Plant available phosphorus by H3A, M3 and AL methods in Estonian soils

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Introduction and background

- P is essential element for plant growth and development
- P mainly is useful for plants in the form of phosphate anion (PO_4^{3-}) in soil solution.
- The average content of P in soil is 0,5-0,8 g/kg. Mainly P is present in soil as insoluble compounds – 95-99%. Insoluble compounds may be both inorganic or organic forms.
- Organic forms concentration in soil depends from soil type, usage and may be from 30 to 65%, sometimes up to 90%
- Both type of compounds are partially soluble in water and water-based extraction solutions

Introduction and background

- Several methods are in use for determining the plant available P content in soil. Mainly these methods are based on the extraction of soil with diferent extragents and thereafter the determination of P content in extragent solution analytically.
- Typically the extragents are water solution of mineral salts or acids with low concentration
- For the determination of P, mainly AES (ICP-OES, MP-AES) and molecular spectrometry are used. Also IC is used in some experiments.

Introduction and background

- The amount of plant available P species extracted from soils is influenced from soil and extractant solution pH and therefore the methods of analysis are limited in working pH range
- Also the amount of extracted P is influenced by soil physical properties, organic matter content, intensity and duration of extraction process
- Unfortunately currently there is not an ideal and universal soil analysis method which could be used for plant available P.

About H3A method

- To mimic the root environment the extraction solution of H3A method composed from compounds typically excreted by plant roots into rhizosphere
- The extraction solution of H3A method is composed from:

