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Phosphorus Extraction from Soil Constituents in Equilibrium and Kinetics Applying Bray P-1, Mehlich-1, and Olsen Solutions

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ABSTRACT

Phosphorus (P) which is an essential macro nutrient is one of the most limiting factors for plant growth in humid tropical soils. There are several methods have been applied to estimate the quantity of available P in soil constituents in relation to the plant production. The method solutions of Bray P-1, Mehlich-1, and Olsen are the most frequently used in equilibrium condition to estimate the available P in the soil constituents. But each of the methods can give some different values that may not describe the availability of P. Therefore, it is necessary to conduct a laboratory experiments to compare the three solutions in equilibrium and kinetics for P release from soil colloids as a basic data for the future relating to plant productions. The objectives of this study is to compare the quantity of P release in equilibrium and kinetics using P Bray P-1, Mehlich-1, and Olsen solutions and rate constant (k) of P release from soil colloids using the three solutions of five soil constituents or treatments: (1) Soil (100% soil), (2) P-rock (100% of phosphate rock), (3) compost (100% of chicken manure compost), (4) soil+P-rock (75% of soil + 25% of phosphate rock), and (5) soil+P-rock+compost (50% of soil + 25% of phosphate rock + 25% of chicken manure compost) which were extracted in triplicate. The results indicated that the quantities of extracted P employing equilibrium conditions in all treatments are significantly lower compare to that of kinetics . The results also showed that Mehlich-1 solution was the most power full to extract P from soil constituents following Bray P-1 solution and the least was Olsen solution, except in the soil+P-rock+compost treatment where the quantity of extracted P using Mehlich-1 solution was still the highest then following that of P extracted by Olsen solution and the lowest was Bray P-1 solution both in equilibrium and kinetics conditions. The highest rate constants (k) of the reaction in all treatments were found in using Melich-1 solution for desorbed P following that of using Bray P-1 solution and the least was that of using Olsen solution.

Keywords: Available phosphorus, compost, equilibrium, kinetic, phosphate rock, P extraction solutions, rate constant, soil

INTRODUCTON

Phosphate (P) deficiency is one of the limiting factors to support the productivity of soils in a humid tropical region in which the soil parent materials have undergone further weathering and leaching (Lumbanraja, 1995; Lumbanraja, *et al*., 1982; Oelkers and Valsami-Jones, 2008). The low pH of the soils could be the indication of high P retention by oxide of iron (Fe) and aluminium (Al) resulted in lower P availability to plants (Lumbanraja, *et al*., 1981; Lumbanraja, *et al*., 1994; Arai and Sparks, 2007; Gustafsson, *et al*., 2012). The works have been done to improve the availability of P of soils such as the addition of phosphate rock, and manufacture phosphate and organic fertilizers (Lumbanraja and Utomo, 1996; Lumbanraja, *et al*., 1995; Vetterlein, *et al*., 1999; Lindsay *et al*., 1989). Natural phosphate rock is the primary raw material used in the manufacture of phosphate fertilizers. Natural phosphate rock comes from rocks containing the mineral apatite which is quite high percentage of P_2O_5 (Lindsay, *et al*., 1989; Wahida, *et al*., 2007). On the other hand, the quantity of P_2O_5 predicted from soil, organics and phosphate rocks is depending on the methods with different kind of extracted solutions (Gartley, *et al*., 2002) .

In predicting the availability of P in the soil, it has to use appropriate methods of soil analysis for any kind of cultivated plants. Phosphate availability is usually measured as a function of chemical equilibrium controlled solubility and rate limited process (Sparks, 1989; Lindsay, *et al*., 1989; Arai and Sparks, 2007). Most methods for available P determination attempt to quantify soluble P using different extract solutions, but few of them relate to P supply rates that are relevant to plant uptake (Ziadi, *et al*., 2001; Lynch, 2011; Meetei *et al*., 2015). Test methods for soil constituents including organic and phosphate rocks do not measure the quantity of