Reaction Products Arising From Seed-Row Placed Monoammonium Phosphate As Affected By Sulfur Fertilization

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Introduction

- Phosphorus (P) and Sulfur (S) are essential nutrients for crop production
- P and S fertilizers are commonly applied together in bands for crop production in Western Canada
- S added together with P may affect speciation and plant availability of the added P

Forms and Availability

Availability of P from fertilizer depends on

- Species formed in soil: *P reaction products*
- Relation to solution phosphate: *immediately available for root uptake*

Interaction with other fertilizers can influence P fertilizer fate and availability

- S fertilizers alter microsite conditions: *acidification, ion concentrations (sulfate)*

Need to Understand!

Traditional Approaches to Study of P Fertilizer Fate

Examining plant availability

- Through plant nutrient uptake and yield response
- Measuring content of total or available forms in soil before and after plant growth

Research Justification

Understand fate of P fertilizers added alone and in combination with S fertilizers in prairie soils

- **P commonly recommended for cereals and pulses, P + S for canola on the prairies**

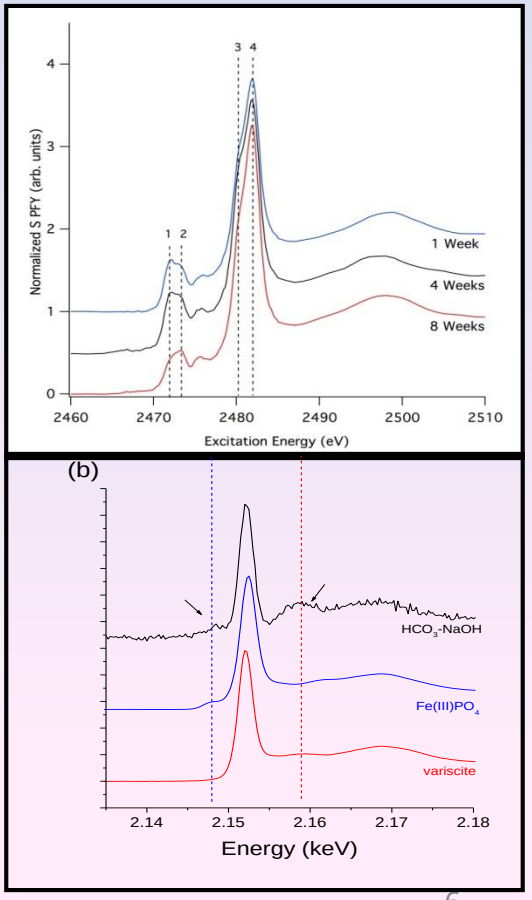
XANES spectroscopy is an emerging tool for study of plant nutrient speciation in agricultural soils

