Comparison of results of different instrumental methodics (MP-AES, UV-Vis spectrometry) for determination of available forms of soil phosphorus

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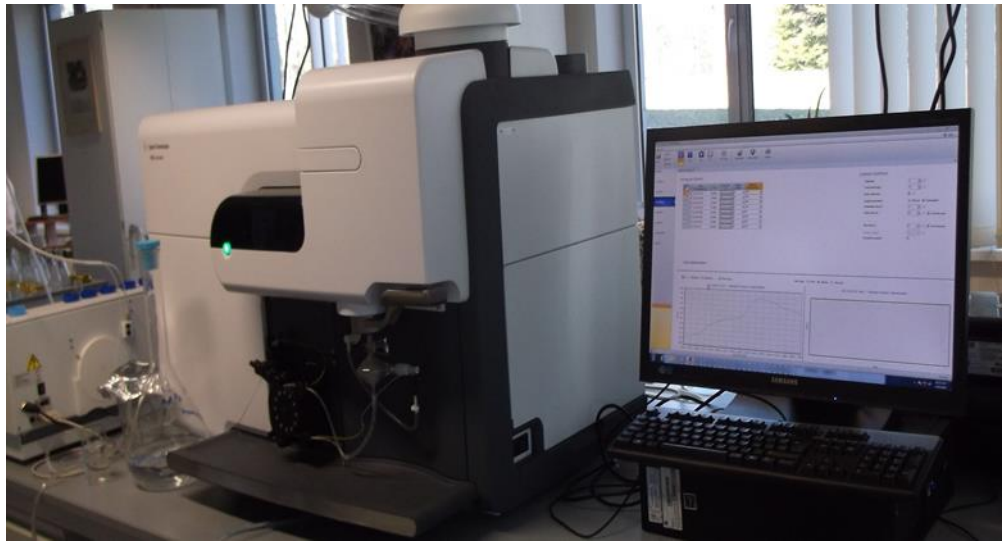
Introduction

Analytical quantitative techniques for determination of plant available P content in soil:

- Vis spectrometry
- ICP-OES
- ICP-MS
- MP-AES



MP AES device (Agilent 4100)

Problems

Vis spectrometry method is based on determination of blue coloured phosphate-molybdate complex and therefore enables to analyse only **phosphate phosphorus** (PO_4^{3-}) **content in the sample**

ICP-OES, ICP-MS and MP-AES measure amount of P atoms in the sample (irrespective of its chemical form) thus **total content of P in sample is analysed**

Problems (continued)

Determined amount of available P in soil by using same extraction method, may vary due to analytical technique used

Relatively low intensity of P atomic emission lines (max intensity of line 547.8, wavelength 213.618 nm)

Relatively low temperature of nitrogen plasma (~ 5000 K)

Methods

Extraction methods used for determination of plant available P in soil:

- AL method
- Mehlich 3 method (M3)
- CAL method

Methods

Extraction method	Composition of extraction solution	Soil:solution ratio (w:v)	pH of extraction solution	Shaking intensity (rpm)	Time of extraction (min)	Reference
M3	0.2M CH_3COOH + 0.015M NH_4F + 0.013M HNO_3 + 0.25M NH_4NO_3 + 0.001M EDTA	1:10	2.50	200	10	Mehlich, 1984
AL	0.1 M NH_4-lactate + 0.4M CH_3COOH	1:20	3.60 ± 0.10	100	240	Egner, Riehm, Domingo, 1960
CAL	0.05M Ca-acetate + 0.05M Ca-lactate + 0.03M CH_3COOH	1:20	4.10	140	120	Schüller, 1969

