

# Assessing the Agronomic Value of Hog Manure-Derived Struvite as a Phosphorus Source for Spring Wheat

Y. Katanda\*, F. Zvomuya, D. Flaten, and N. Cicek



# Introduction



- Hog manure disposal challenges
  - Eutrophication
  - Strict regulations



# Introduction



- Hog manure disposal challenges
  - Eutrophication
  - Strict regulations
- Management options
  - Feed
  - Solid-liquid separation
  - Crop choices
  - Phosphorus extraction from manure



# Introduction



- Recovered from sewage, poultry, dairy and swine manures

**Struvite**  
**( $\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$ )**



# Introduction



**How effective is it as a P fertilizer?**

**Spring wheat**  
(Massey et al., 2009)

**Canola**  
(Ackerman et al., 2013)

**Struvite**  
( $\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$ )



# Objectives



- Evaluate the effectiveness of hog manure-derived struvite on spring wheat (grown in rotation with canola):
  - Dry matter yield (DMY)
  - Phosphorus uptake (PU)



# Hypotheses



- ✓  $H_0: DMY_{\text{struvite}} = DMY_{\text{commercial fertilizers}}$
- ✓  $H_0: PU_{\text{struvite}} = PU_{\text{commercial fert.}}$



# Experimental Setup



Cycle 1	Cycle 2	Cycle 3
Wheat	Canola	Wheat
Canola	Wheat	Canola





# Experimental Design



- **CRD –factorial plus 2 controls (3 replicates)**
  - **P source**
    - Struvite, CMAP, and MAP
  - **P rate**
    - 25 and 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>
  - **P placement**
    - Seedrow and side-band
  - **Soil**
    - Sand (3.5 mg Olsen P kg<sup>-1</sup>)
    - Clay loam (6 mg kg<sup>-1</sup>)



# Methodology



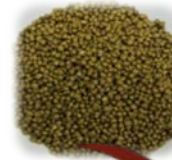
Struvite



5.7: 23: 0.4



CMAP



MAP



~60% WFPS



2.5 cm



362 plants m<sup>-2</sup>  
Red wheat (cv. AC Barrie)

# Statistical Analyses



$$y_{ijkl} = \mu + S_i + A_j + R_k + P_l + SA_{ij} + \dots + e_{ijklm}$$

soil — P source — rate — placement — interactions

- ANOVA - Proc MIXED (SAS Inc. 2012)
- Mean separation - Tukey-Kramer
- Significant at  $P < 0.05$

