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EVALUATION OF SOIL TEST METHODS FOR THE ESTIMATION OF PLANT AVAILABLE PHOSPHORUS IN THE MOST REPRESENTATIVE SOILS FROM PORTUGAL II - A GREENHOUSE STUDY WITH NORTH-EASTERN SOILS

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The major objective of soil tests for P is (i) to provide an index of the capacity of the soil to supply P to a crop and (ii) to group soils into classes for the purpose of making profitable fertiliser P recommendations (Kamprath et al 1980). Subsequently results obtained from chemical methods must have a biological meaning and the first condition is that P status of soils as determined by the extraction must predict the P uptake by the plants on the same soils (Peck et al 1990). The suitability of soil tests is influenced by differences in the chemical and mineralogical properties of soils. Probably no single method can be equally applicable to all situations as the result of complexity of the soil P chemistry. Difficulties arise however in the process of comparing results on similar soils obtained with different procedures. The number of the more extended soil test methods for P has decreased in recent years. Although some new procedures appear to offer some advantages over others now being used, namely the exchange resins methods and extraction solutions to determine multiple nutrient element availability.

To study some of these questions in relation to soils from Portugal, a national research project was undertaken. The aim of this work is to contribute for the study of the extracting solutions most suitable for accurately measuring the available P on Portuguese and similar soils. The work was continued with this second phase using a population of soils collected in the north-eastern part of the country.

**Methods:** Twenty-six soil samples (0-20 cm) were selected from different locations in the northeast of Portugal to represent a wide variety of the major soils from this region. The range of some properties of the soils is presented in Table 1.

	pH water	org matter g kg <sup>-1</sup>	clay %	CEC effective cmol(+) kg <sup>-1</sup>	exch. Al kg <sup>-1</sup>
maximum	6.5	83.8	29.1	14.18	1.53
minimum	4.4	4.4	4.1	1.92	nd

Table 1. Range of some properties of the soils under study.

Fourteen chemical extractants to assess soil P availability have been compared with respect to their biological effectiveness in extracting P. The extracting procedures used were the following: Dyer (C<sub>6</sub>H<sub>8</sub>O<sub>7</sub> 2%); Bray I (0.03M NH<sub>4</sub>F+0.025M HCl); Bray II (0.03M NH<sub>4</sub>F+0.1M HCl); Burriel-Hernando (0.002M H<sub>2</sub>SO<sub>4</sub>+0.06M HOAc); Olsen (0.5M NaHCO<sub>3</sub>); Joret-Hébert (0.1M (NH<sub>4</sub>)<sub>2</sub>C<sub>2</sub>O<sub>4</sub>); Morgan (1.2M NaOAc+0.5M HOAc); Egnér-Riehm (0.4M NH<sub>4</sub>C<sub>3</sub>H<sub>5</sub>O<sub>3</sub>+0.1M HOAc); DPTA (1M NH<sub>4</sub>HCO<sub>3</sub>+0.005M DPTA); Mehlich II (0.2M NH<sub>4</sub>Cl+0.2M HOAc+0.05M NH<sub>4</sub>F+ 0.012M HCl); Mehlich III (0.2M HOAc+ 0.25M NH<sub>4</sub>NO<sub>3</sub>+ 0.015M NH<sub>4</sub>F+0.013 HCl+ 0.001M EDTA); CaCl<sub>2</sub> (0.01M CaCl<sub>2</sub>); AER (anion exchange resin); and ACER (anion/cation exchange resin).

A pot experiment was carried out in a greenhouse with ryegrass (*Lolium perenne* cv. Karamba). Each soil received two treatments (with and without P) in triplicate. The total aerial part was harvested at 20 cm, dried (65 °C) and weighed. Plant samples were digested by the H<sub>2</sub>SO<sub>4</sub>+H<sub>2</sub>O<sub>2</sub> method. Soil and plant extracts were analysed for P by the ascorbic acid reducing method. The suitability of a soil test for predicting the P status of a soil was evaluated by correlating the extracted soil P with P uptake and concentration in the plant. Asymptotic exponential models were used as the expected distribution of the observations.

**Results:** The values of r<sup>2</sup> for each type of P extraction are shown in Table 2, taking into account P uptake and P concentration individually. In the same Table 2 is presented the ranking of the methods when the two biological parameters are considered simultaneously.

method	extr P vs P uptake	extr P vs P conc	ranking
DYER	0.514	0.643	9
BRAY I	0.476	0.614	14
BRAY II	0.506	0.626	11
BUR-HERNANDO	0.686	0.822	2
OLSEN	0.508	0.668	8
JOR-HÉBERT	0.479	0.631	12
MORGAN	0.644	0.869	1
EGNÉR-RIEHM	0.529	0.672	6
DPTA	0.549	0.662	7
MEHLICH II	0.477	0.615	13
MEHLICH III	0.506	0.637	10
CaCl <sub>2</sub>	0.557	0.772	4
AER	0.569	0.695	5
ACER	0.625	0.715	3

Table 2. Values of r<sup>2</sup> for extractable P vs P uptake and concentration; ranking of the methods according to their correlation.

Morgan and Burriel-Hernando acid extraction methods showed the best correlation for this population of soils which included a majority of sandy acid soils derived from schist and granite. These methods are followed by neutral extractions: (i) exchange resins, indicating their suitability over a wide range of soil properties, also observed in a more heterogeneous population of Portuguese soils (Fernandes et al 1992), and (ii) CaCl<sub>2</sub> which primarily measure P intensity factor. Values of r<sup>2</sup> are particularly poor for Olsen and Bray methods, nowadays the more used methods in several countries (Fixen et al, 1990). Egnér-Riehm method, used for fertiliser recommendations in the whole of Portugal, also did not perform well.

Fernandes et al 1992 Proc 2nd ESA Congress 246-247 Warwick  
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