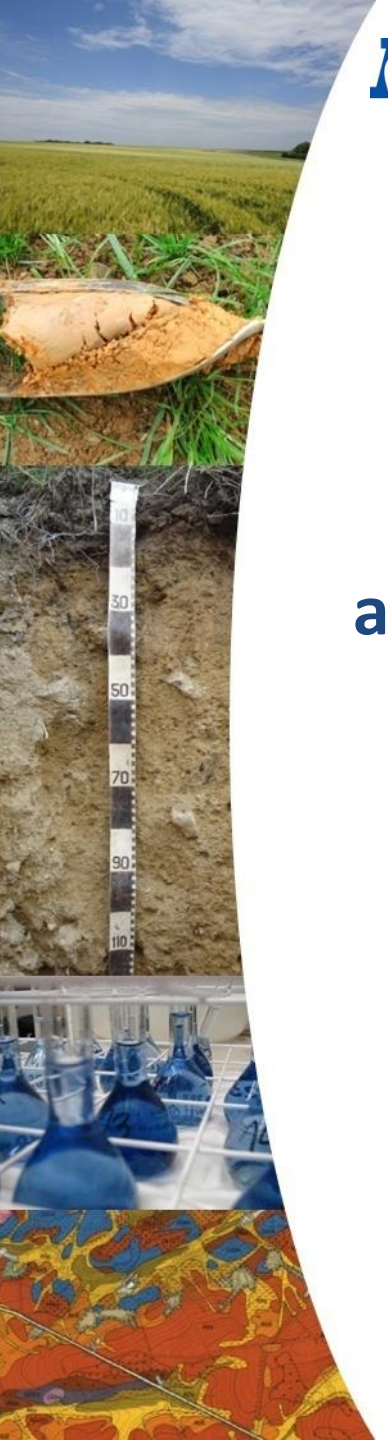


Agriculture Is Life.be

2015 International Year of Soils

Improvement of phosphorus availability by agricultural practices: crop residues management & recycling OM waste – first results

Barbieux Sophie & Gilles Colinet

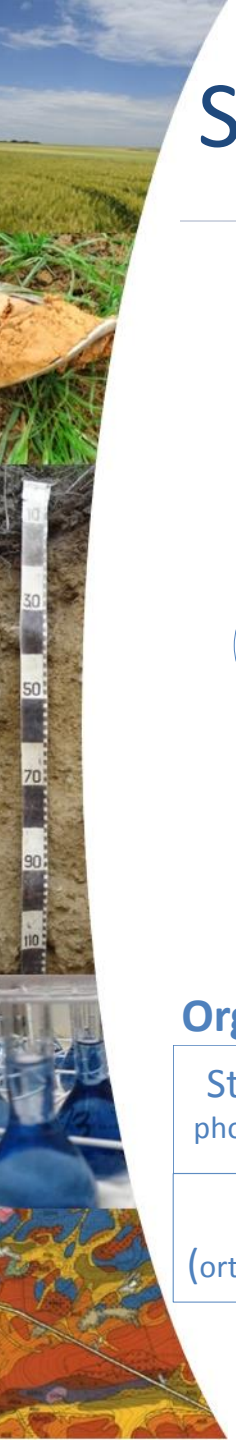
Water – Soil - Plant Exchanges

AgricultureIsLife – Biosystems Engineering

Gembloux Agro-Bio Tech
Université de Liège

Introduction & context

Soil P dynamics in agro-ecosystems



P export to humans and animals

Erosion
Runoff

Microbial biomass

Mineralization
Immobilization

Death
Assimilation

Organic P

- Stabilized Po (inositol phosphates, phosphonates)
- Active Po (orthophosphate diester, ...)

Dissolved P (in soil solution)

Sorption
Desorption
Dissolution
Precipitation

Inorganic P

- Sorbed P (clays, metal oxides)
- Precipitate P (Ca, Fe, Al phosphates)
- Insoluble P (apatites)

Soil P dynamics in agroecosystems

P export to humans and animals

Stock (forms & quantity), kinetics of mineralization/ immobilization

pH, reserves & ionic balance

Erosion
Runoff

Organic P

Mineralization

Immobilization

Dissolved P (in soil solution)

Sorption

Desorption

Dissolution

Precipitation

Inorganic P

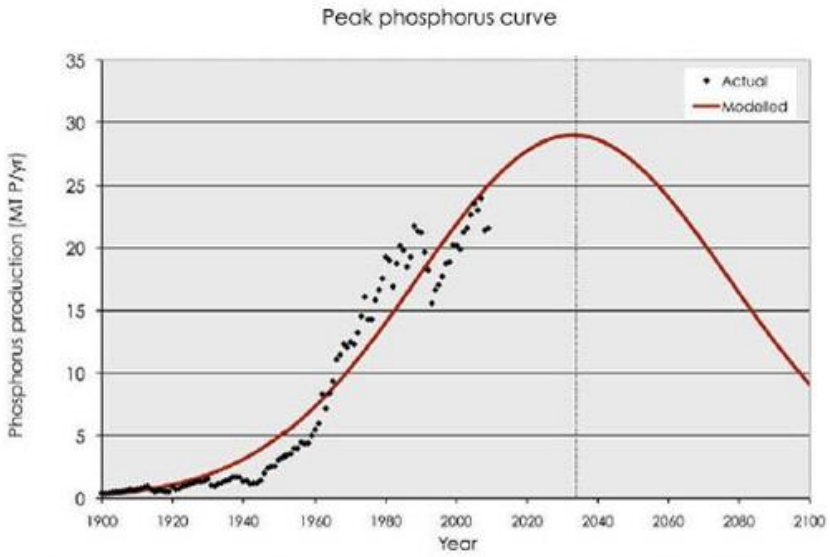
Sorbed P (clays, metal oxides)

Precipitate P (Ca, Fe, Al phosphates)

Insoluble P (apatites)