1. Citric acid
2. Oxalic acid
3. Malic acid

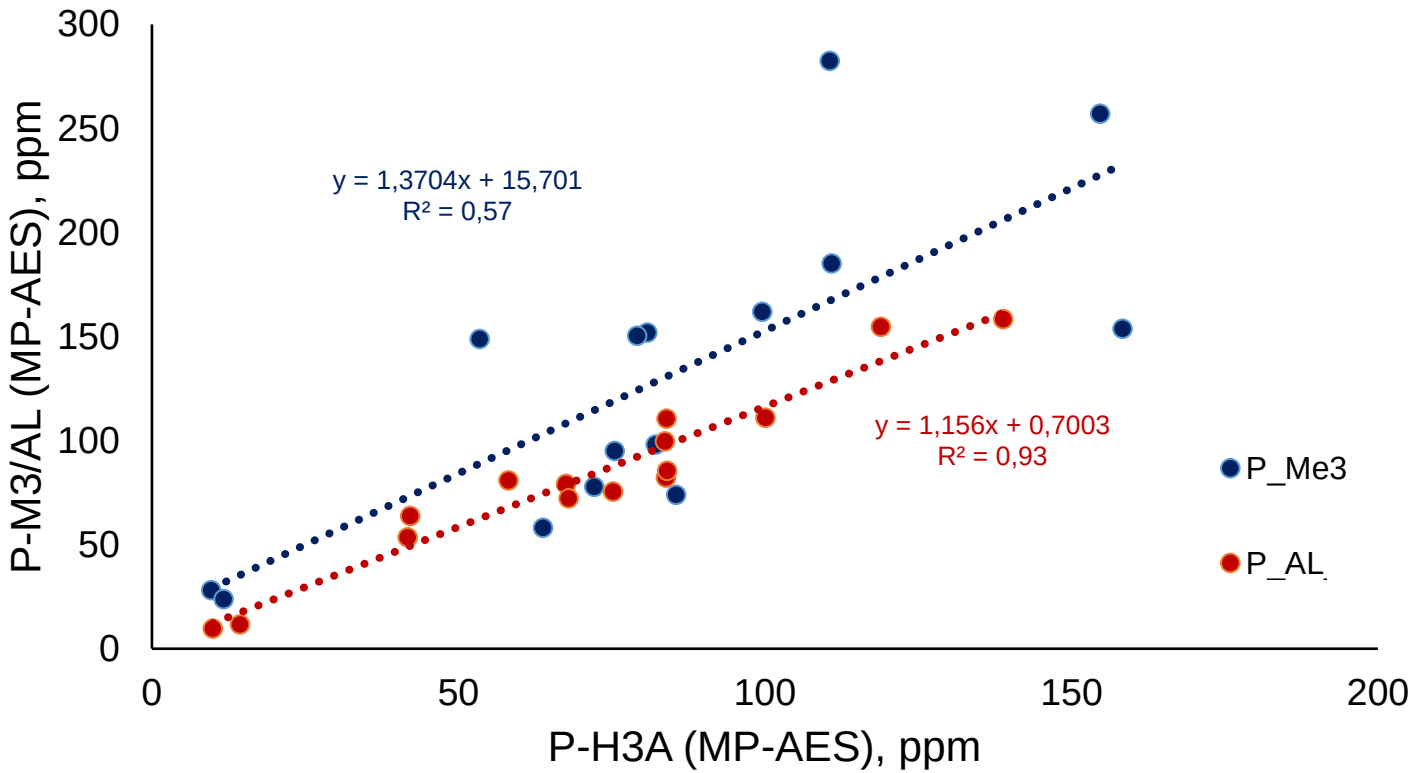
Material and methods

- Soil phosphorus was determined using H3A, M3 and AL method
- Additionally the content organic carbon , pH_{KCl} and soil texture was determined.
- The content of phosphorus in all extracts was analyzed using MP-AES
- Additionally spectrometric and ion-chromatographic (IC) methods were used for analysis of P in H3A extracts
- Content of organic P (Porg) in extract was calculated from the difference of MP-AES and spectrometric method results

Characterization of used soil sample set

	P-H3A	P-M3	P-AL	pH	C	Clay	Dust
	ppm	ppm	ppm		%	%	%
Minimum	10	24	10	4,4	1,2	8,3	15,1
Maximum	158	283	139	7,0	3,5	20,4	37,2
Average	83	129	71	5,8	2,4	11,8	27,3
Median	81	118	75	5,8	2,3	10,6	27,4

