How phosphorus availability is influenced by agricultural practices ?

S. Barbieux[1,3], M-P. Hiel[2,3], B. Bodson[2], F. Cobert[1],, M. Renneson[1] & G. Colinet[1]

[1] University of Liege - Gembloux Agro-Bio Tech – Soil-Water System Unit.
[2] University of Liege - Gembloux Agro-Bio Tech – Crop production of temperate regions Unit.
[3] University of Liege - Gembloux Agro-Bio Tech – AgricultureIsLife.
Passage des Déportés, 2. B-5030 Gembloux - sophie.barbieux@ulg.ac.be

CONTEXT AND 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 phosphorus 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).

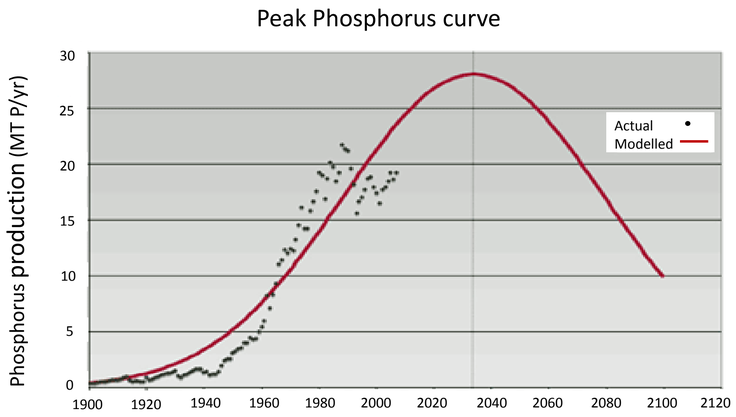

Fig.1. Peak phosphorus curve. Source: phosphorousfutures.org

- **In Wallonia**, the total reserves of phosphorus in soils (P_{tot}) are high (904 mg P/kg on average in the topsoil – extractable by CH_3COONH_4 + EDTA). However only a small part of P_{tot} is available for plant nutrition (9% of P_{tot} - 71.6 mg P/kg) due to a high soil P sorption capacity (Renneson et al., 2013).

- Other agronomic practices are needed in order to increase the efficiency of mobilization of P present in soil.

- In that context, **the objective** of this research is to study the influence of tillage and crop residues restitution on P distribution within topsoil.

METHODS

Field
- Silty soil
- 4 modalities (Fig.2)

Soil sampling
- 0-10, 10-20, 20-30 cm
- Twice a year since 2009

Chemical analyses
- $pH_{KC}l$, TOC
- Soluble elements (P_w, Ca_w, Mg_w), HWC
- Available elements determined by Lakanen-Erviö method ($CH_3COO\text{-}NH_4$ + EDTA, pH 4.65 – P_{NH4}, Ca_{NH4}, Mg_{NH4})