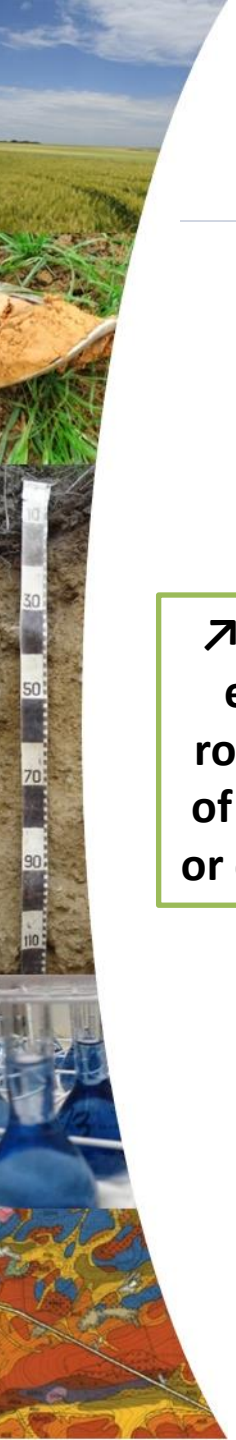
Issue concerning P

- Phosphorus, a non-renewable resource



(Cordell et al., 2009)

Increasing the P availability



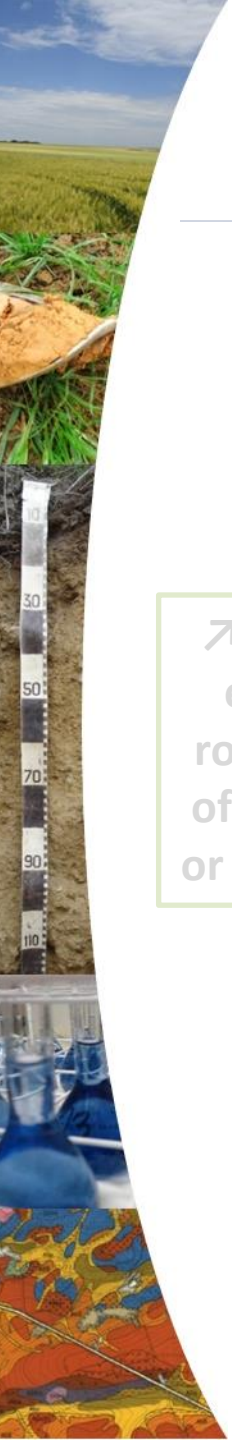
↗ volume actually exploited by the roots (modification of root architecture or crop associations)

Changing the composition of the rhizosphere microorganisms

Dissolved P

Adding compounds that promote the P solubilization (from fertilizer or root secretions)

Increasing the P availability



↗ volume actually exploited by the roots (modification of root architecture or crop associations)

Changing the composition of the rhizosphere microorganisms

Dissolved P

Adding compounds that promote the P solubilization (from fertilizer or root secretions)

Research hypothesis & questions

Research hypothesis

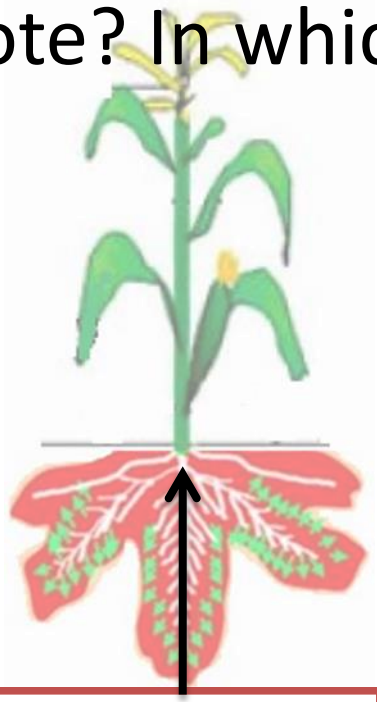
P fertility in agricultural soils

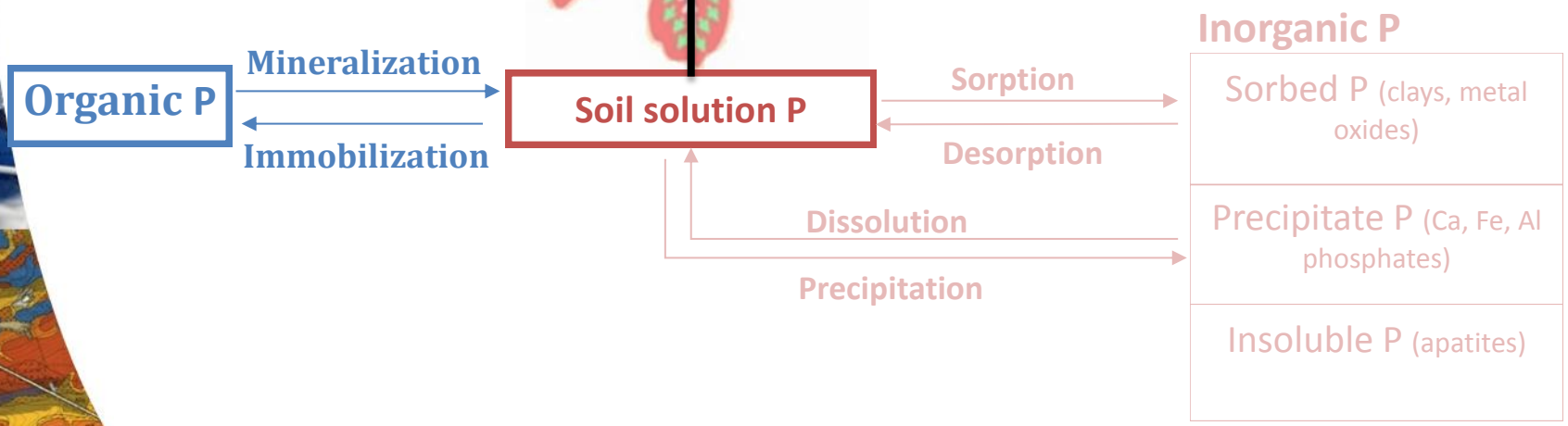
Inorganic P → **Organic P**

recycling of exogenous OM

Research questions

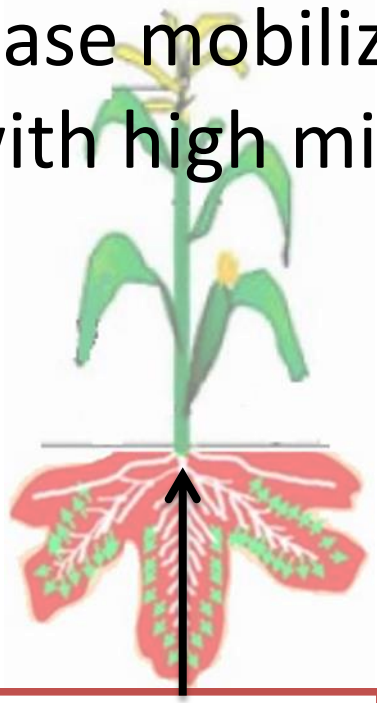
1. Is the increase of organic stocks a future to promote? In which conditions?