Why XANES

Traditional wet chemical analyses methods

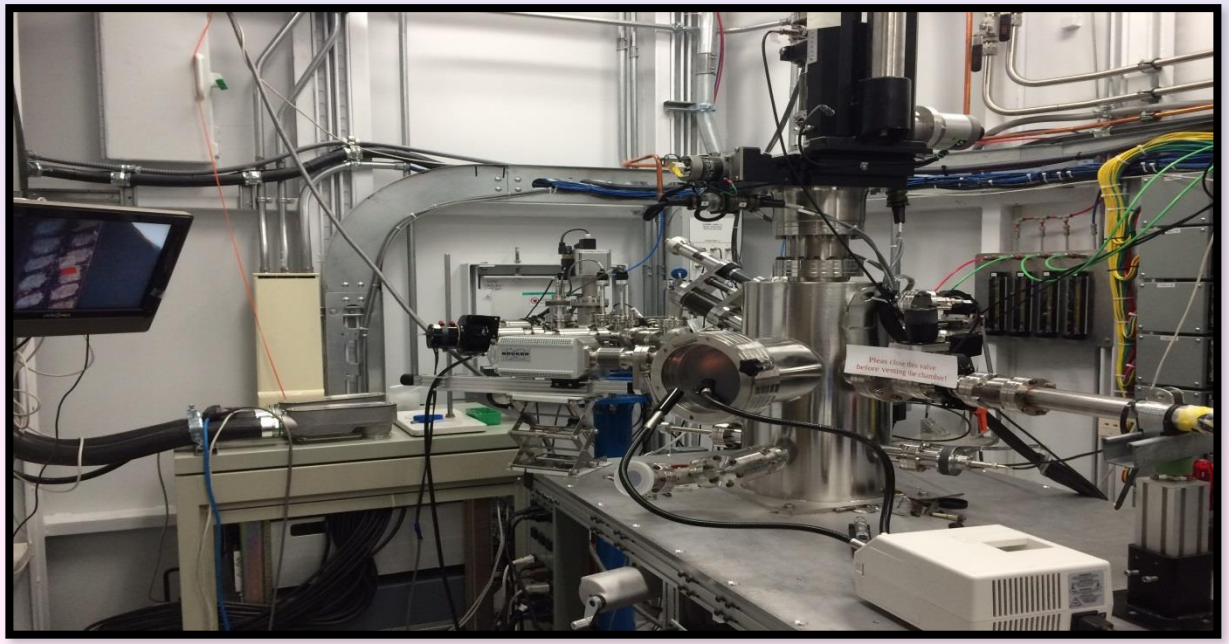
- *May not be able to identify some P species in soil.*

- ***XANES spectroscopy can distinguish different molecular bonds, structure, oxidation states of an element***
- ***Offers unique ability to follow transformation of fertilizers P into different forms in the soil***



Objective

- To employ a synchrotron technique to assess the fate of seed-row placed MAP fertilizer alone and in combination with S fertilizer.



Field Study Sites

Saskatchewan, Canada

★ **Brown Chernozem**
Central Butte

www.maptown.com/.../canada-topo-maps.html

Experimental

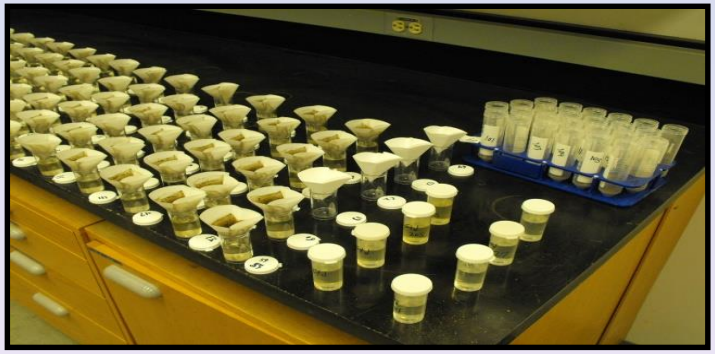
- **Soil**: Calcareous Brown Chernozem
- **Treatments**: *Mono ammonium phosphate*

11-52-0 (MAP) alone; MAP with 1) ammonium sulfate, 2)calcium sulfate, 3) elemental S

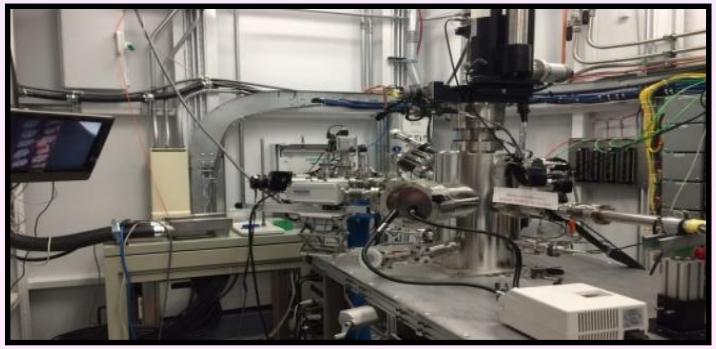
- **Application rate**: 20 kg P_2O_5 ha^{-1} and 20 kg S ha^{-1} in seed-row
- Soil sample collection: from the seed-row 1 and 8 weeks after seeding canola.