# Results

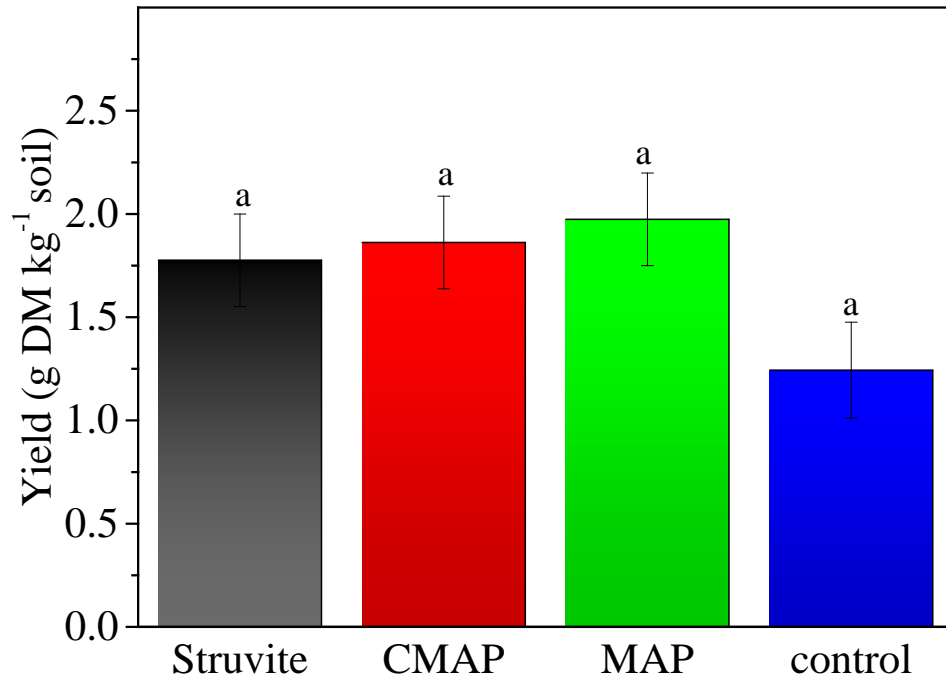


**Harvest at 39 – 43 DAE  
(Zadock stages 39-57)**

# First Cycle



## Biomass Yield



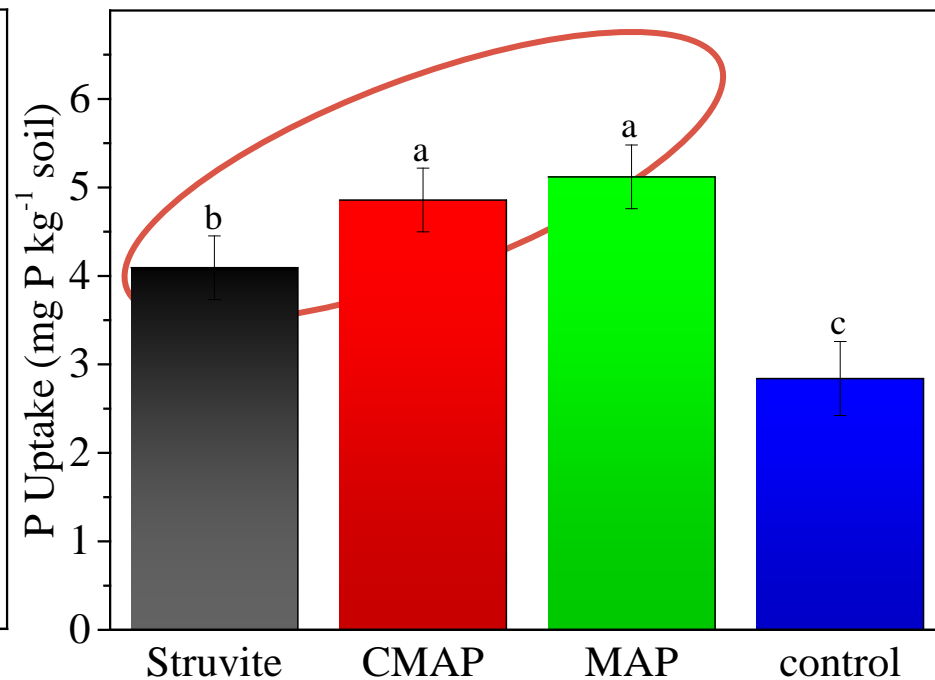
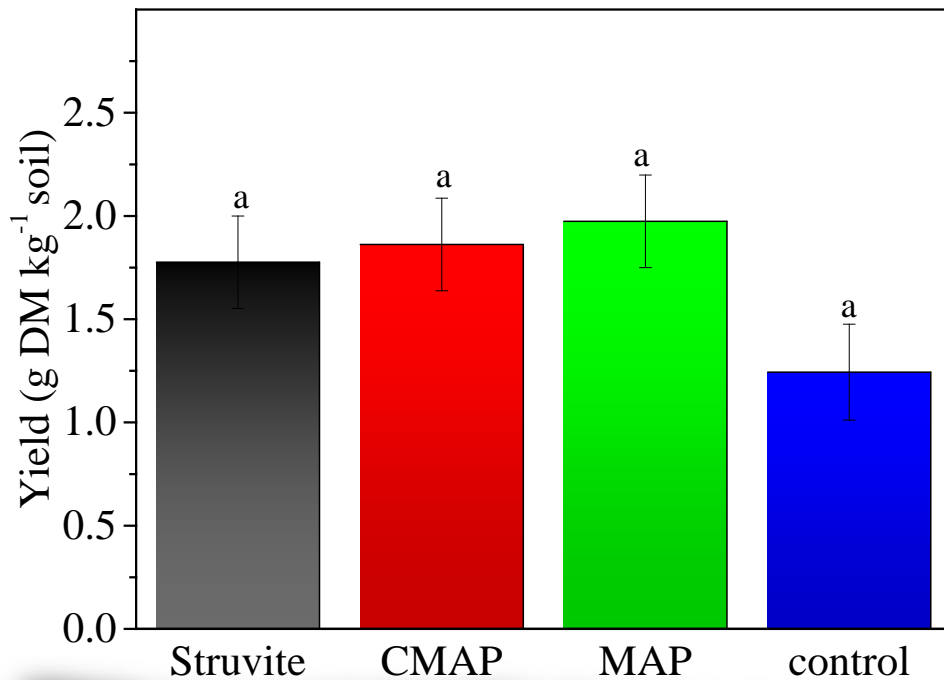
- Struvite similar to commercial fertilizers