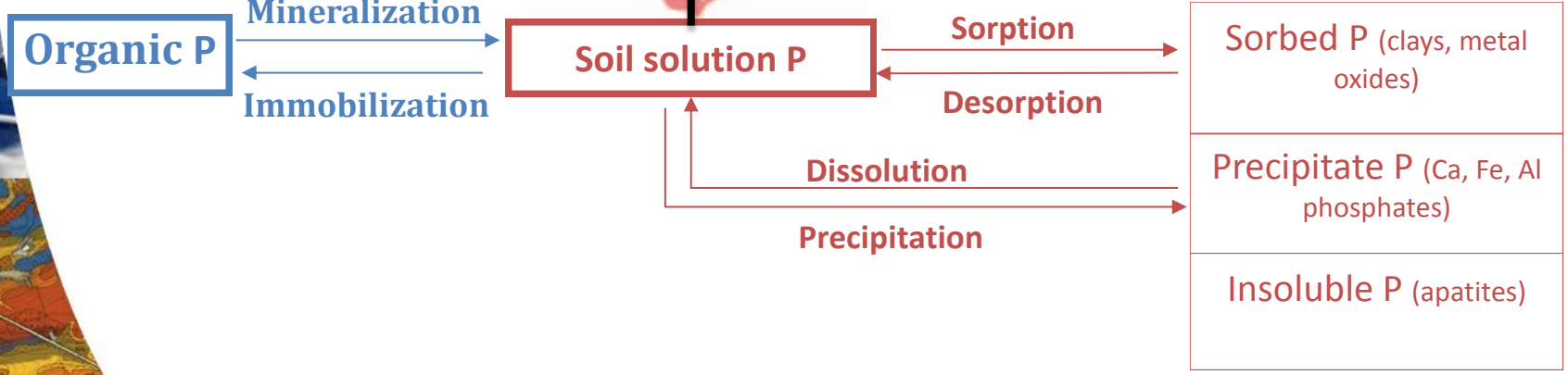




Research questions

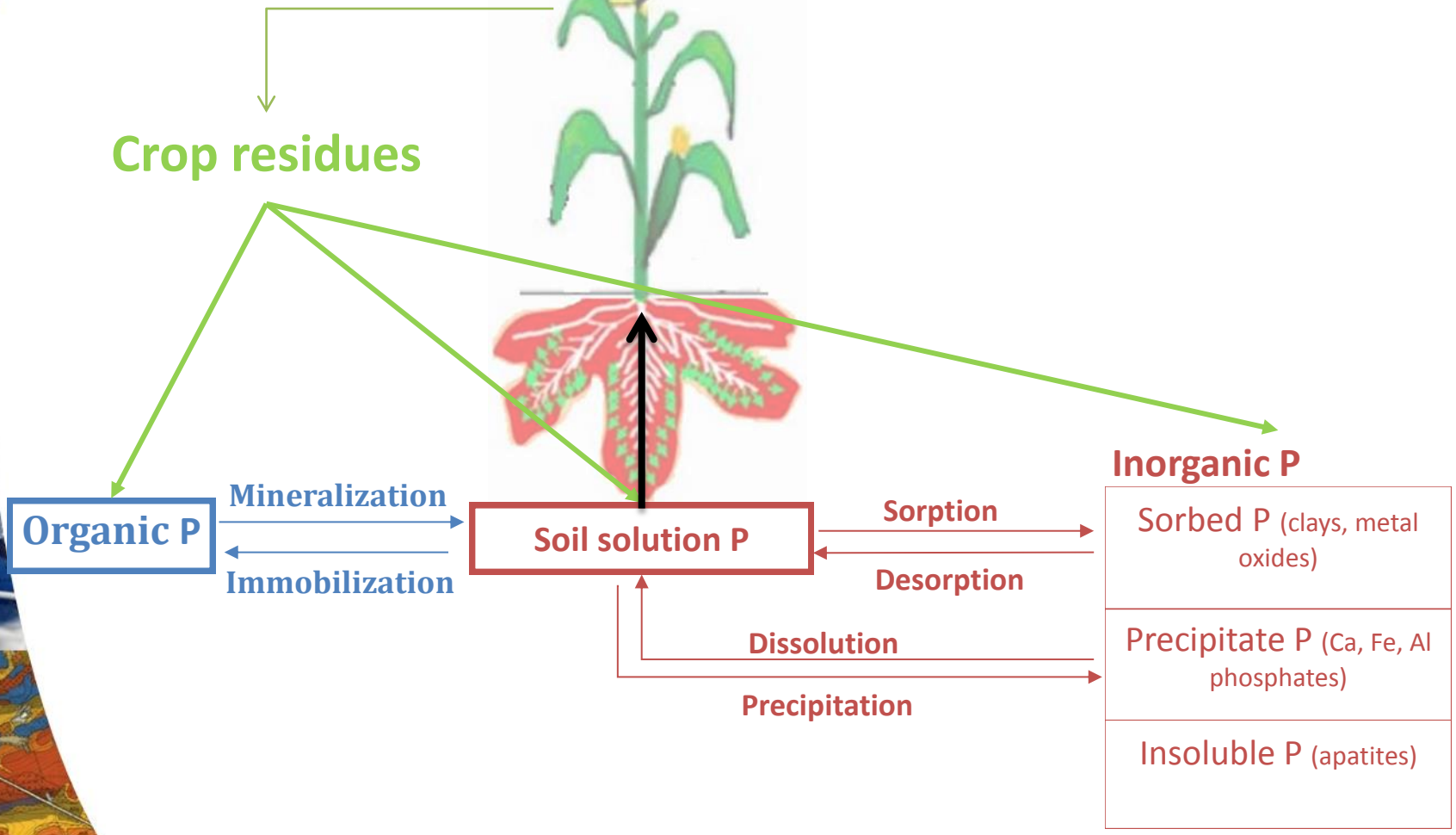
2. Does inserting grassland in the cropping system increase mobilization of the soil P in soils with high mineral reserve?