Analytical Techniques

- **Wet chemical analysis:**
  - Available P and PRS supply rate

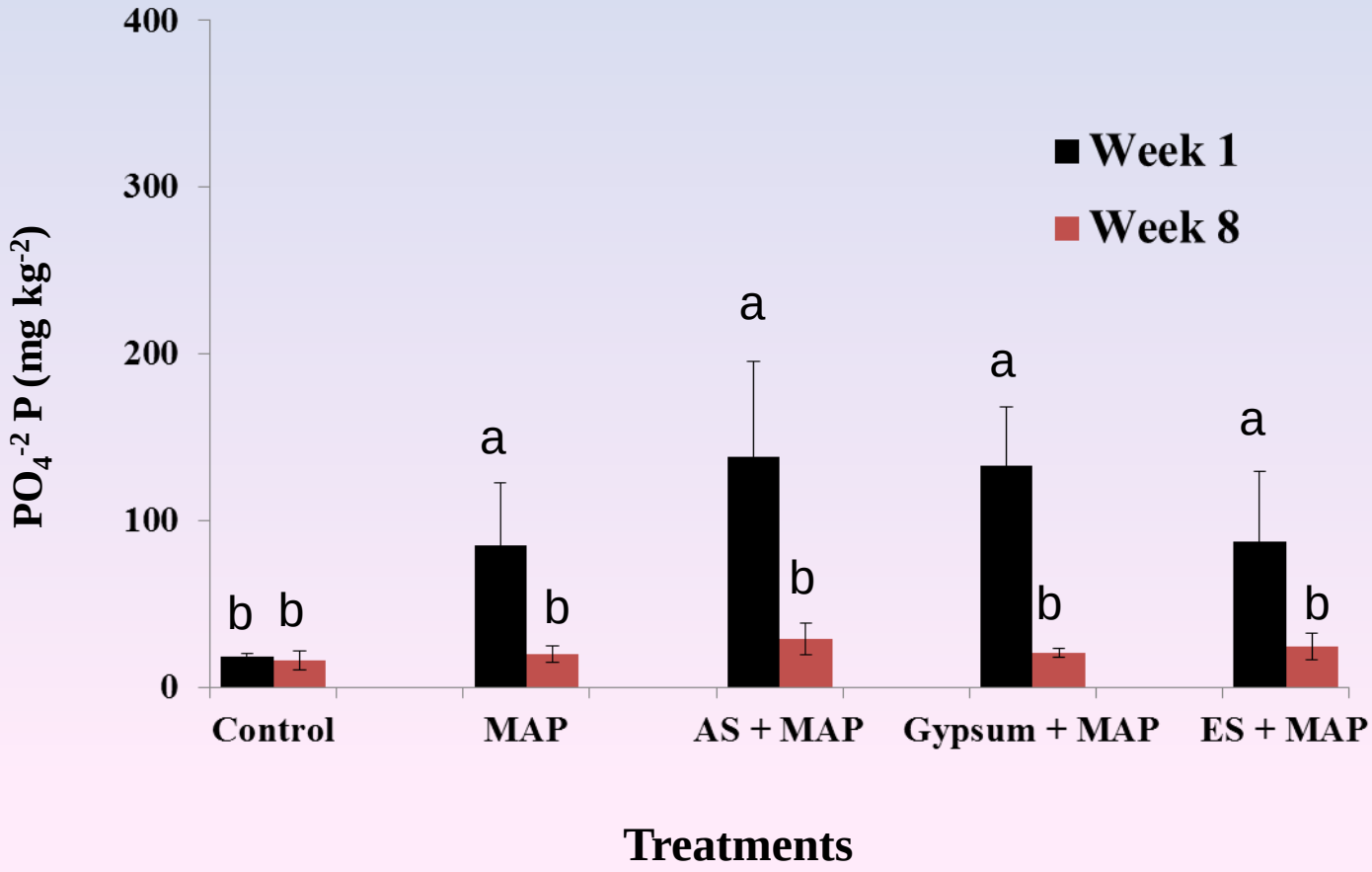


- **XAS spectroscopic techniques:**

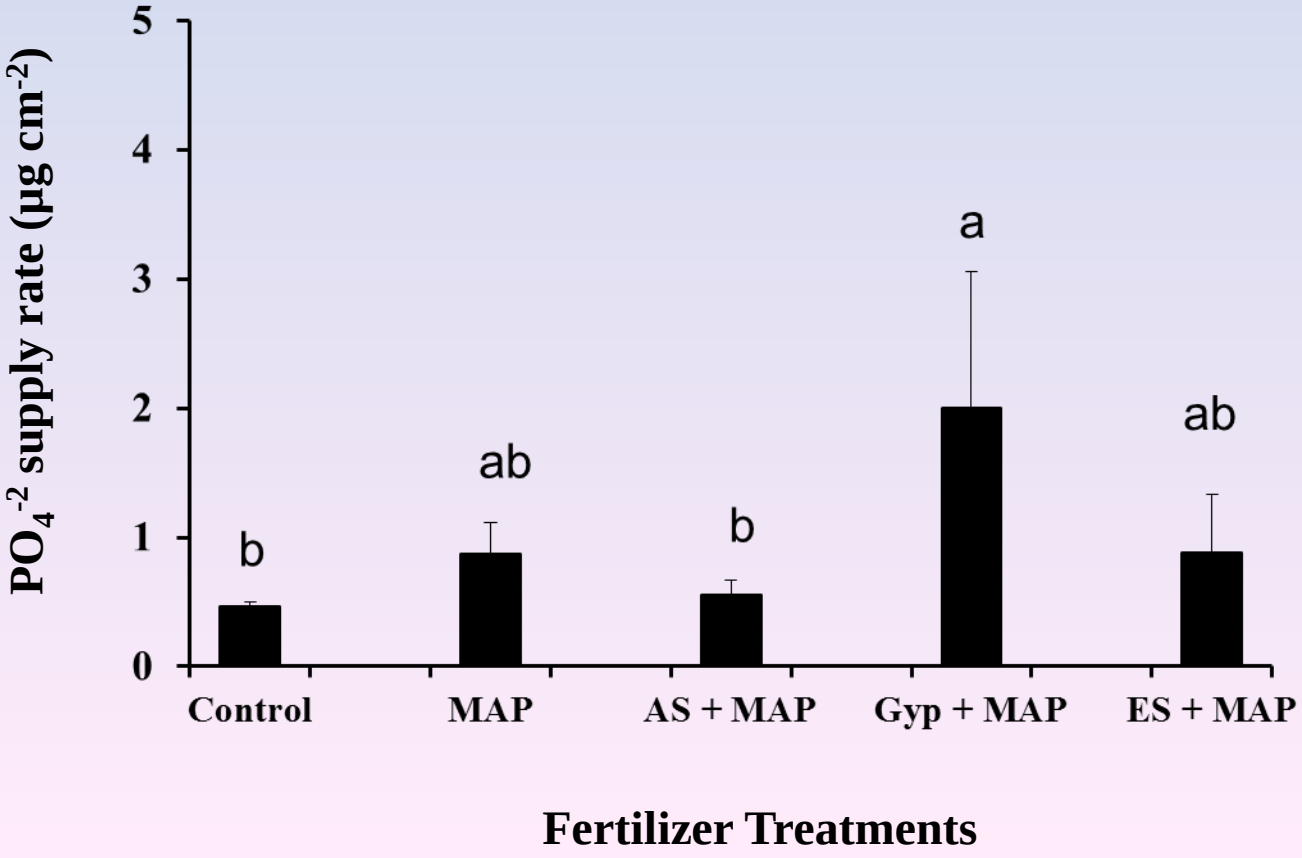