Results. The correlations between P content by H3A, AL , M3 methods



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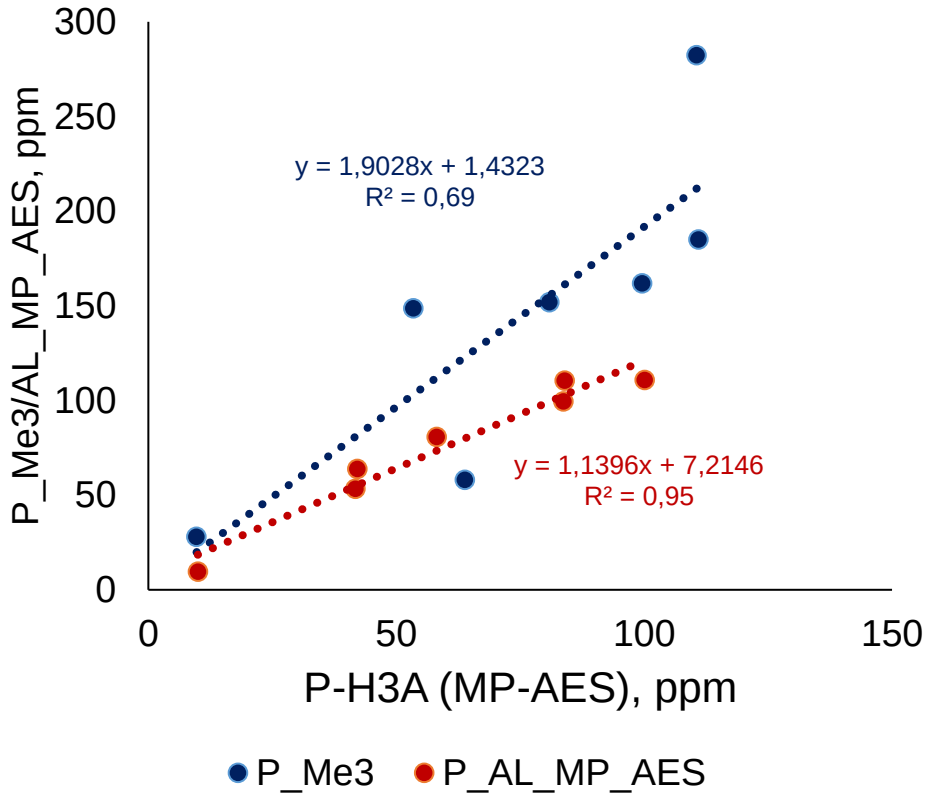
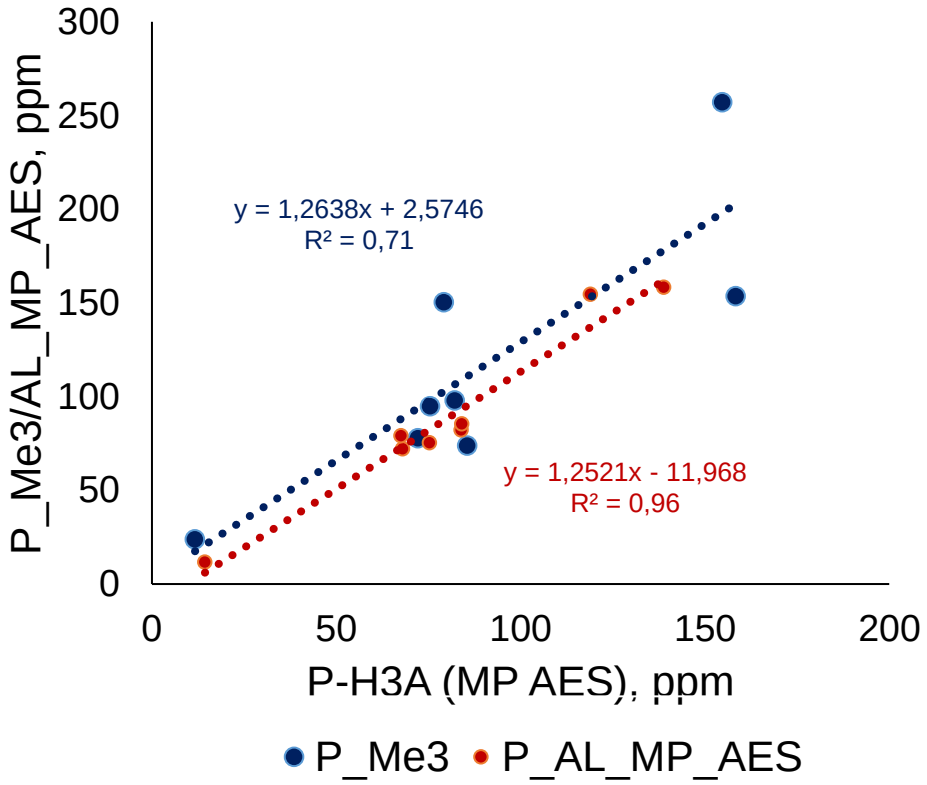
Results. Diferences between methods in dependence with soil pH