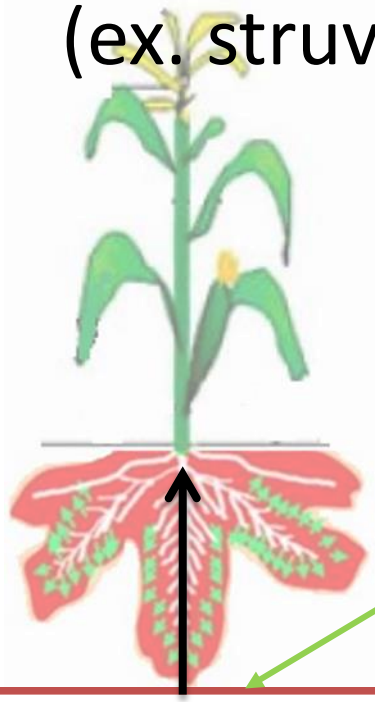
Research questions

3. How does the crop residue management affect soil P availability ?



Research questions

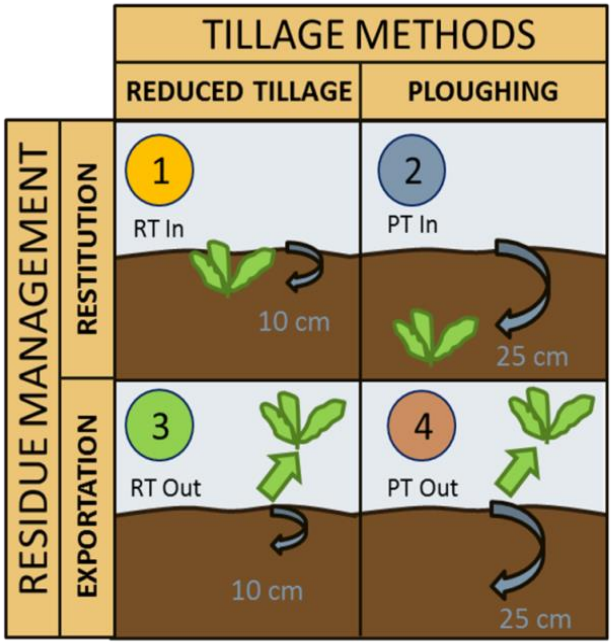
4. Is the recycling of waste MO desirable? (ex. struvite)