Results

Extractable soil phosphate in seed-row 1 and 8 weeks after seeding

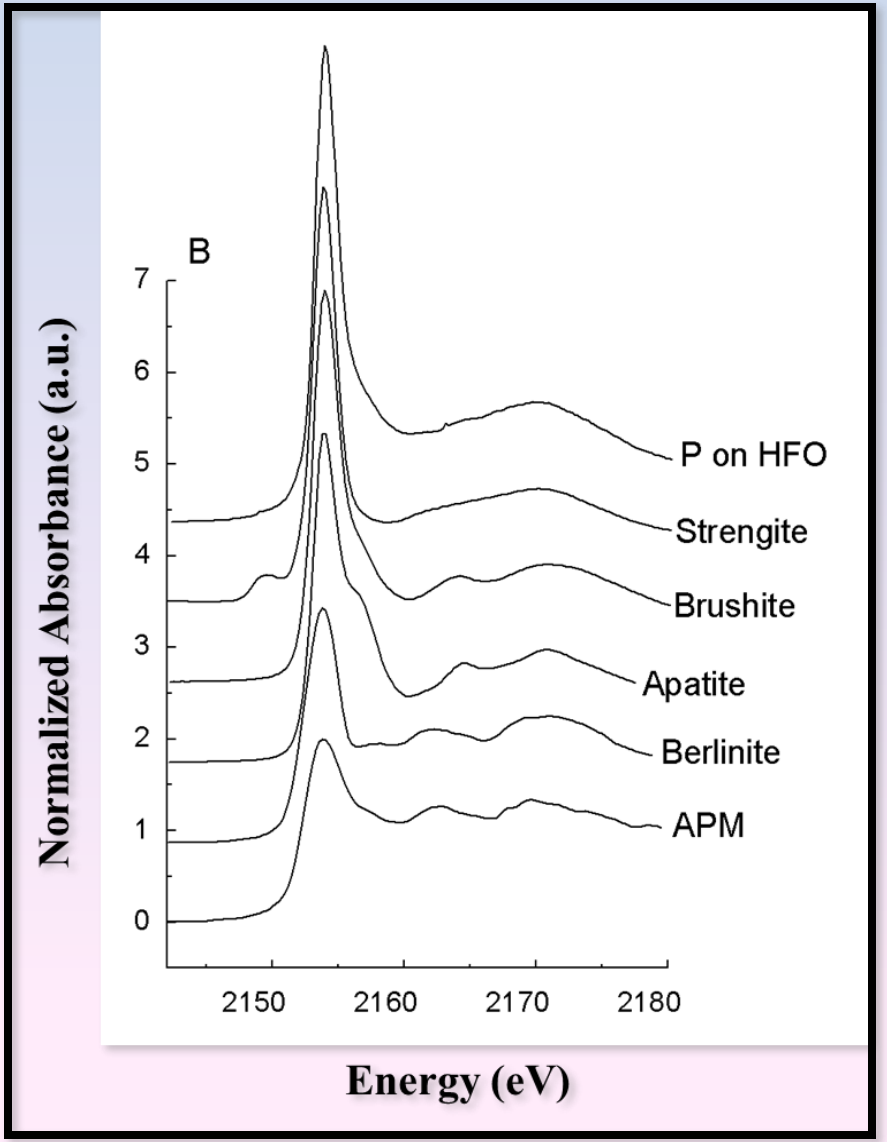


Effects of S fertilizers on P supply in seed row over 8 weeks