# First Cycle



## Biomass Yield

## P uptake



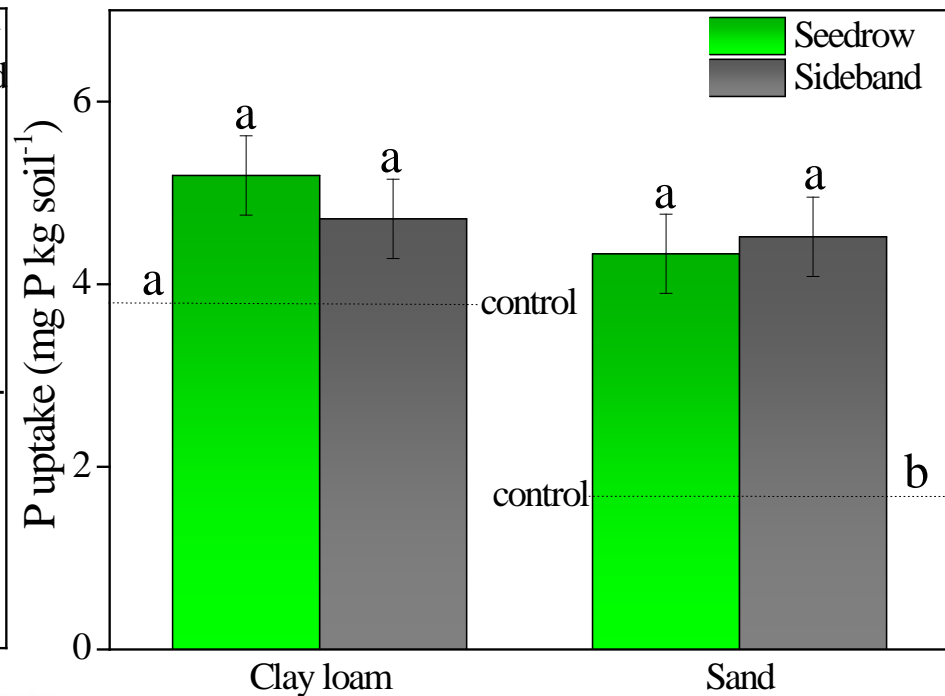
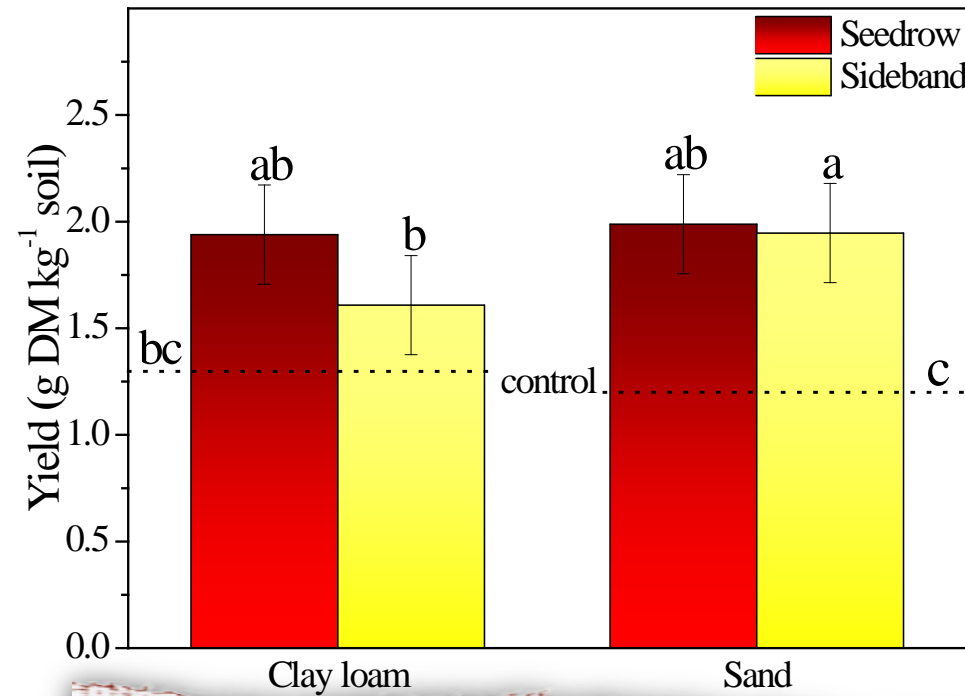
- Significantly lower P uptake from struvite