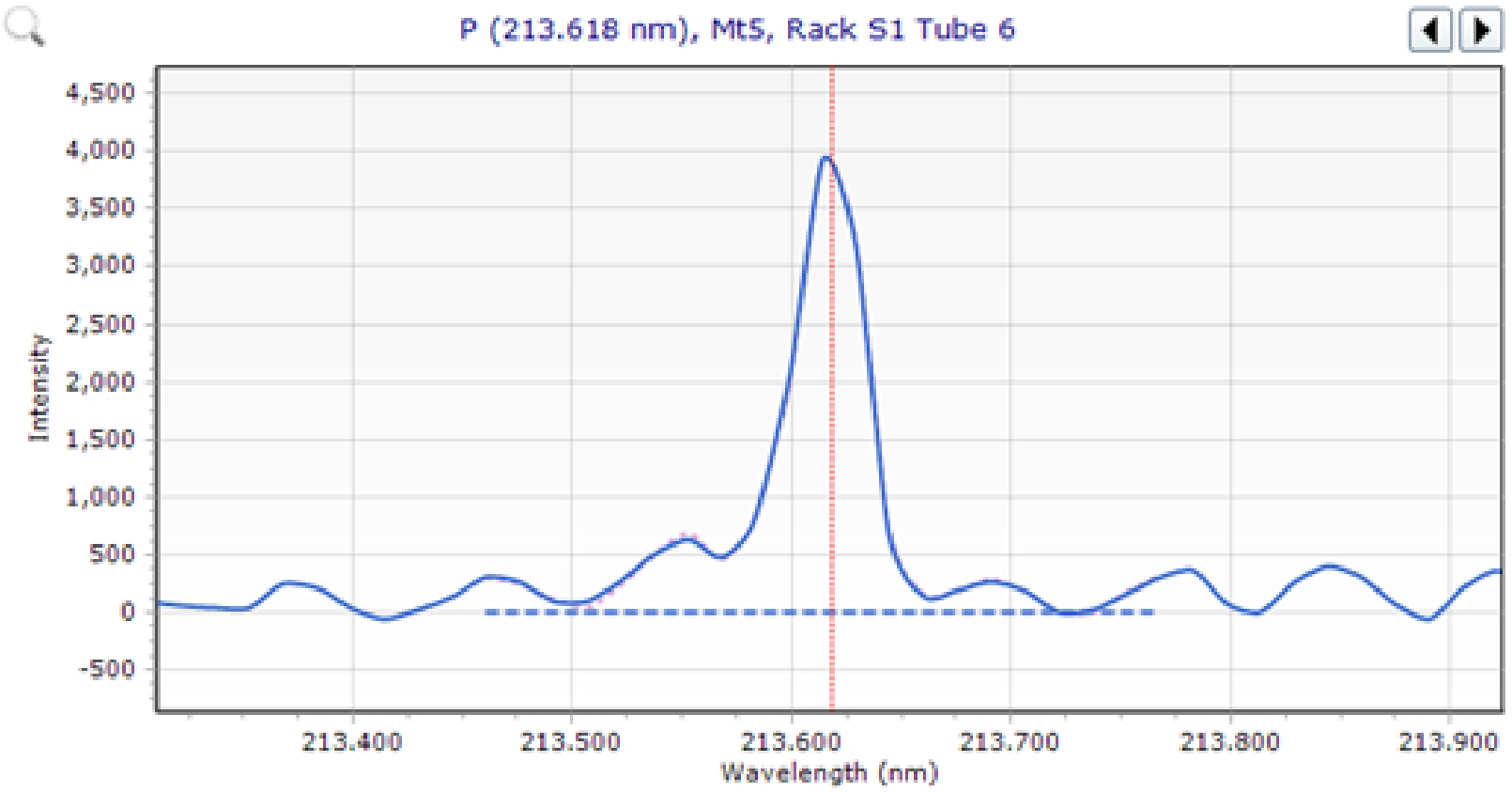
Methods

The determination of P was performed from:

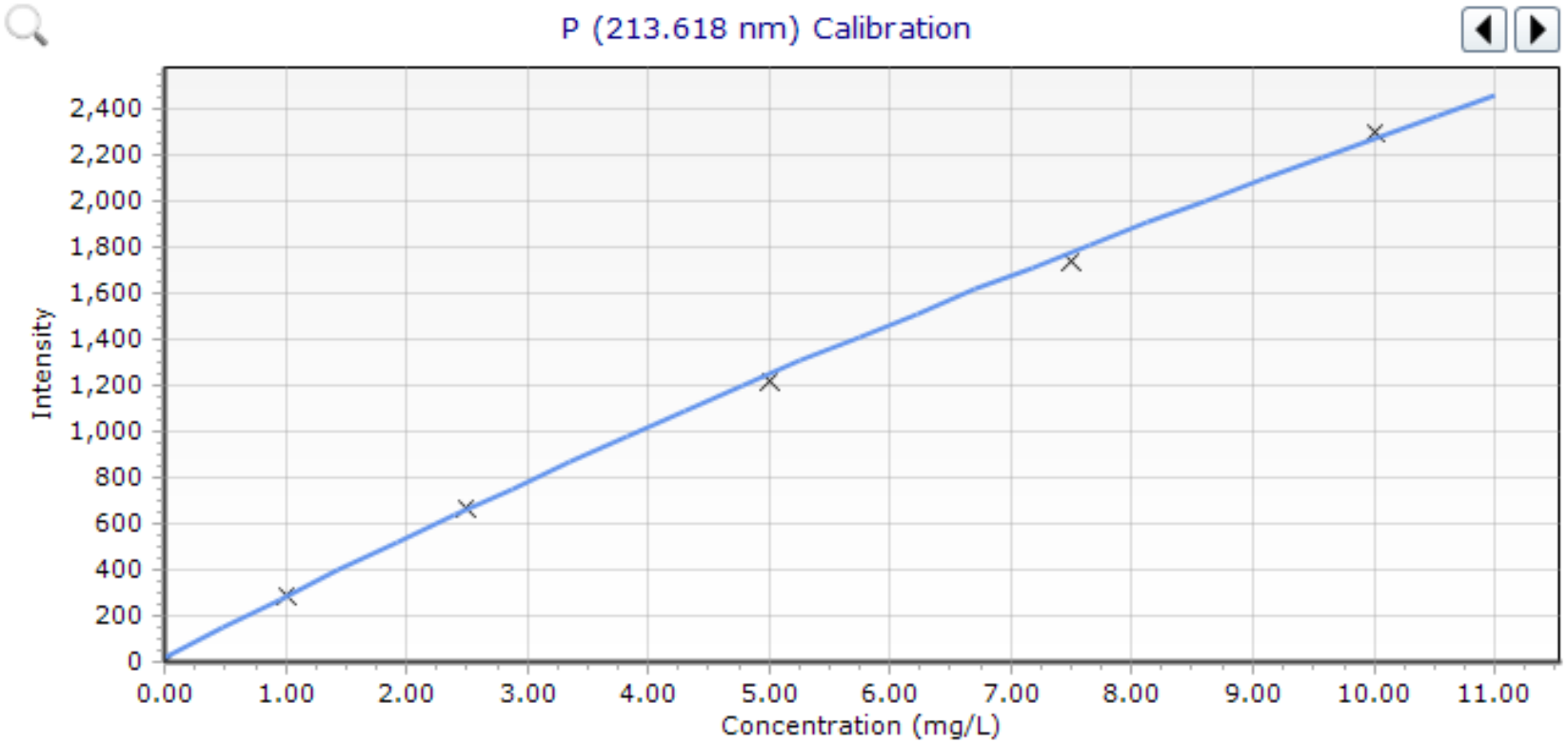
- Air dried soils with content of organic C in range 1.0 – 3.0%
- Heated soils, 2 h at 550°C, organic carbon content ≈ 0.0%, i.e. organic free soils