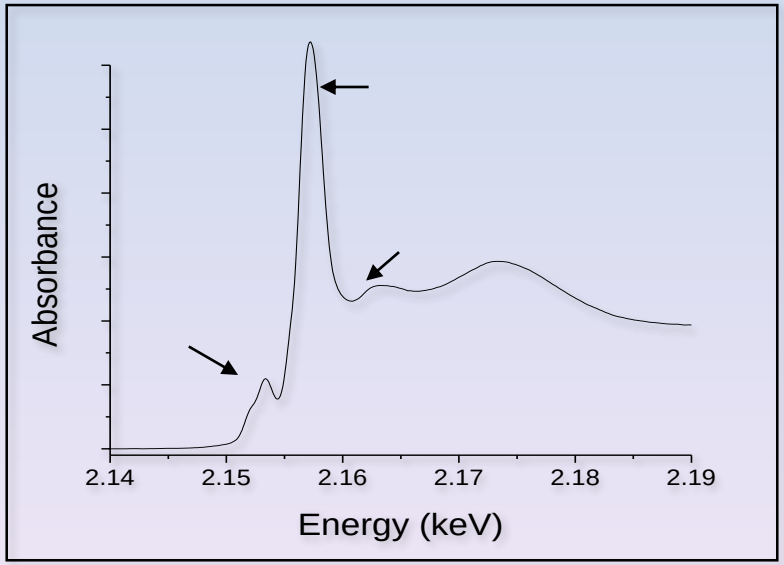
XANES Fits for P Reference Compounds

- XANES spectra of P reference compounds exhibited peaks at different energy levels, allowing identification of P compounds.