# First Cycle



## Biomass Yield

## P uptake



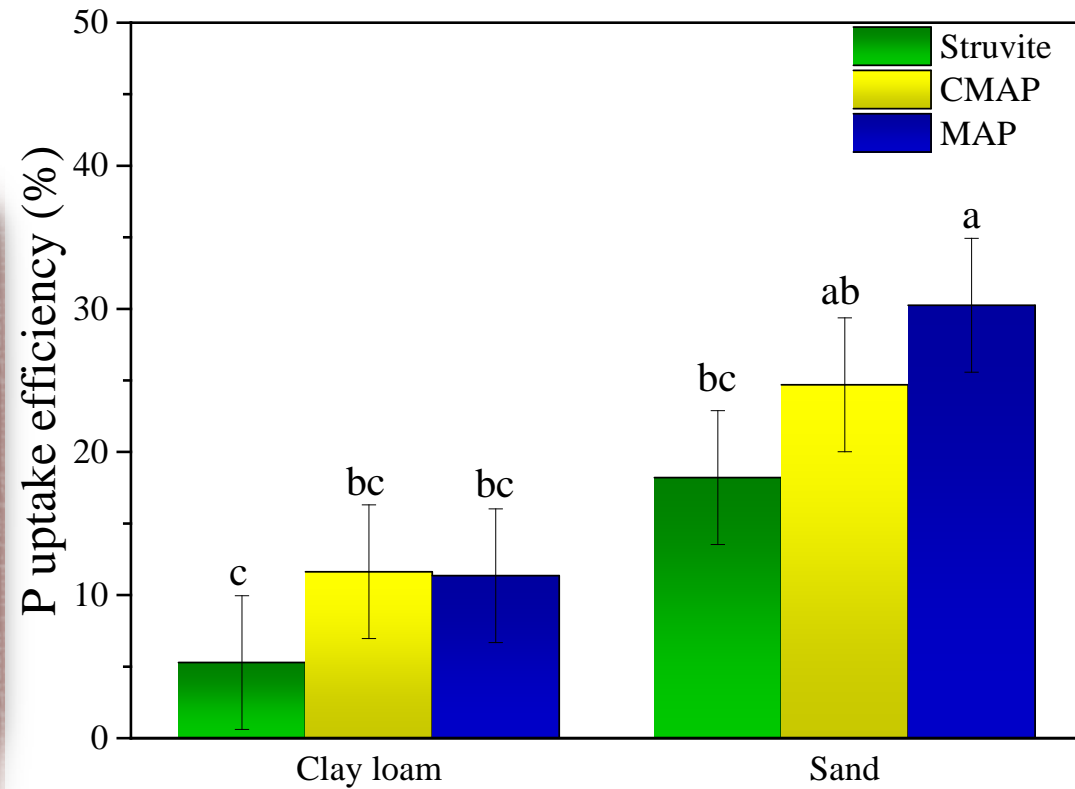
- No response in CL
- No differences between placement methods
- Yield<sub>high rate</sub> > Yield<sub>low rate</sub>