Q 3: Management of crop residues

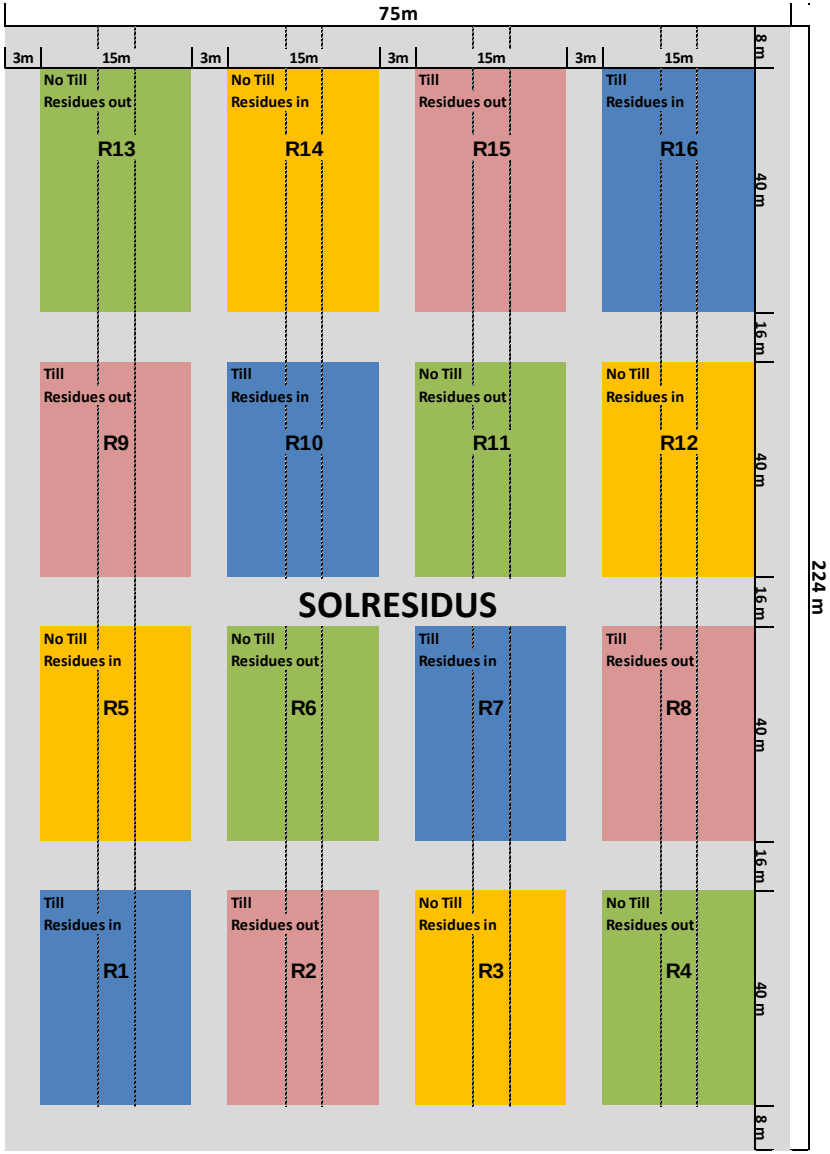
Experimental field

Since 2009
No P input



Source: MP Hiel

2009 – 2012 : winter wheat
2013 : faba bean
2014 : winter wheat
2015 : corn



Sampling & Analyses

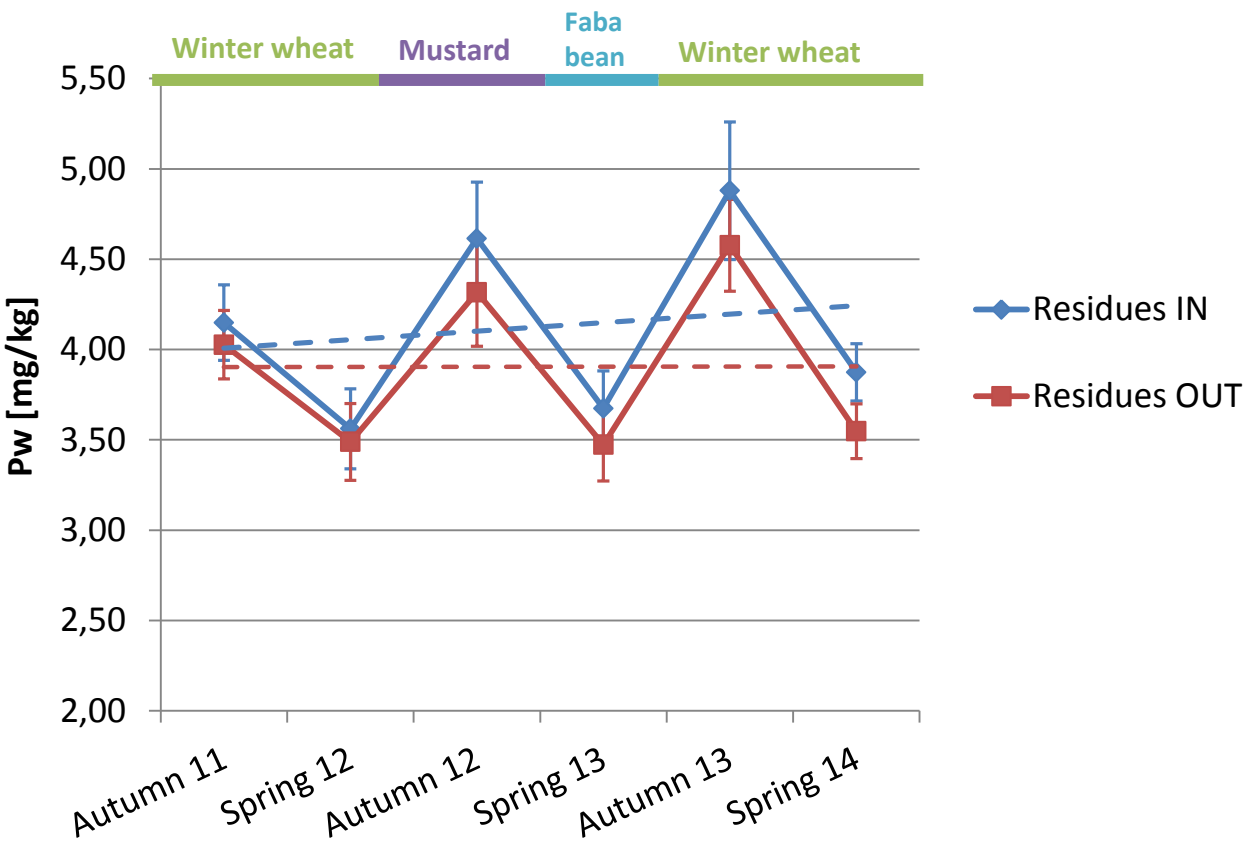
Hypothesis: ploughing influences the vertical distribution of P and crop residues increase P availability in soil

Methods

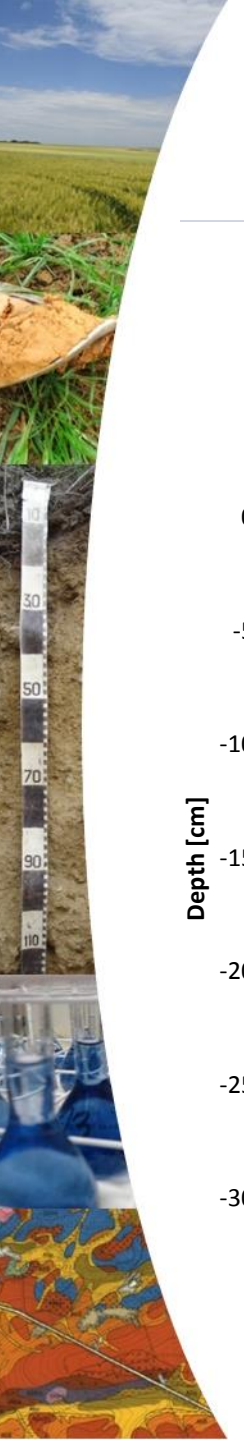
- Composite sampling
  - at 3 depths (0-10, 10-20, 20-30 cm)
  - twice a year (April & October)
- Chemical analyses
  - pH_{KCl}, pH_{water}
  - TOC, HWC
  - Soluble elements (in the soil solution): Ca_w, Mg_w, P_w, K_w
  - Available elements (easily available for crops) (AA-EDTA) : Ca_{NH4}, Mg_{NH4}, P_{NH4}, K_{NH4}

Temporal evolutions

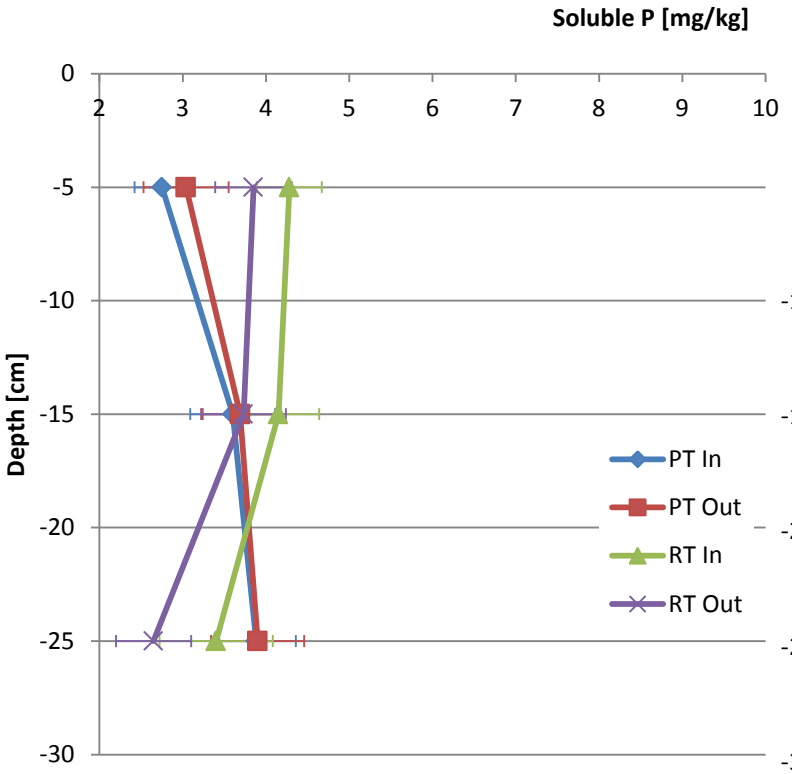
Temporal evolution of soluble P content with (Residues IN) or without (Residues OUT) restitution of crop residues



