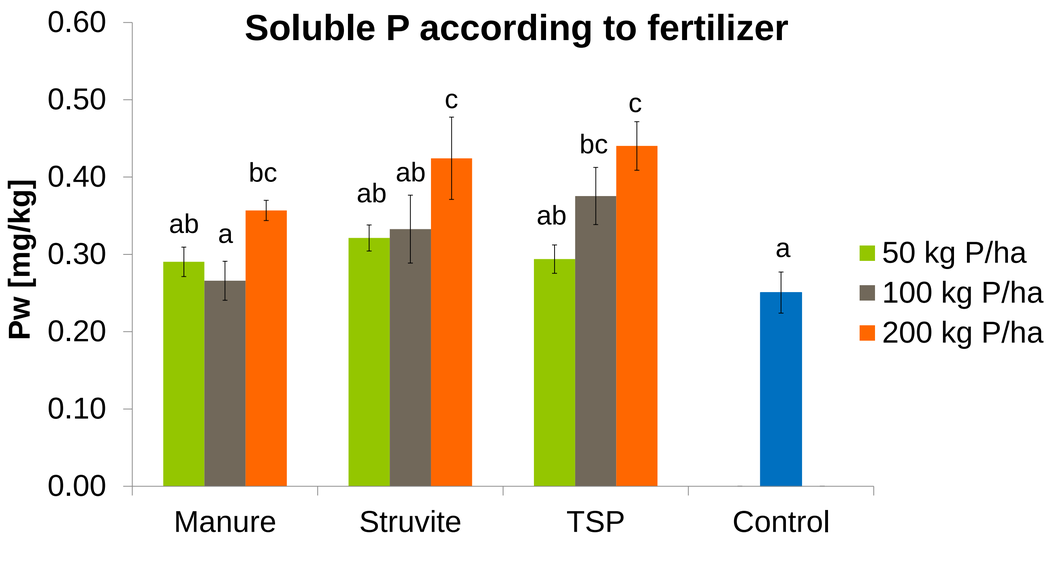
Total P, Mg, K: HNO_3 + $HClO_4$ mineralization (w:v 1:50)
Total N: Kjeldahl method

Soil :

Soluble P (Pw): water extraction (w:v 2:10)
Microbial elements (P, N & C): fumigation – extraction method
Phosphatase activity (phosphomonoesterases): Tabatabai and Bremmer method (*p*-NPP hydrolysis)
Available P: Lakanen-Erviö method (CH_3-COO-NH_4 + EDTA, pH 4.65, w:v 1:5)
Inorganic & organic P: H_2SO_4 6N extraction (w:v 1:40)
pH: water and KCl 1N (w:v 2:5)
Hot Water-extractable C (w:v 1:10)
Nitrate: KCl 0.1N extraction (w:v 1:5)

PRELIMINARY RESULTS

Fertilizer	Pw [mg/kg]	
	Mean	Standard Error
MA 50	0.29	0.02
MA 100	0.27	0.03
MA 200	0.36	0.01
STR 50	0.32	0.02
STR 100	0.33	0.04
STR 200	0.42	0.05
TSP 50	0.29	0.02
TSP 100	0.38	0.04
TSP 200	0.44	0.03
Control	0.25	0.03



The type and the rate of fertilizer do not have effect on **nitrate** content (data not shown)

Pw results

- Generally, a gradient is observed with increased rate of fertilizer
- The manure effect is lower than struvite and TSP
  The TSP effect is faster observed than struvite.
- At 50 kg P/ha: none is significantly different from the control
  At 100 kg P/ha: only TSP is higher than the control
  At 200 kg P/ha: all of the fertilizer are significantly different from the control

CONCLUSIONS & PERSPECTIVES

- The experiment is achieved but the analyses are still in progress. At this point, we observed an effect of the type of fertilizer on Pw content in soil: mineral sources show a higher solubilization than organic. This was also observed by other authors, a.o. Peak et al. (2012).
- We will evaluate the effect of fertilization on the microbiological activity through microbial and enzymatic parameters as well as the HWC. This will indicate whether a parameter is a better indicator than the others in a low-P soil with potentially high fixing power.
  Analysis of P content in plant and in soil (microbial, available, inorganic and organic pools) is intended to evaluate the fate of P from fertilizers.
- Later, the same experiment will be realized with soils from long-term fertilization trial.

Cordell, D., Drangert, J.-O., and White, S. (2009). The story of phosphorus: Global food security and food for thought. Glob. Environ. Change *19*, 292–305.
Peak, D., Kar, G., Hundal, L., and Schoenau, J. (2012). Kinetics and mechanisms of phosphorus release in a soil amended with biosolids or inorganic fertilizer. Soil Sci. *177*, 183–187
Rockström, J., Steffen, W., Noone, K., Persson, \AAsa, Chapin, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., and Schellnhuber, H.J. (2009). A safe operating space for humanity. Nature *461*, 472–475.
Stanford, G., and DeMent, J.D. (1957). A Method for Measuring Short-Term Nutrient Absorption by Plants: I. Phosphorus1. Soil Sci. Soc. Am. J. *21*, 612.