Results

AES peak of P (20 mg l^{-1}) from M3 extract at wavelength λ=213.618 nm



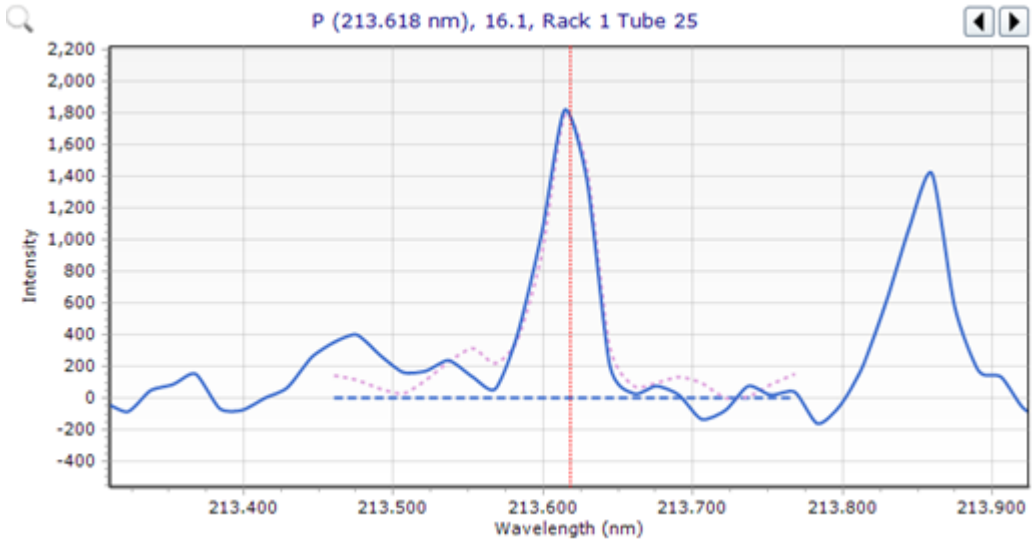
P calibration curve for M3 method in range 1 - 20 mg l^{-1} at wavelength λ=213.618 nm