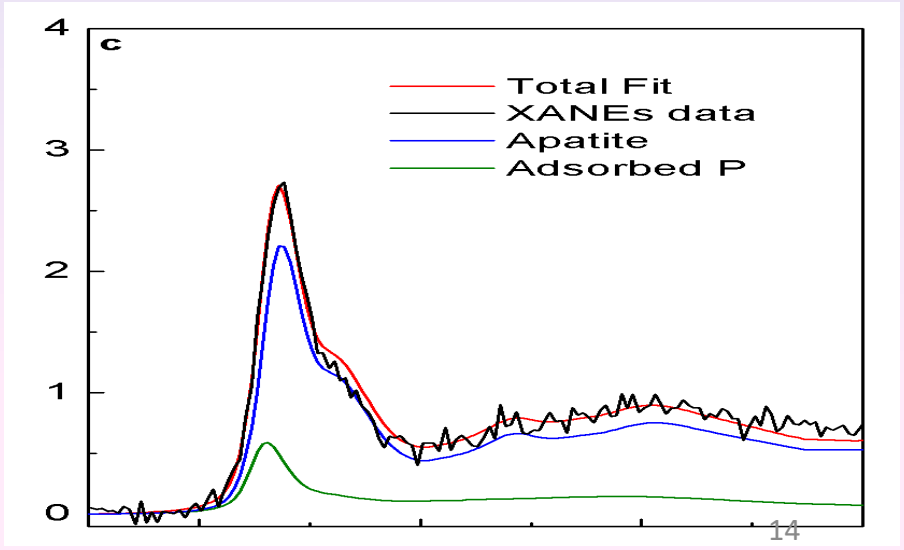


XANES Data Analysis Approaches

- **Qualitative analysis**
  - Fingerprint technique

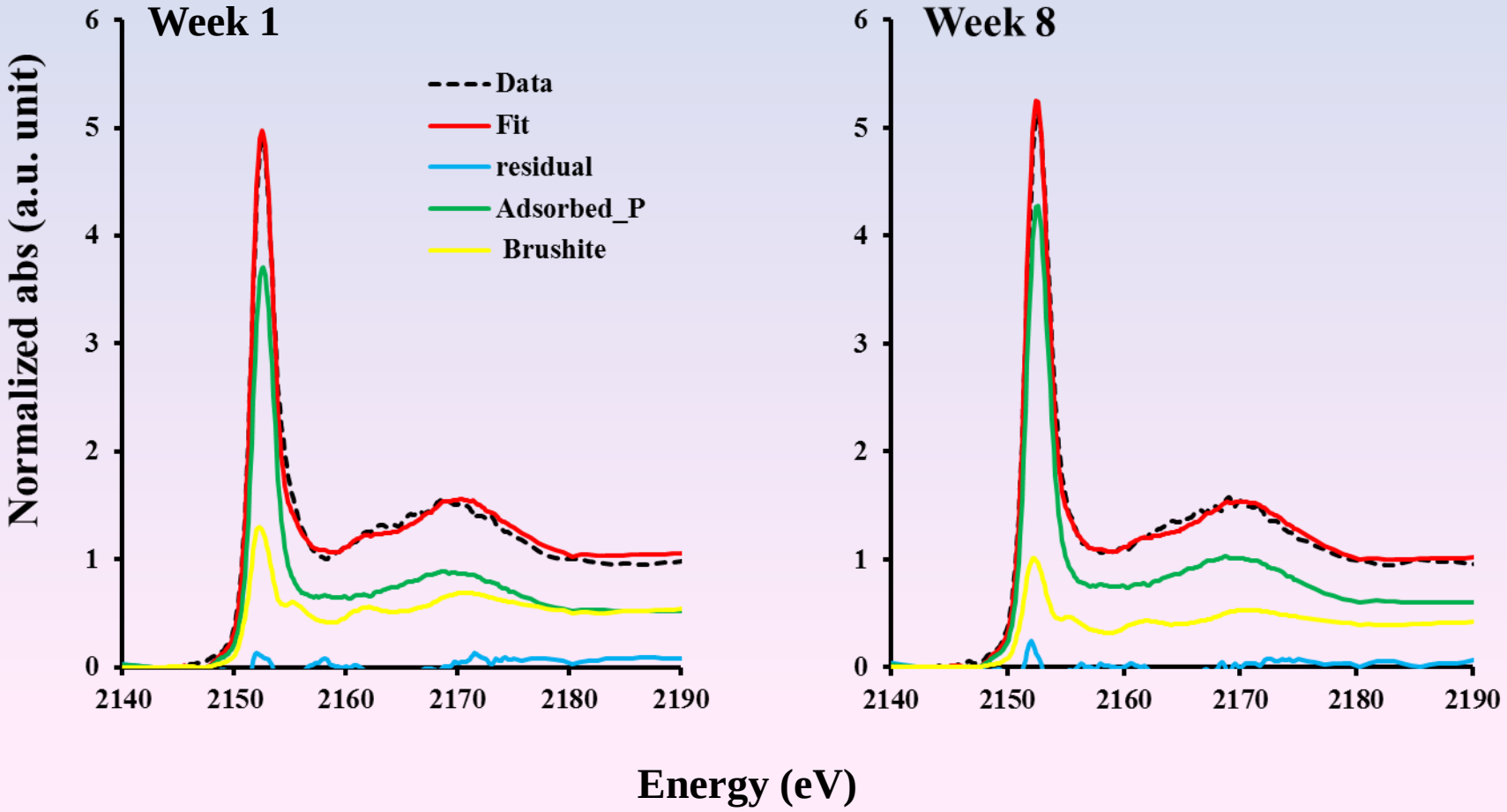


- **Quantitative analysis**
  - LC fitting technique

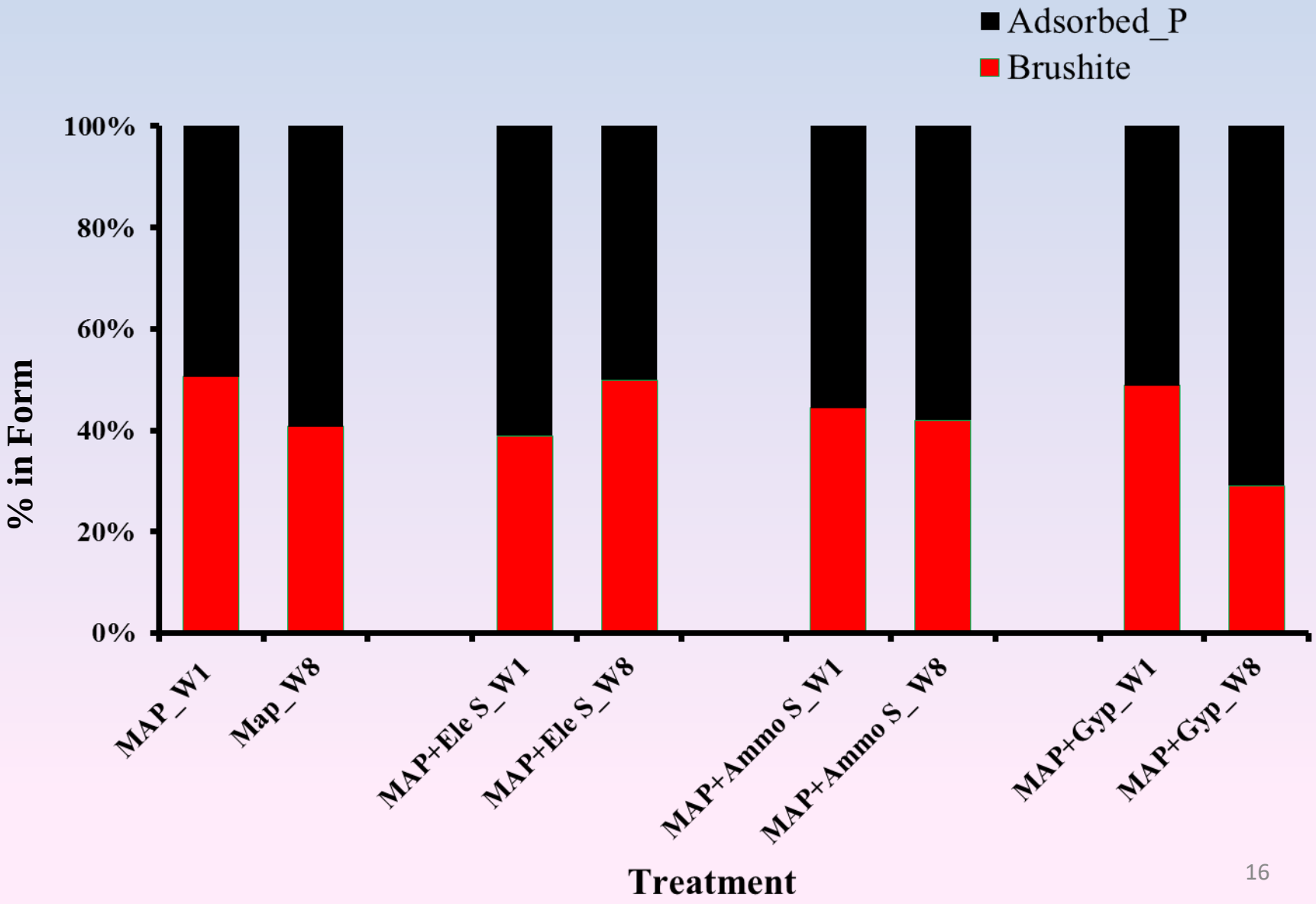


LC XANES Fits

MAP fertilized after 1 and 8 weeks



XANES Fit Results



Major findings….

- MAP was effective in providing **early supply** of plant available P in seed-row that was taken up over 8 weeks of canola growth.
- Main P fertilizer reaction products identified in this calcareous Chernozem were **brushite** (dicalcium phosphate) and **adsorbed** P.
  - Proportion of P in adsorbed form increases with time possibly due to organic acids produced in canola root rhizosphere
- **Some positive effects** of S fertilizers on enhancing availability of P in seed-row were observed, likely related to influence on P reaction products formed.
  - Sulfate fertilizers, especially gypsum, increased proportion of adsorbed P versus brushite P reaction product.

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THANK YOU
Questions?