Evaluation of soil test methods for the estimation of plant available phosphorus in soils derived from volcanic material

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Soil testing is the most convenient and widely used procedure for estimating the P status of the soils when providing fertilizer recommendations. Nevertheless, routine tests often fail because the extractant solutions dissolve a fraction of P which is not always proportionally related to plant availability. The complexity of P behaviour involves differences in mineralogical and chemical and characteristics of soils and great diversity exists among and within agricultural regions. Accordingly, the inadequacy of using one single method applicable to all situations has been evident and justifies the effort needed for the selection of the most appropriate procedure for a particular region. Consequently, a study was undertaken to compare soil P tests in soils derived from volcanic materials of Azores Islands, mostly classified in the Andisol Order.
Fifty-one soil samples (0-10 cm) from grazed pastures were selected from different islands in Azores, to represent a wide variety of the major soils from this region. Seven soil P were compared with respect to their effectiveness in extracting P. The extracting procedures used were the following: Bray I (0.03M NH_4F+0.025M HCl); Bray II (0.03M NH_4F+0.1M HCl); Olsen (0.5M $NaHCO_3$); Egner-Riehm (0.4M $NH_4C_3H_5O_3$+0.1M $C_2H_4O_2$); Truog (0.01M H2SO_4+0.023M $(NH_4)_2SO_4$); AEM (anion exchange resin membranes) and (CAEM (cation-anion exchange resin membranes). A pot experiment was carried out in a greenhouse with ryegrass (*Lolium perenne*) and orchardgrass (*Dactylis glomerata*). Each soil received two treatments (nil and 150 mg P kg^{-1} soil) in four replications. The aerial biomass was harvested twice, at about 20 cm height, dried (65ºC), weighed and grounded. Soil P in the extracts was determined by the Murphy and Riley method. The suitability of the different tests was evaluated by correlating the amounts of soil P extracted by each method with relative dry matter yield (P_0/P_{150} x 100) of the biomass. The asymptotic exponential model was used as the expected distribution of the observations. Complementarily, the analytical procedure of Cate-Nelson for partitioning data into two classes was applied and the number of false positive and false negative diagnosis of P deficiency were counted.
The values of r^2 (ranging from 0.654 to 0.477) and $S_{y.x}$ (ranging from 13.8 to 19.6) obtained with the regressions revealed different levels of correlation for each soil P test, in the following crescent order: Bray II < Bray I ≈ Truog < Egner-Riehm < CAEM < Olsen < AEM. Considering the false diagnosis of P deficiency (false positives + false negatives), the crescent order was: Olsen (5) < AEM = CAEM (6) < Bray II (8) < Egner-Riehm (9) < Truog (10) < Bray I (12).
For this heterogeneous group of pasture soils, which includes a very wide range of soil pH as well as clay and organic matter contents, a differentiation occurs among soil tests. Olsen (a worldwide used procedure) and methods based on exchange membrane techniques showed equivalent performances in accessing the P status of these soils. The Egner-Riehm method (traditionally used in Portugal for fertilizer recommendations), Truog method (used in some regions with volcanic soils, such as Hawaii) and both alternatives of the Bray procedure revealed to be lower accuracy tests for these particular soils. Those conclusions (i) advice the use of Olsen method as the most reliable test to be used in routine laboratories for these type of soils; (ii) and agree with our previous results regarding the promising use of resin (membrane) techniques to assess the soil P availability.