Peaks of P from soil M3 extracts

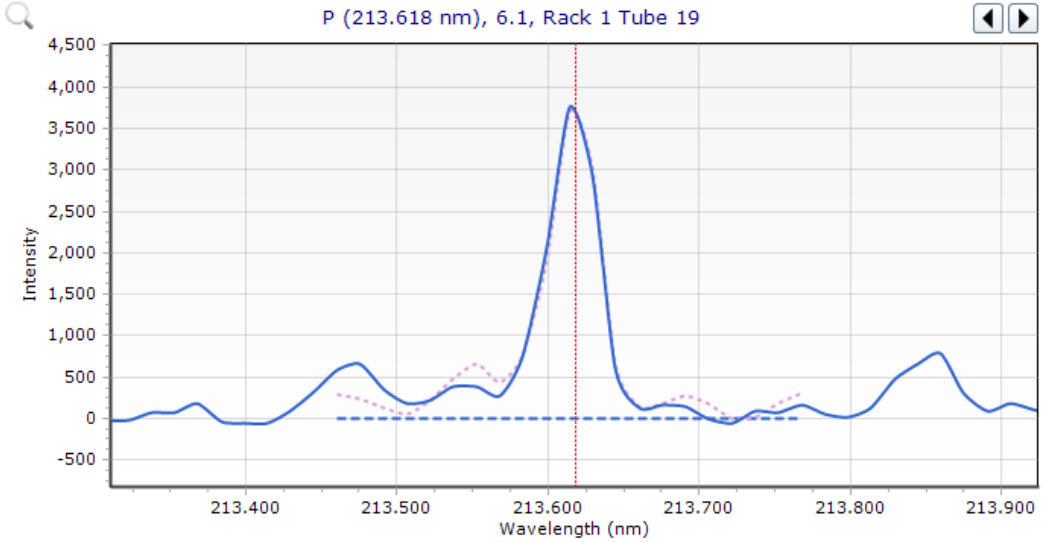
AIR DRIED SOIL SAMPLE,

P – 118.7 mg kg^{-1} , C - 2.0%

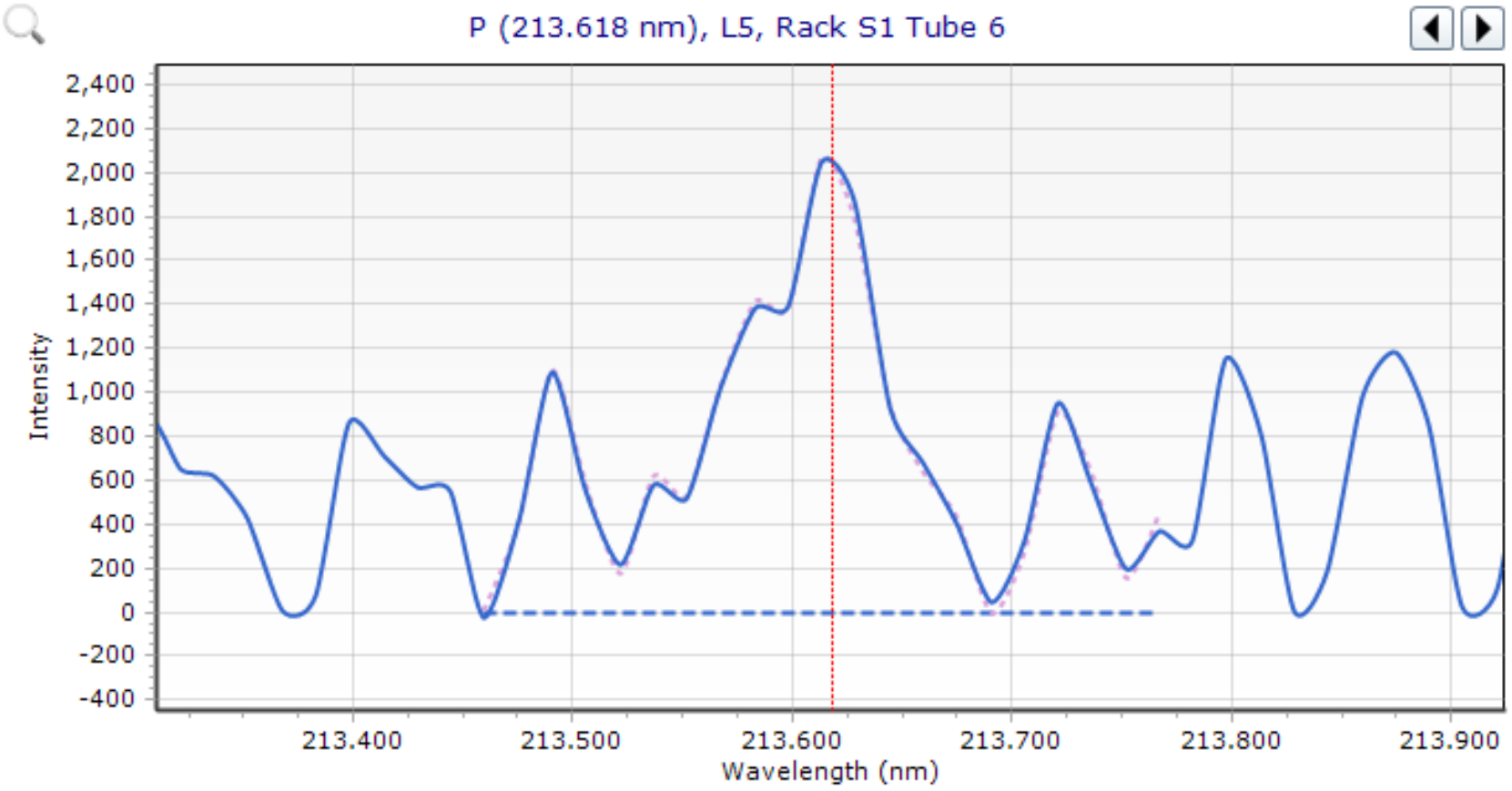


ORGANIC C FREE SOIL SAMPLE,

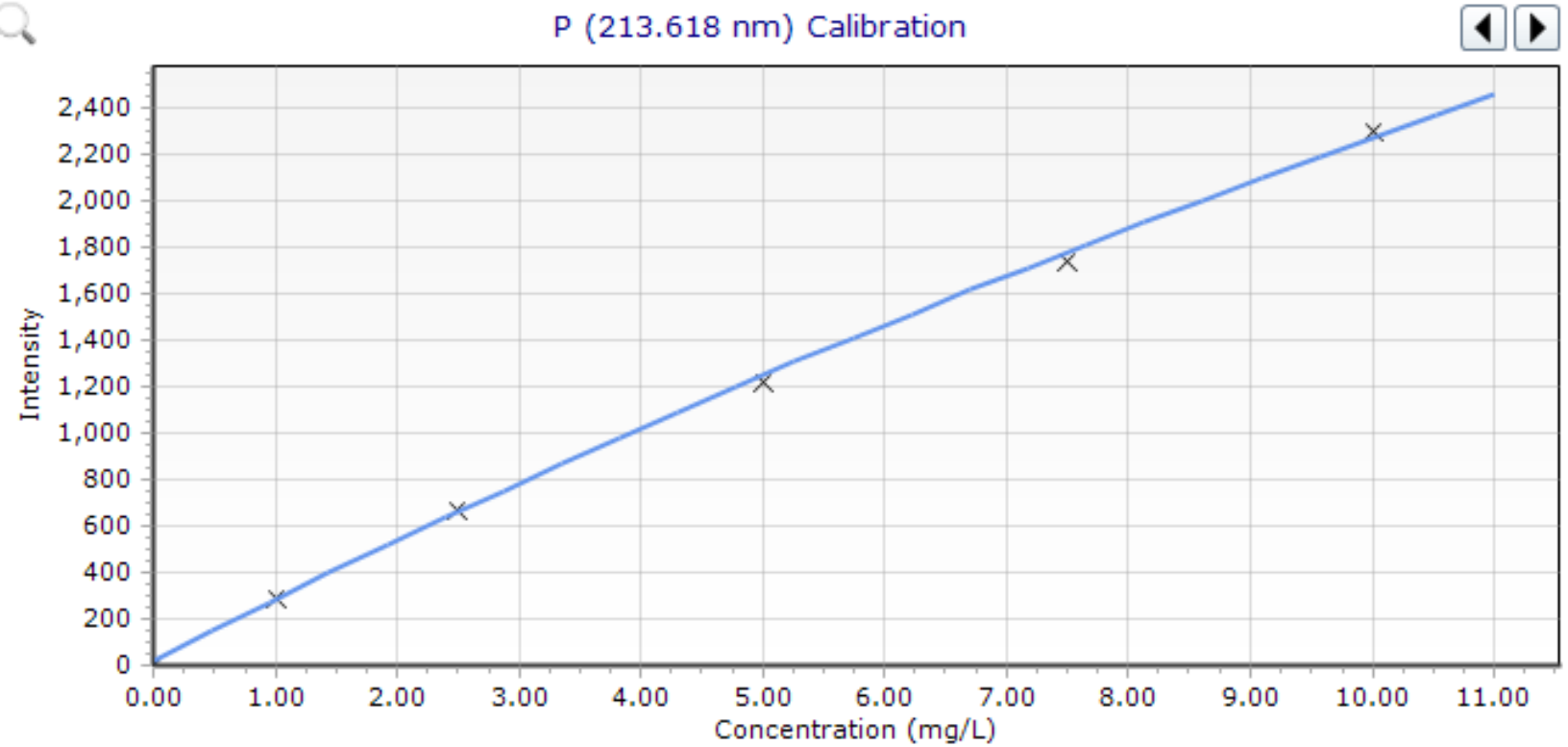
P – 173.2 mg kg^{-1} , C – 0.0%