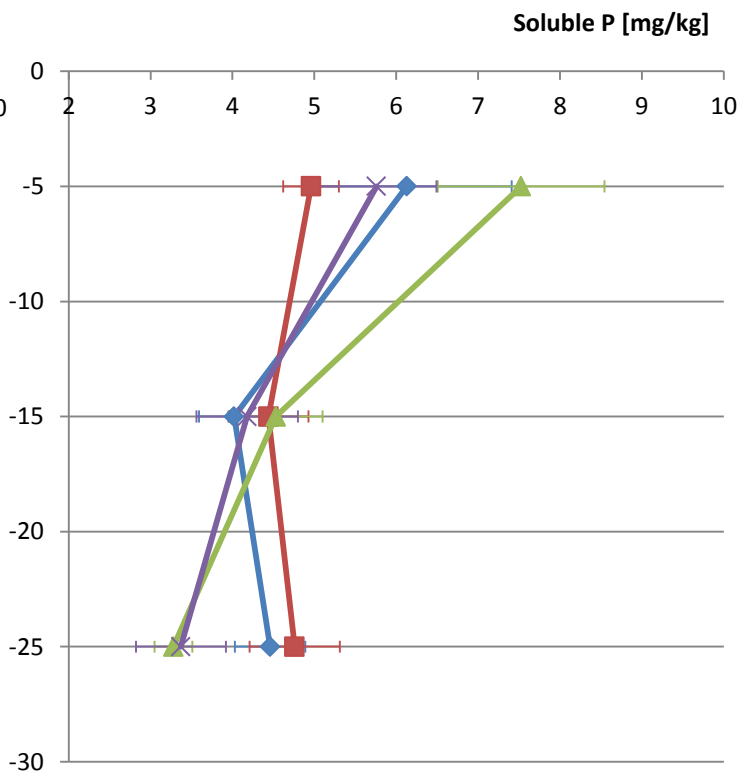
Vertical distribution & seasonal variability



Spring 2013



Autumn 2013



Preliminary conclusions

Hypothesis: ploughing influences the vertical distribution of P and crop residues increase P availability in soil

→ Conclusions

- YES, tillage practices have an impact on vertical distribution of P_w → redistribution of P within topsoil under ploughing >< Higher at soil surface in RT
- YES, crop residues increase P_w in soil

Q 4: fertilization with recycled waste (struvite)

Material & Methods

Objective: study the effect of alternative amendments (struvite & manure) on P availability for plants (ryegrass)

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 (roots) are then placed in contact with a soil-fertilizer mixture (low P soil):