# First Cycle



## P Uptake Efficiency

- $PUE_{\text{struvite}} = PUE_{\text{fert.}}$   
in CL
- $PUE_{\text{str}} < PUE_{\text{MAP}}$   
in Sand

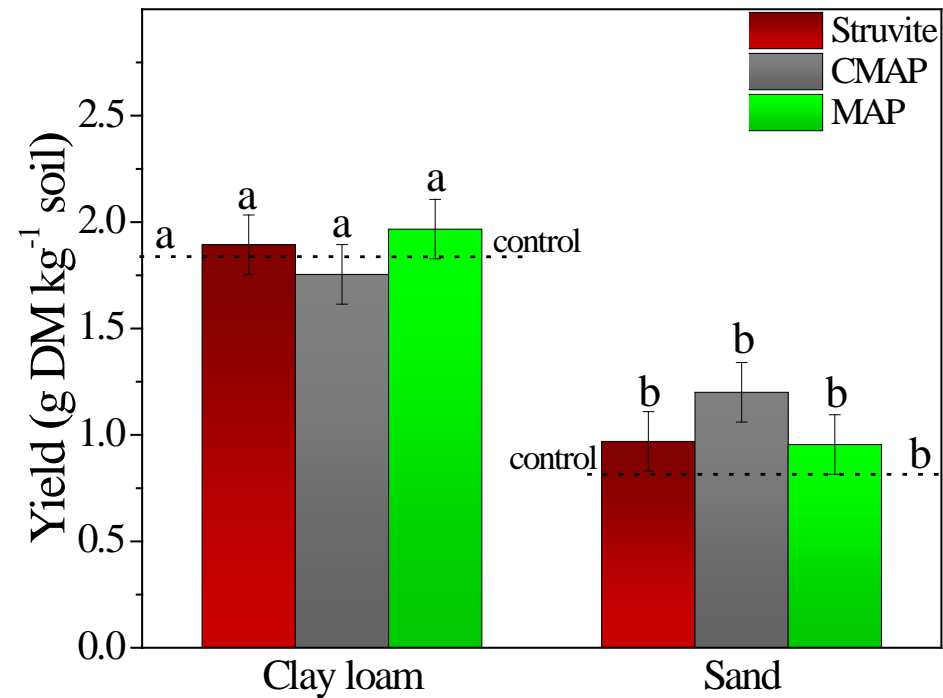