AES peak of P (10 mg l^{-1}) from AL extract at wavelength λ=213.618 nm



P calibration curve for AL method in range 1 - 10 mg l^{-1} at wavelength λ=213.618 nm

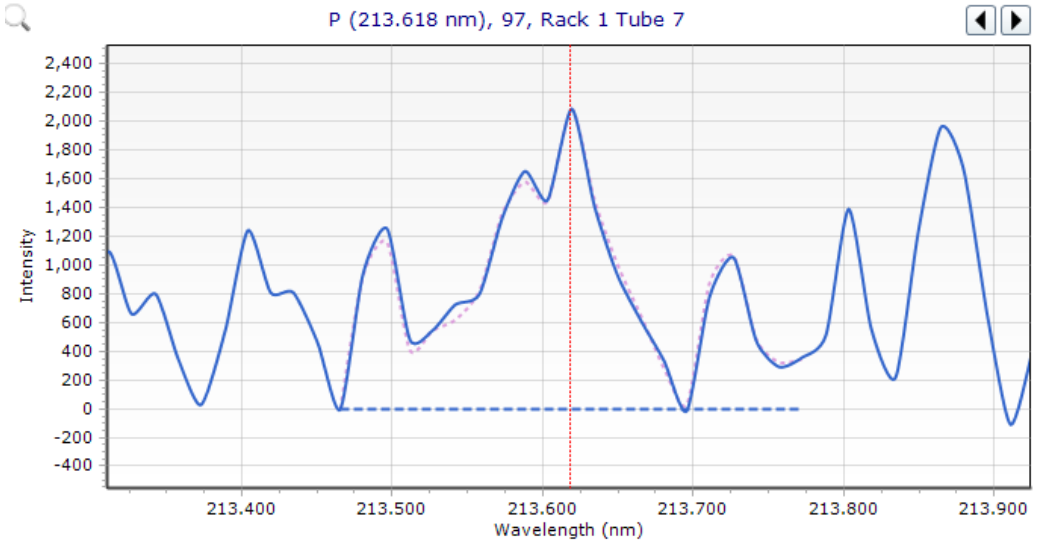


Intensity = (270.41 * Concentration + 21.15) / (1 + 0.02 * Concentration)
Correlation coefficient: 0.99946