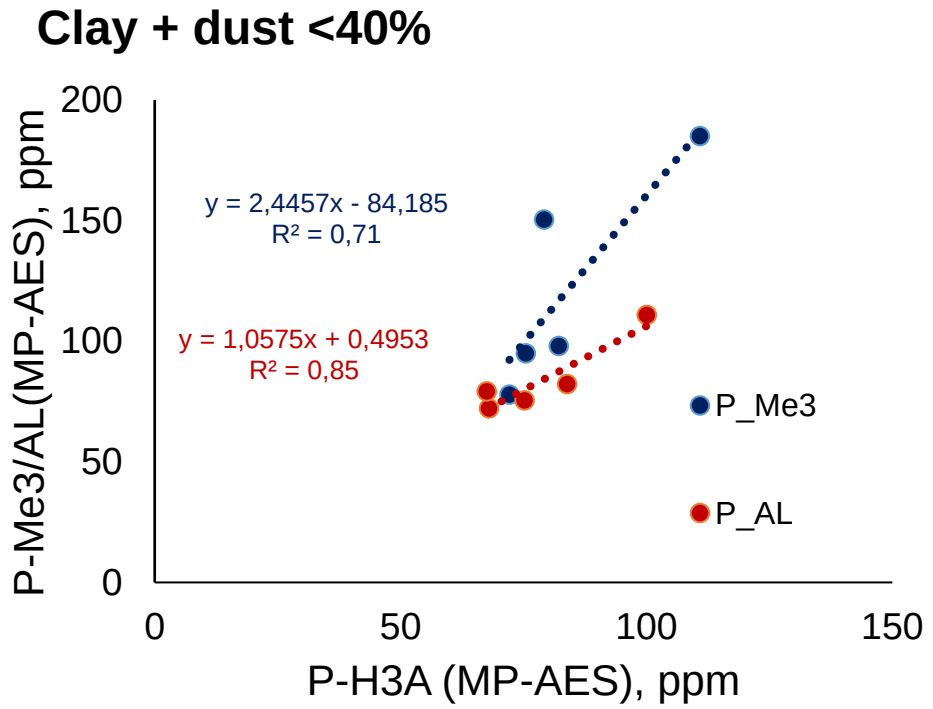
pH ≤5,7, acidic soils

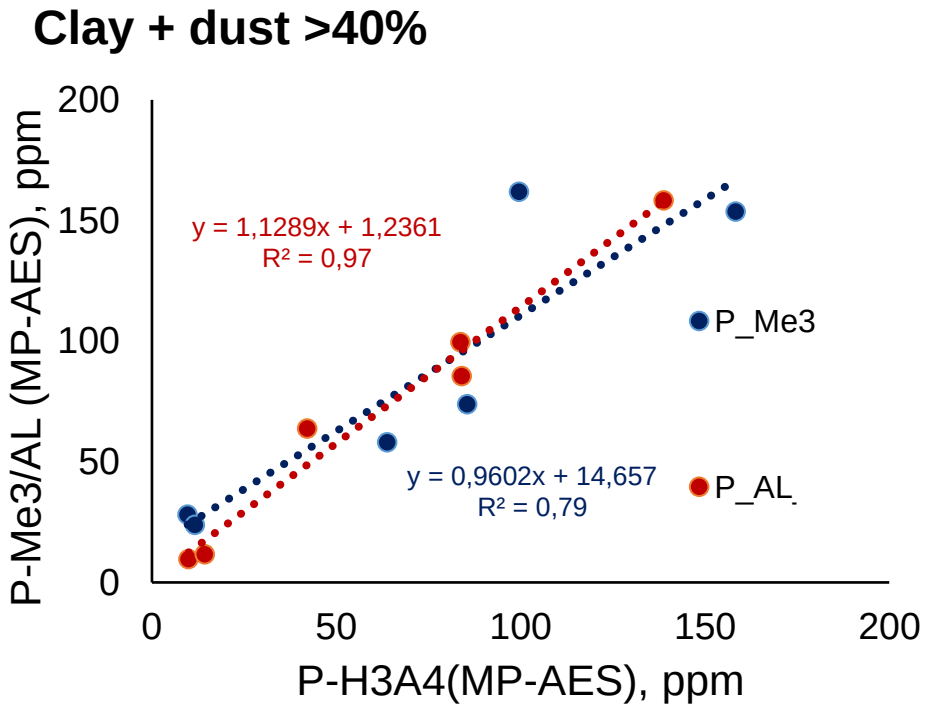


pH≥5,75, slightly acidic and neutral soils



Results. Diferences between methods in dependence with soil clay+dust content





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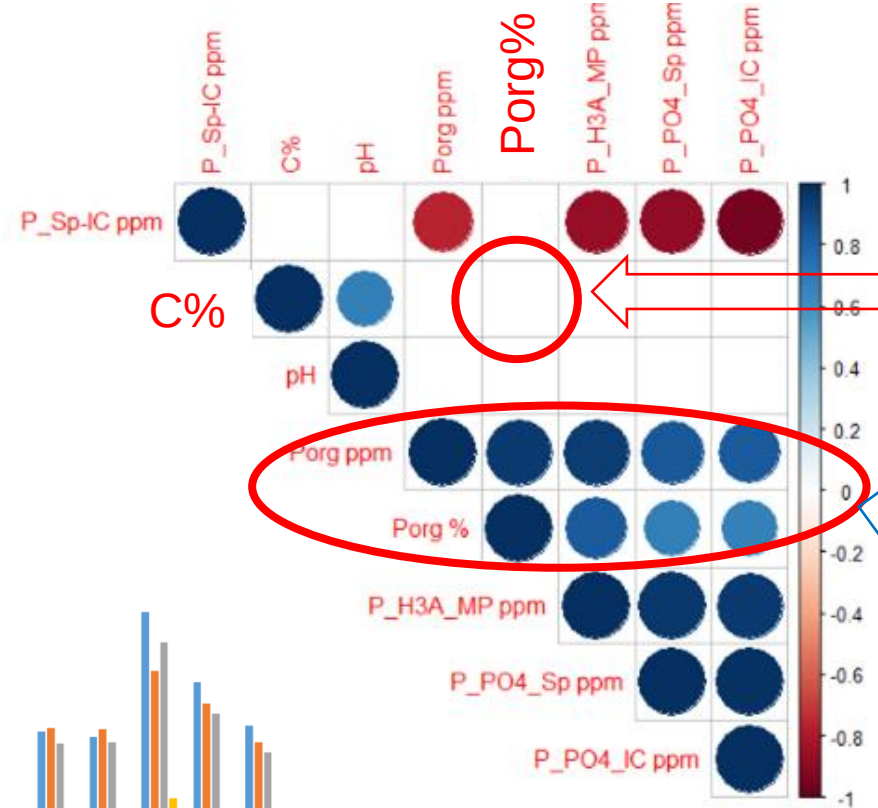
Results. The content of P fractions extracted by H3A method and determined using different analytical techniques

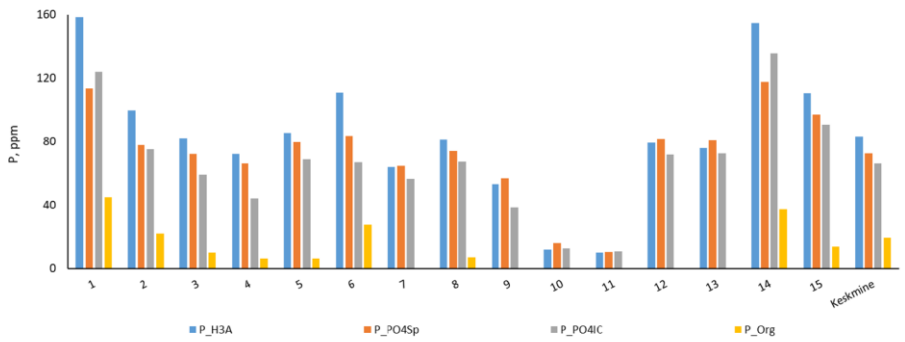
	P fractions					
	Total extraxted P	$P\text{-}PO_4$ (mineral)	$P\text{-}PO_4$ (mineral)	Porg	Porg	$P\text{-}PO_4$
	MP-AES	Spectrometry	IC			
	ppm	ppm	ppm	ppm	%	%
Minimum	10	10	10	0,0	0	71
Average	83	73	66	19	16	84
Maximum	158	117	135	45	29	100
Median	81	78	67	14	12	88

The correlations between results of P-H3A determined using different instrumental method, Porg and organic carbon content



There is no correlation between soil organic carbon content and soil organic phosphorus content, extracted by H3A method

Porg have correlation with total extracted P and mineral P extraxtracted with H3A extragent



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Conclusions

- There is very good correlation between H3A and AL extractable P
- The correlations between H3A and M3 methods is lower than between H3A and AL methods
- The soil texture (clay, dust, sand content) have an influence to the correlation between methods
- The average amount of extracted P by H3A method is higher than by AL method and lower than by M3 method
- Average content of organic P in H3A extracts was 16%
- The instrumental methods affect the results of analysis of plant available P in soil

Thank You for your attention!