# Second Cycle



## Biomass Yield



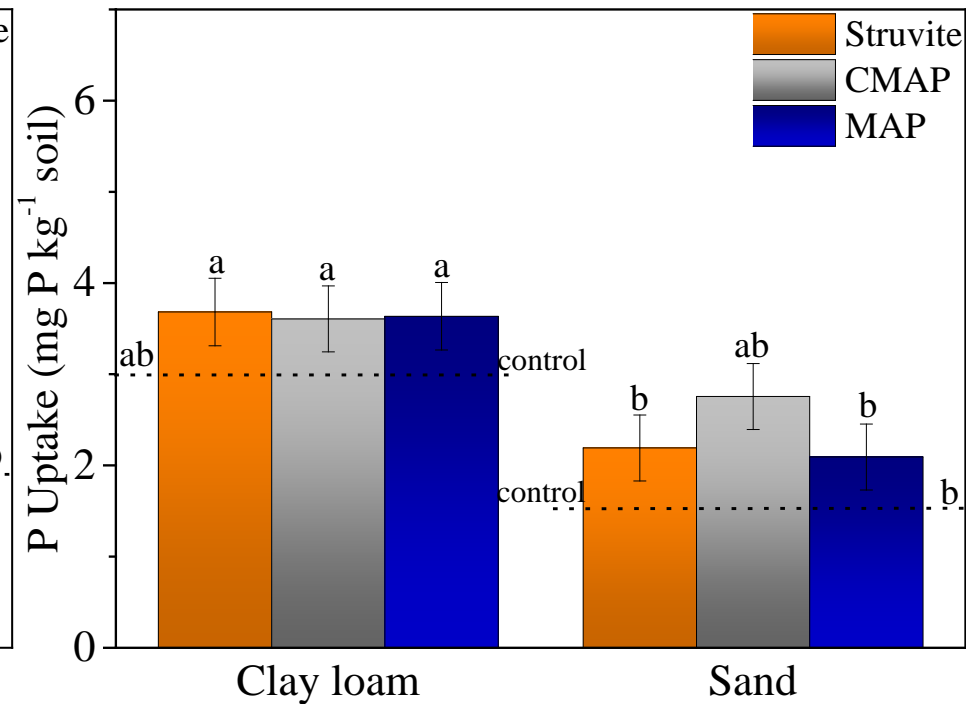
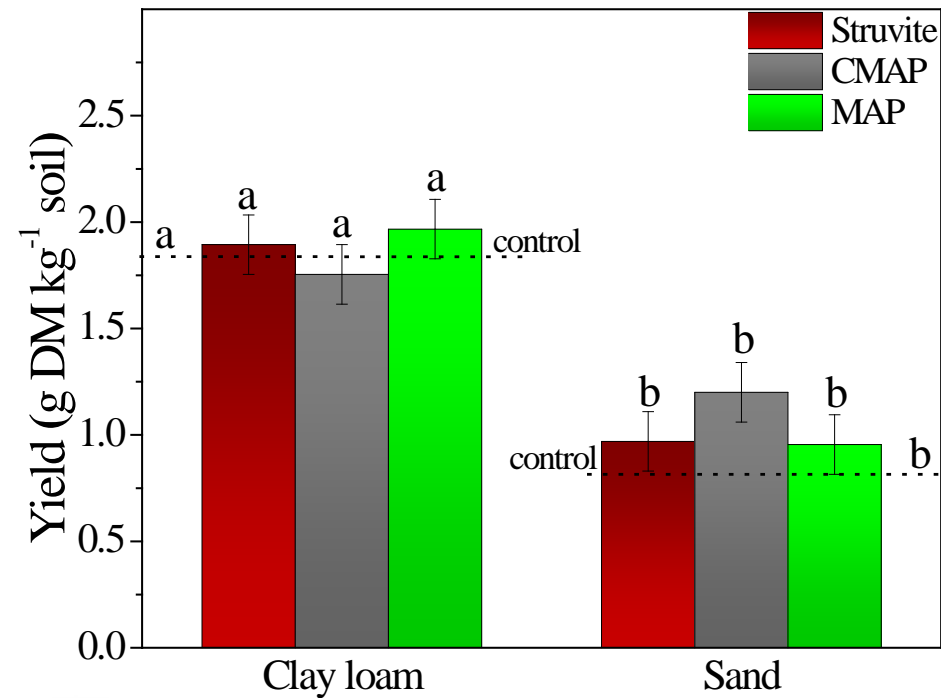
- Struvite comparable to MAP/CMAP
- Yield<sub>CL</sub> > Yield<sub>Sand</sub>
- No yield response to P applied in first cycle