Peaks of P from soil AL method extracts

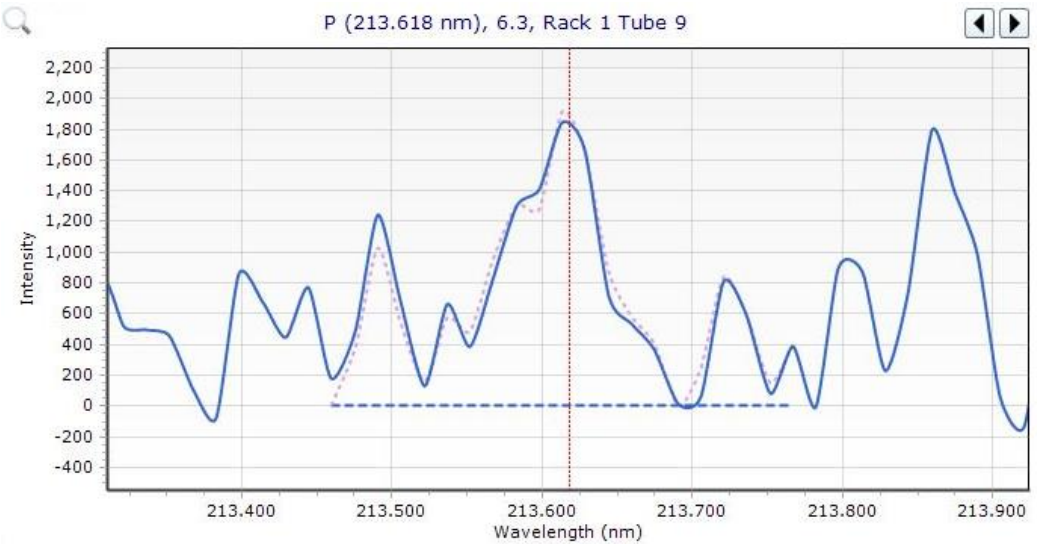
AIR DRIED SOIL SAMPLE,

P – 260.9 mg kg^{-1}, C – 1,82%



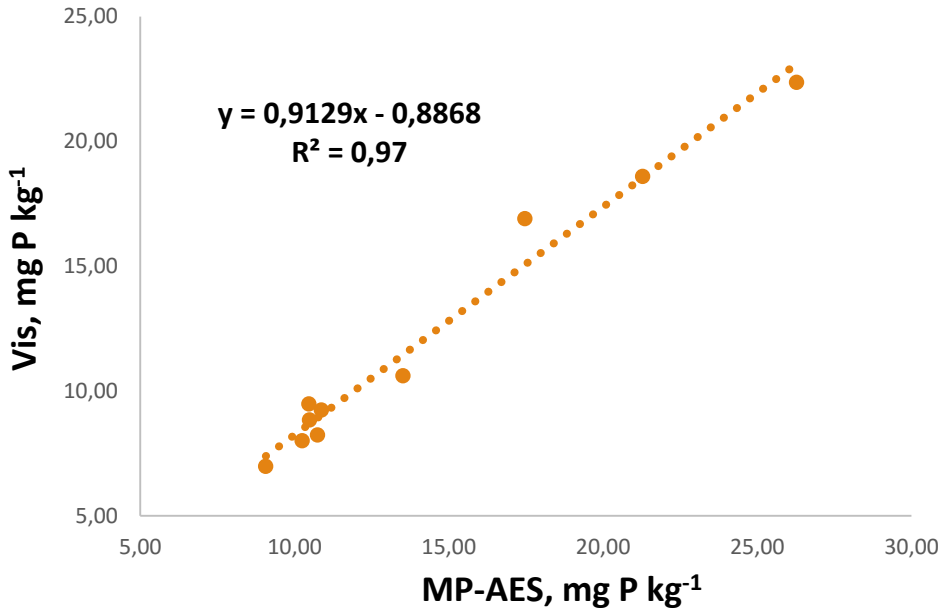
ORGANIC C FREE SOIL SAMPLE,

P –173.2 mg kg^{-1}, C-0.00%

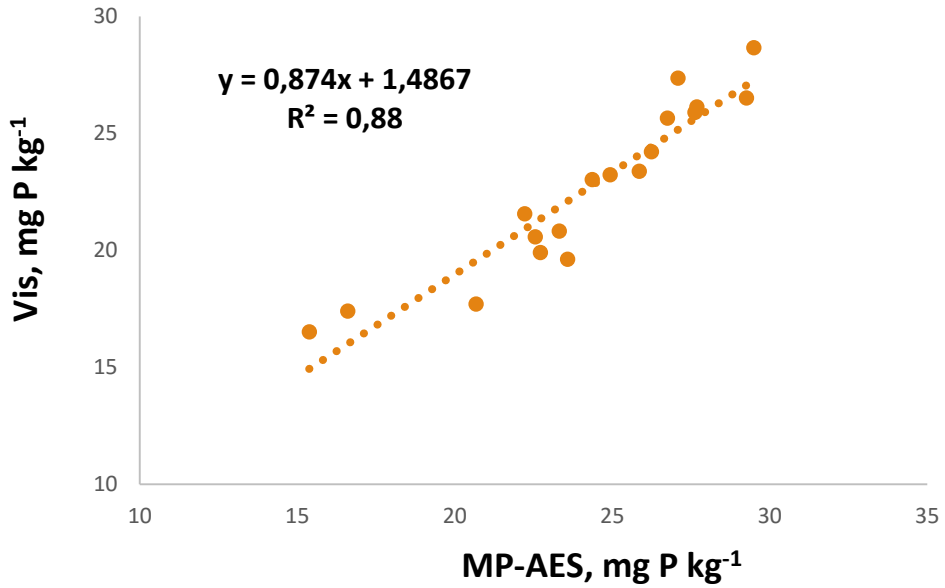


Relationship of P determined from soil by M3 method

MP-AES vs Vis, air dried soils

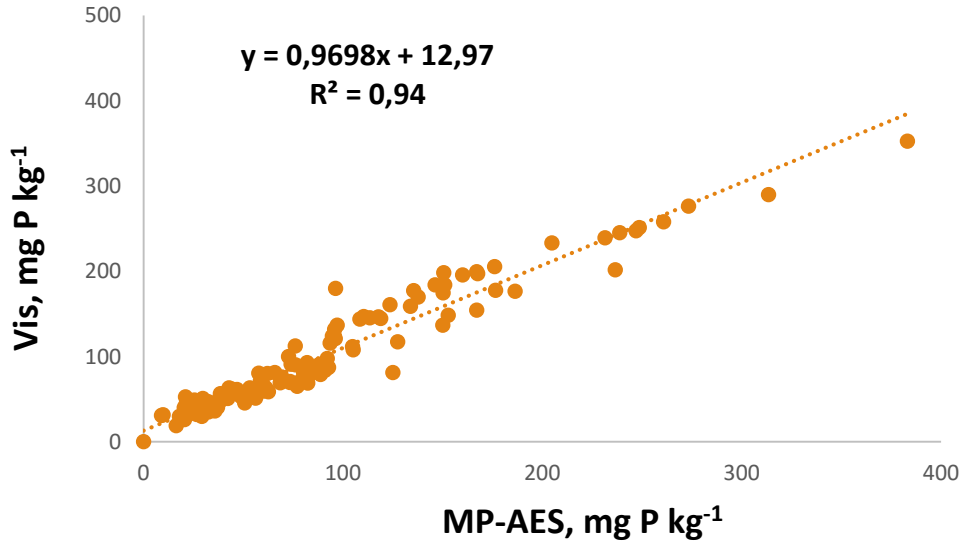


MP-AES vs Vis, organic C free soils

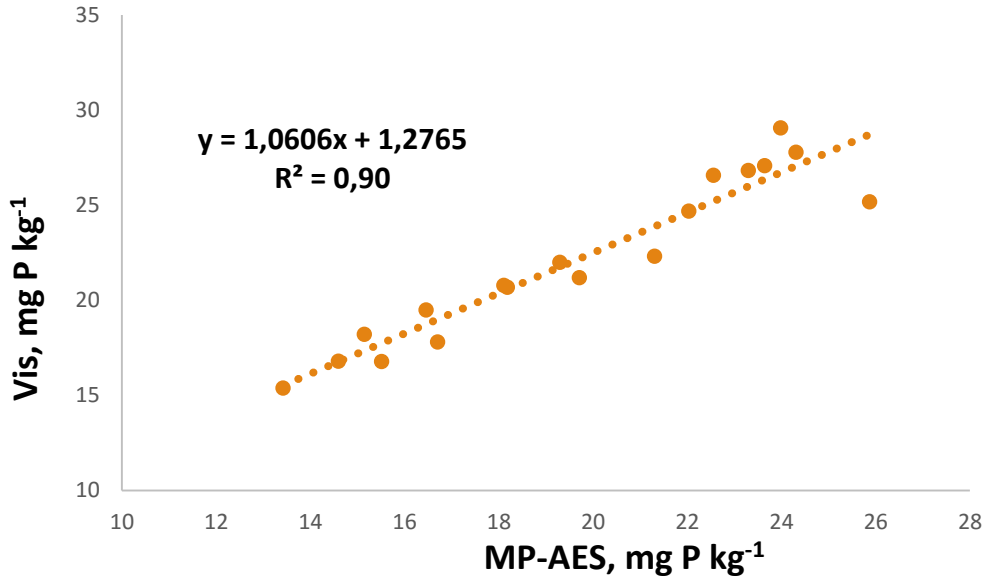


Relationship of P determined from soil by AL method

MP-AES vs Vis, air dried soils

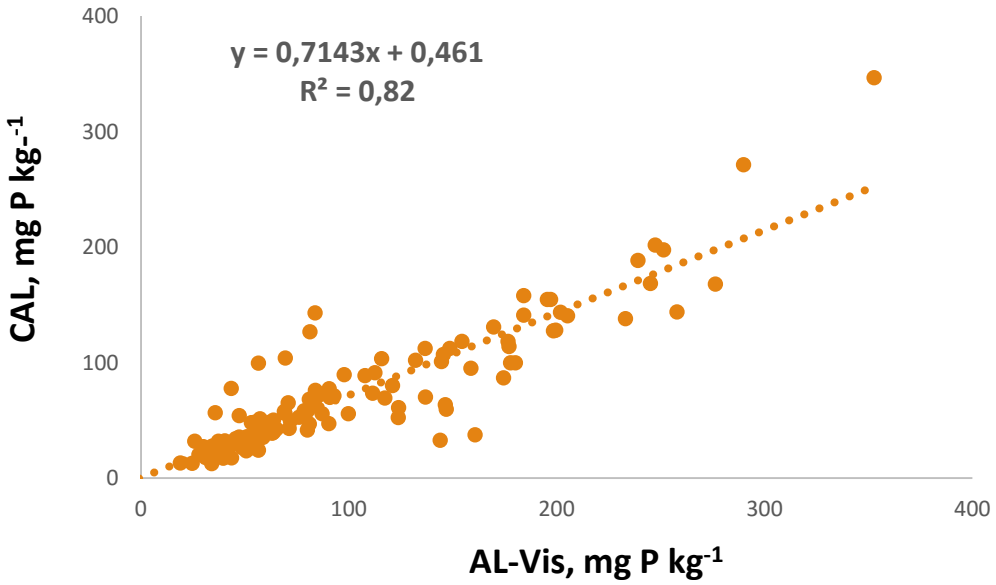


MP-AES vs Vis, organic C free soils

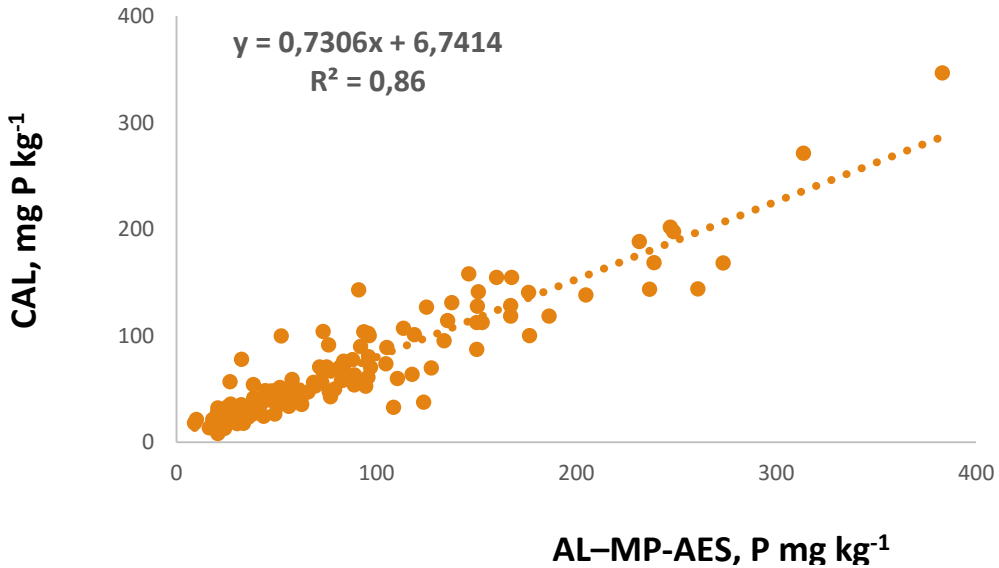


Relationship of P determined from soil by AL vs CAL methods

