ASSESSEMENT OF THE BIOLOGICAL AVAILABILITY OF PARTICULATE-PHASE PHOSPHORUS

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ABSTRACT

A bioassay procedure for particulate-phase phosphorus (P), using Anabaena subcylindrica was developed and evaluated. Measurements of chlorophyll concentration and whole cell alkaline phosphatase activity were established as reliable indices of biomass and algal P status, respectively. Algal P content was found to be dependent on external P availability and was directly related to biomass, only when P availability was constant. The availability of P to Anabaena was controlled by culturing Anabaena in systems containing P sorbed on hydrous ferric oxide gel, saturated to varying proportions of the sorption maximum. By manipulating the amounts of P and gel, algae of similar P status to those grown in soil systems were produced.

The combined bioassay-chemical fractionation procedure developed was used to chemically characterize the amounts and forms of biologically-available particulate inorganic P (IP) and organic P (OP) in potential surface runoff fractions from a wide range of soils. The simultaneous fractionation of Anabaena of similar P status to those in the bioassay systems, enabled a correction to be made for the algal-P contribution to extractable soil + algal P. In this way, the depletion of particulate IP and OP could be monitored. Algal growth depleted P from the 0.1M NaOH-soil-P fraction only; in several bioassays, 0.1M NaOH-soil-OP constituted the larger part of the P depleted. For most of the materials studied, except allophanic material, 0.1M NaOH-soil-P was depleted by 70 to 100% during the growth of Anabaena. Extractability in 0.1M NaOH suggests that biologically-available IP is present as surface-sorbed IP. A similar origin is probable for particulate-phase OP.

The amounts of particulate P extracted by persulphate digestion, a

commonly-used extraction procedure, were greater than those of biologically-available particulate P. Conversely, the amounts of isotopically-exchangeable P underestimated those of biologically-available particulate IP, as determined by the developed procedure.

Algal-soil contact was an important factor influencing the depletion of soil P. Soluble, algal-extracellular products, acting in isolation from the algae, had little influence on particulate IP desorption. Also, the simple desorption of particulate IP was unable to account for the release of large amounts of P to the algae. The initial solution P concentration maintained by a particulate P source material considerably influenced the amount of algal growth and the extent to which particulate P was subsequently depleted.

Biologically-available OP in two soil materials was extracted with 0.1M NaOH and the extracts were separated into humic and fulvic material, which were fractionated by agar gel and Sephadex gel chromatography, respectively. Most of the OP in the humic extract was present as high molecular weight organic matter-Fe-P complexes. In the fulvic extract, both high and low molecular weight organic matter-Fe-P complexes were identified. Inositol polyphosphates, both free and complexed, were identified by ion-exchange chromatography in the fulvic material.

A major objective of the present study was the development of a chemical test for estimating the amount of biologically-available P in stream sediment-source materials. Except for samples containing allophanic material, the extraction of a water sample with 0.1M NaOH is proposed as a rapid and simple test for estimating the maximum amount of biologically-available P present in the sample.

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