# Second Cycle



## Biomass Yield

## P uptake

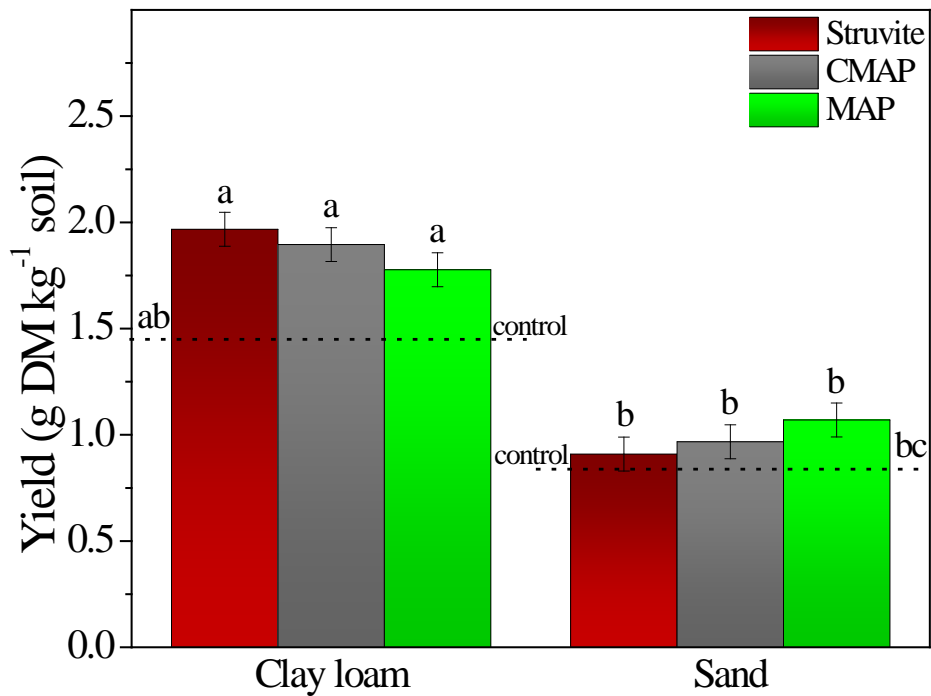


- Struvite comparable to MAP and CMAP
- $\text{Yield/PU}_{\text{CL}} > \text{Yield/PU}_{\text{Sand}}$