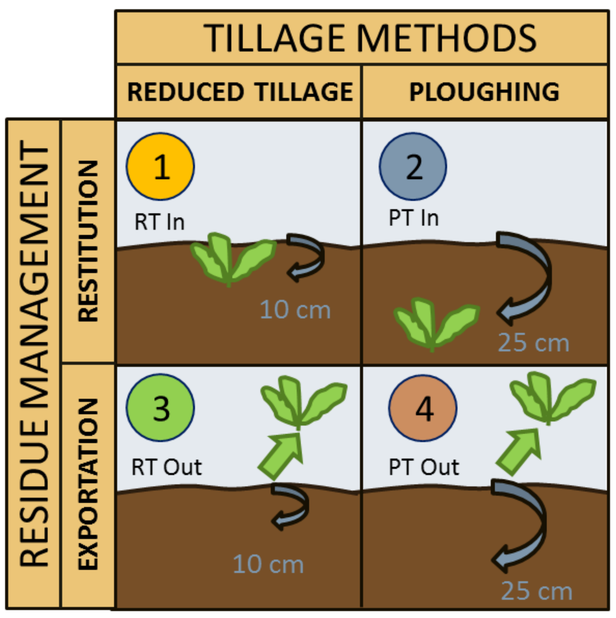

Fig.2. Studied modalities. Source : M-P Hiel

RESULTS

Vertical distribution of P_w content within topsoil in Spring 2013

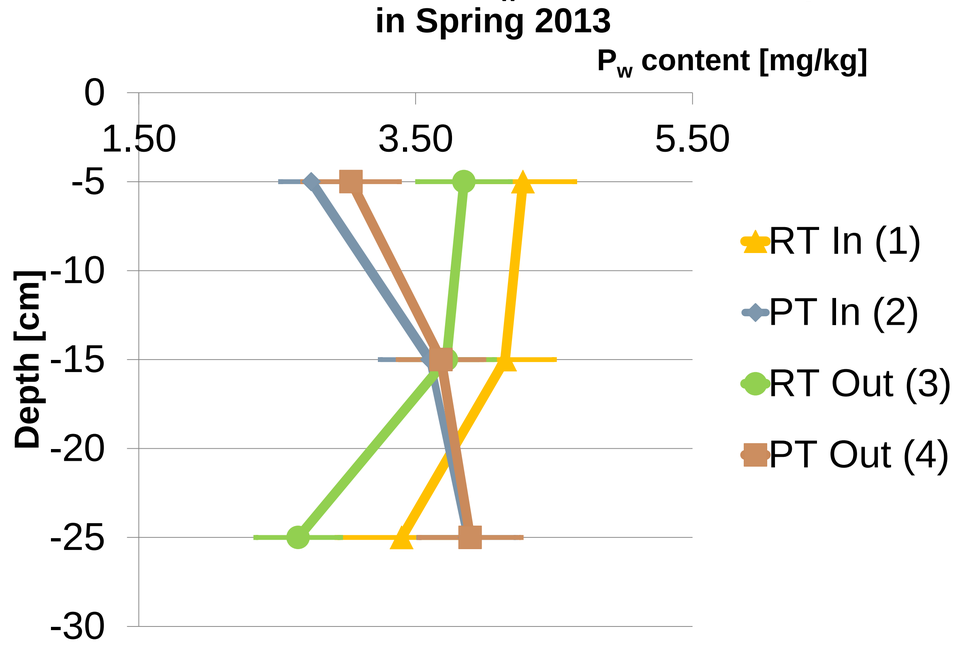

Fig.3. Pw distribution within topsoil. Values: means, Error bars: St. Dev. (n=8)

- **Vertical distribution** (Fig.3)**:**

Under shallow tillage practices (1 & 3): P_w > at the soil surface and decreased with depth while the opposite trend is observed under plough soil (2 & 4), although not statistically significant.

- **Temporal evolution:**

Since autumn 2009, Mg_{NH4} content tends to decrease with time. It is the same for Mg_w, Ca_w and pH_{KCl} since autumn 2011. However, Ca_{NH4} as well as P_w, and P_{NH4} tend to remain constant.

- **Effect of residues restitution:**

$P_w(1)$ > $P_w(3)$ → effect of crop residues restitution. Actually the decomposition of crop residues left on the field constitute a source of P (Ulén, 1997). This cannot be observed under ploughing because of a bigger dilution of the residues in the soil.

- **Correlations:**

Results also revealed a negative correlation between P_{NH4} and Ca_{NH4} as well as between P_w and Mg_w → Genot *et al*. (2012) showed that the Mg content in Walloon soils was increasing while P was decreasing. Moreover, Cobert *et al.* (2013) observed by modelling that an increase of Mg content results in a decrease of PO_4 ions in soil solution.

REMEMBER !

- **Tillage treatments influence the spatial distribution of P_w within soil profile**
- **The crop residues left on field decompose and constitute a significant source of soluble P**
- **Suspicion of immobilization of P due to equilibration between elements**

COLLABORATION

This project is part of multidisciplinary projects from AgricultureIsLife Platform (Gembloux Agro-Bio Tech)

REFERENCES

- 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.
- Genot, V., Renneson, M., Colinet, G., Goffaux, M.J., Cugnon, T., Toussaint, B., Buffet, D., and Oger, R. (2012). Base de données sols de REQUASUD.
- Renneson, M., Dufey, J., Legrain, X., Genot, V., Bock, L., and Colinet, G. (2013). Relationships between the P status of surface and deep horizons of agricultural soils under various cropping systems and for different soil types: a case study in Belgium. Soil Use Manag. *29*, 103–113.
- 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.
- Ulén, B. (1997). Nutrient losses by surface run-off from soils with winter cover crops and spring-ploughed soils in the south of Sweden. Soil Tillage Res. *44*, 165–177.
- Cobert, F., Pourret, O., Renneson, M., Colinet, G. (2013). Phosphorus availability in agricultural soil of Wallonia – A modeling approach. *Goldschmidt*, Florence, Italie