3 fertilizers: TSP, manure, struvite

3 rates: 50, 100 or 200 kg P/ha

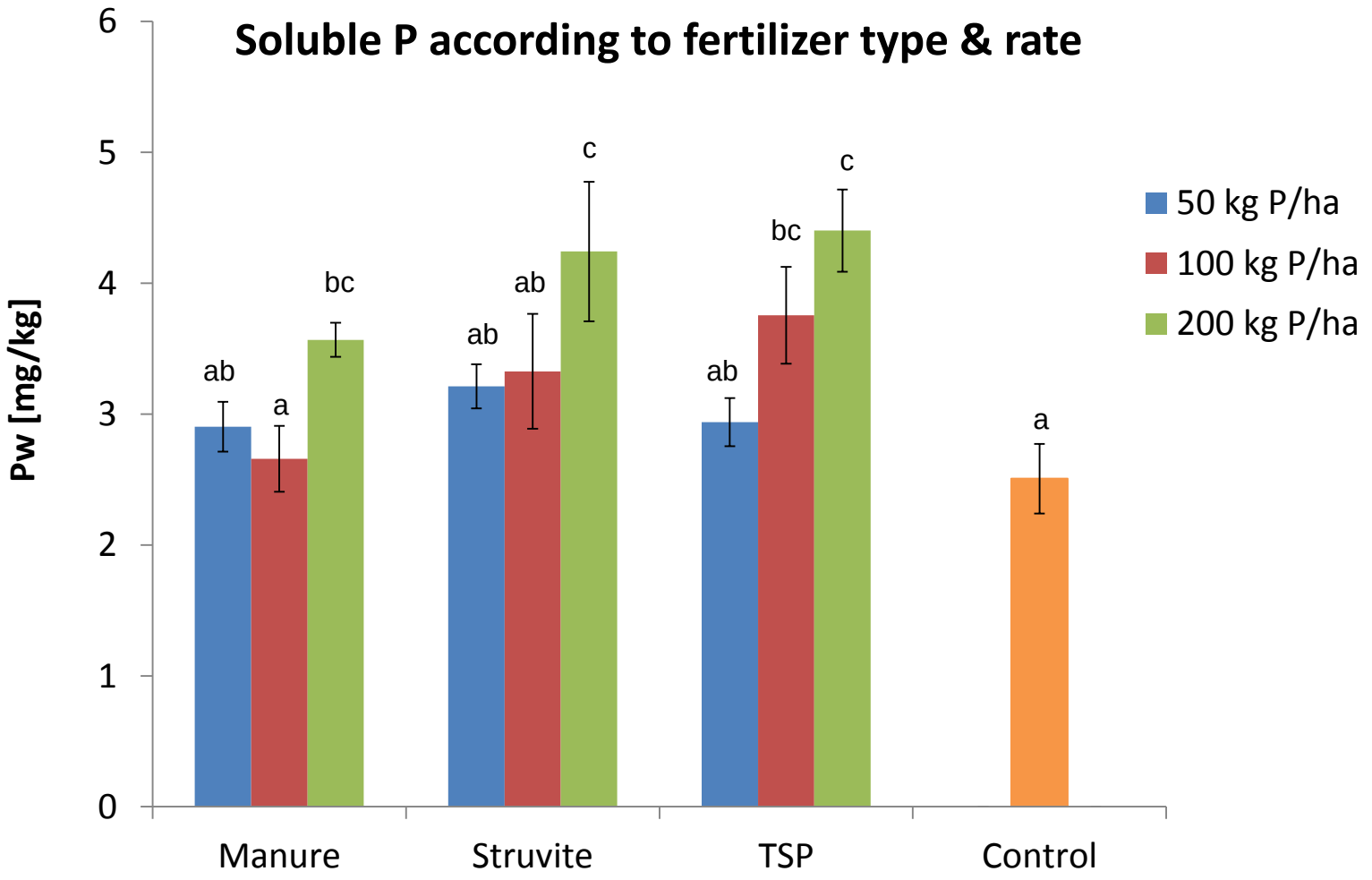
1 control

15 days

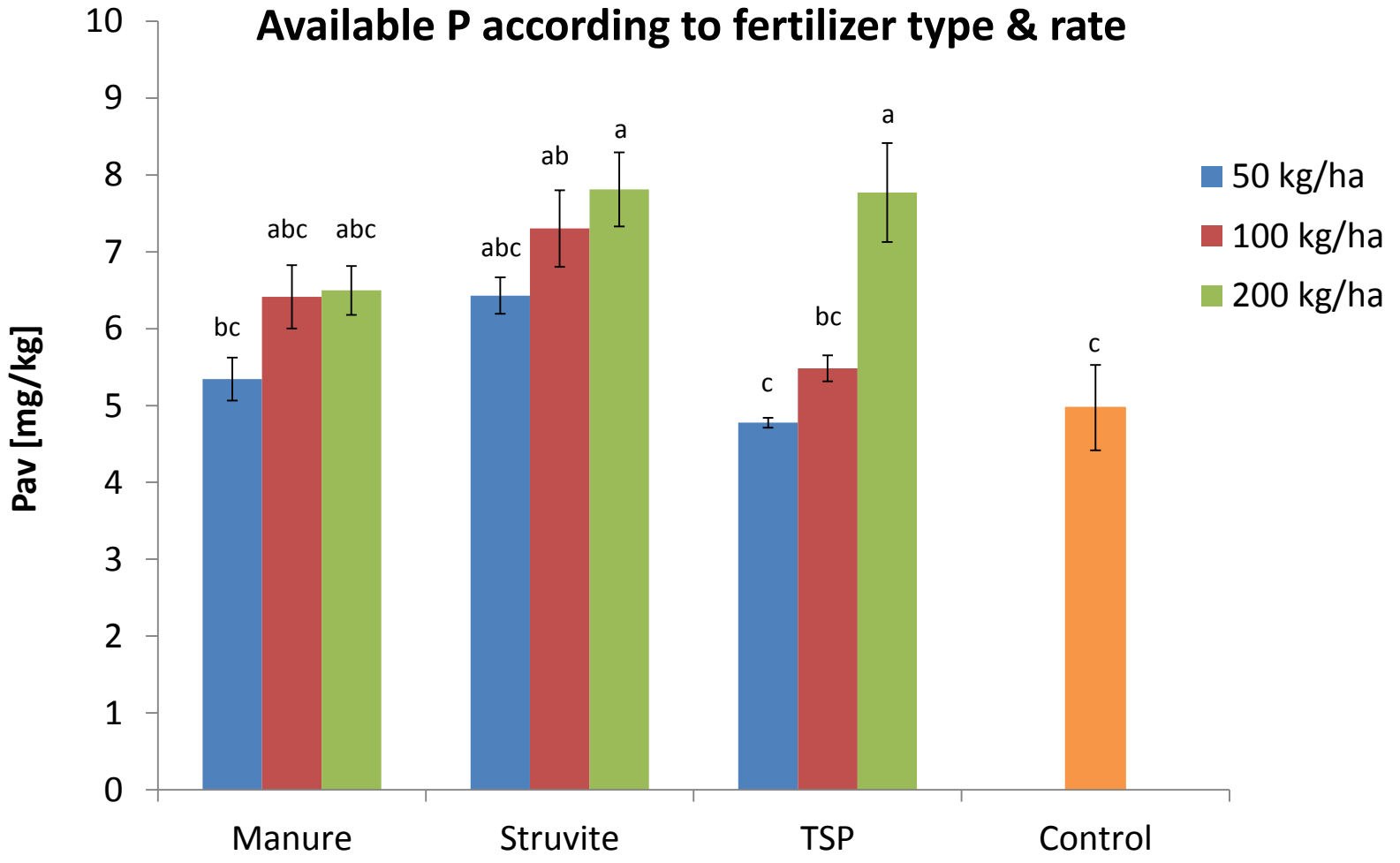
Shoot :
Total P
Total N

Soil :
Soluble P
Phosphatase activity
Available P
pH
TOC
Nitrate

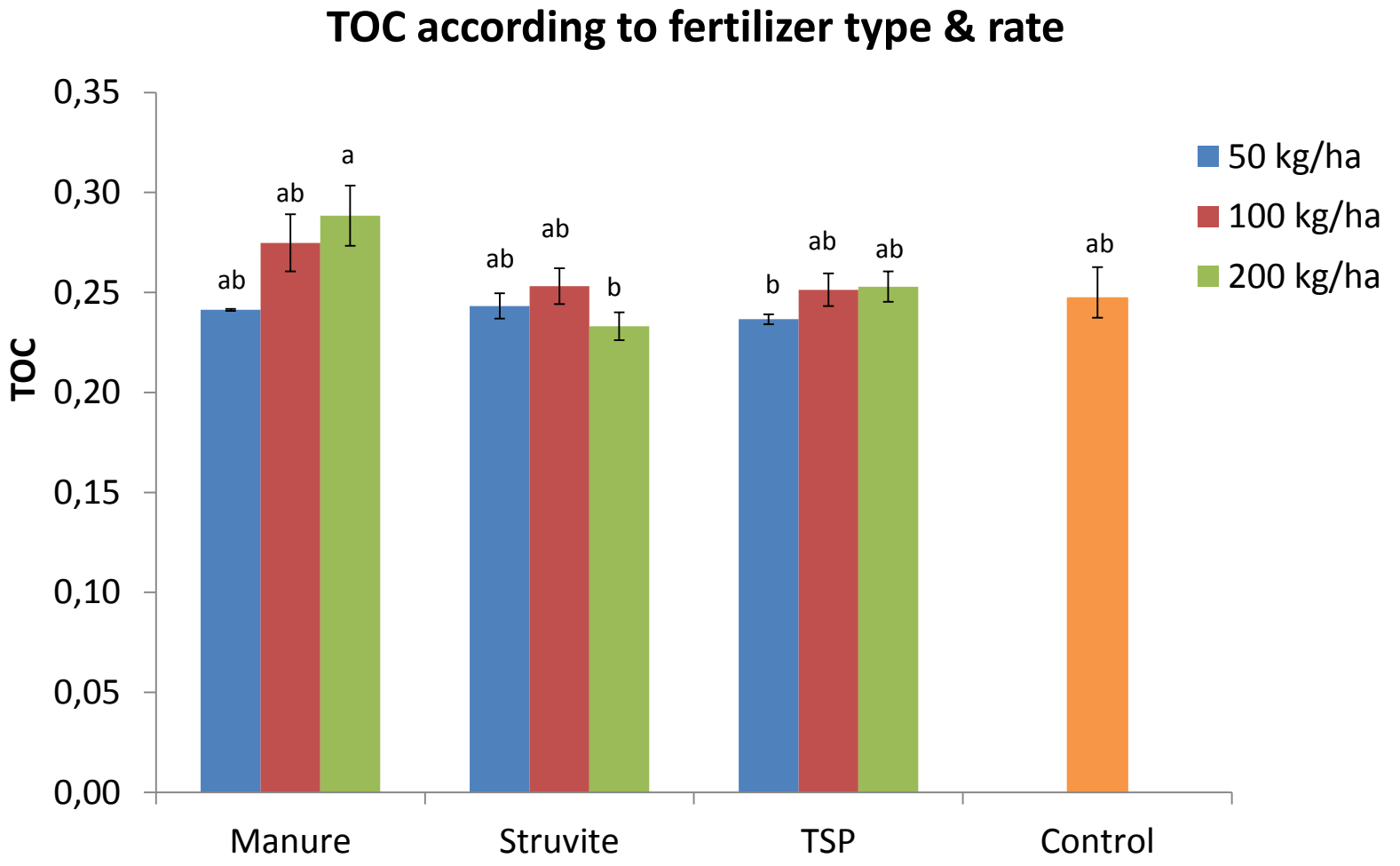
Soluble phosphorus



Available phosphorus

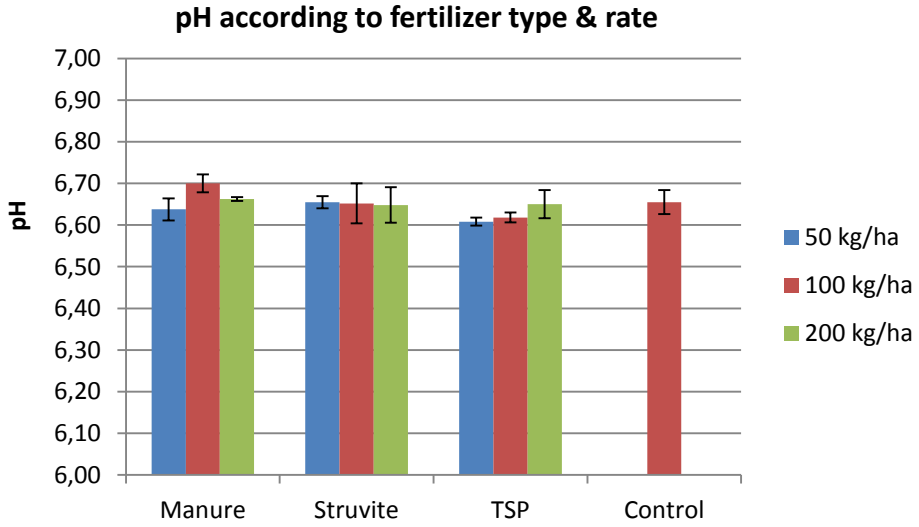


Total Organic Carbon



Other results

- No significative differences :
  - pH
  - Phosphatase activity (acid & alkaline)
  - Nitrate