# Third Cycle



## Biomass Yield



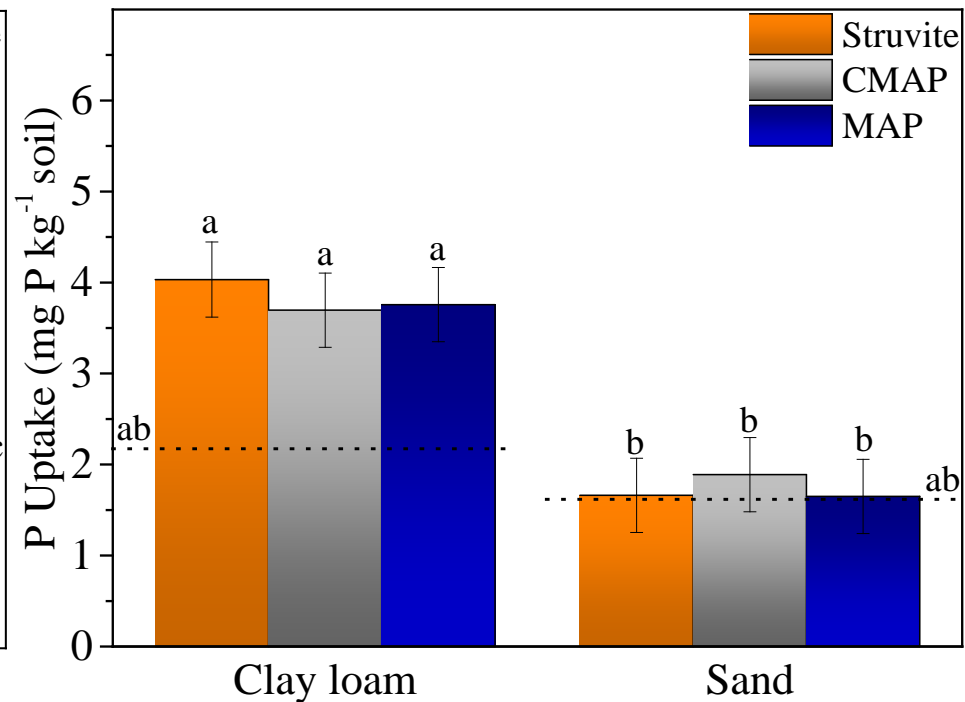
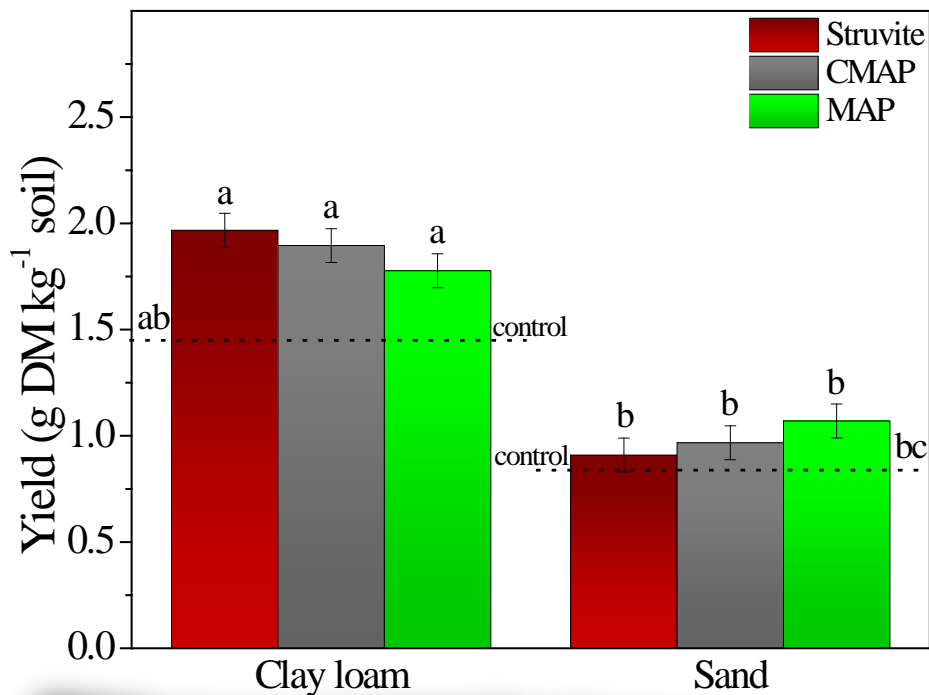
- Struvite comparable to MAP/CMAP
- Yield<sub>CL</sub> > Yield<sub>Sand</sub>
- No yield response to P

# Third Cycle



## Biomass Yield

## P uptake



- No significant amendment differences
- $\text{Yield/PU}_{\text{high rate}} > \text{Yield/PU}_{\text{low rate}}$

# Conclusions



- Struvite was as effective as MAP and CMAP in improving wheat DMY

# Conclusions



- Struvite was as effective as MAP and CMAP in improving wheat DMY
- Although less P was taken up from struvite in the first cycle, yield was not significantly lowered

# Conclusions



- Struvite was as effective as MAP and CMAP in improving wheat DMY
- Although less P was taken up from struvite in the first cycle, yield was not significantly lowered
- No significant residual benefits were observed from the slow release fertilizers (CMAP and struvite)

# Conclusions



- Struvite was as effective as MAP and CMAP in improving wheat DMY
- Although less P was taken up from struvite in the first cycle, yield was not significantly lowered
- No significant residual benefits were observed from the slow release fertilizers (CMAP and struvite)
- Struvite is a promising P source for wheat and certainly deserves field testing



# Acknowledgements



Thank you

- Sponsors
- Advisory committee
- Colleagues, friends and family