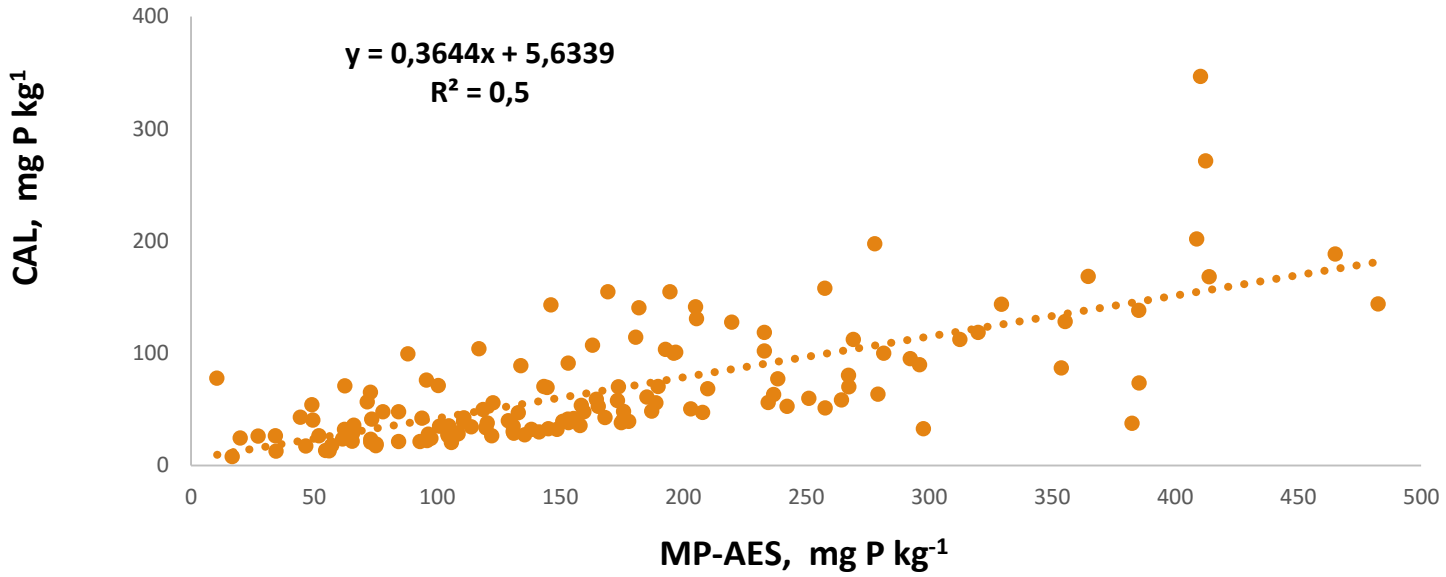
AL Vis vs CAL



AL MP-AES vs CAL



Relationship of P determined from soil by M3 MP-AES vs CAL methods



Conclusions

- No negative effect, derived from soil organic carbon content, was observed for emission peak at λ=213.618 nm, that was used for determination of soil available phosphorus by AL and Mehlich 3 extraction method
- Good correlation of soil P content between MP-AES and Vis spectrometrical results

Conclusions

- MP-AES gives higher content of P compared to Vis spectrometry by Mehlich 3 method
- In average, AL method by MP-AES gives ~4% lower P content values compared to Vis spectrometry results.
- MP-AES is suitable method for determination of plant available P content in soil by AL and Mehlich 3 methods but results differ from those obtained by Vis spectrometry

References

- Egnér, H., Riehm, H.and Domingo, W.R. 1960. Untersuchungen über die chemische Bodenanalyse als Grundlage für die Beurteilung des Nährstoffzustandes der Böden, II: Chemishe Extraktionsmethoden zur Phosphor- und Kaliumbestimmung. *Kungliga. Landbrukshögskole Annale* 26:199-215.

- Mehlich, A. 1984. Mehlich 3 soil test extractant: A modification of Mehlich 2 extractant. *Communications in Soil Science and Plant Analysis* 15:1409-1416.

- Schüller, H. 1969. Die CAL-Methode, eine neue Methode zur Bestimmung des pflanzenverfügbarenPhosphates in Böden. *Plant Nutition and Soil Science* 123:48-63.

Acknowledgement

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