  - P uptake by plants



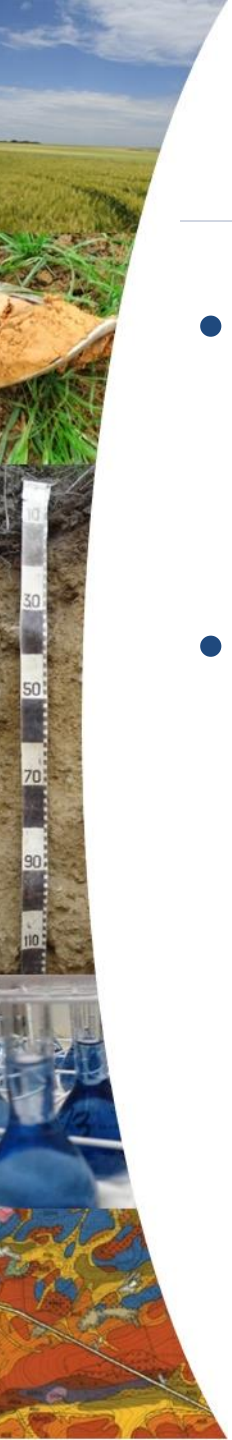
Preliminary conclusions

- Effect of the type of fertilizer on soluble and available P content in soil:

→ Mineral sources: higher solubilization

- Struvite is as efficient as TSP

General conclusions & perspectives



- **Q3 : crop residues management**

  Vertical distribution of Pw → mapping pits (change in scale – decimetric)

- **Q4 : use of alternative fertilizers**

  No convincing results → adapt the protocol


Thank you for your attention