Using Soil Properties to Predict Soluble Phosphorus Losses from Indiana Soils

J.A. Brokish, B.C. Joern, and T.L. Provin

SUMMARY

Excessive phosphorus (P) levels in surface water can degrade water quality by causing algal blooms and accelerating the eutrophication process. Agriculture has been implicated as a major nonpoint source of P, so many states have considered restricting P applications from inorganic fertilizers, manures, and other P-containing materials once soil test P levels exceed "threshold values". Relationships between soil properties and soluble P loss potential have not been well-documented. This laboratory study was conducted to quantify relationships between easily measured soil properties and (i) solution P concentrations and (ii) total P mass loss potential in selected Indiana soils. In the first study, 42 soil horizons were incubated for one year at 25C after adding 25, 50, 100 and 200 mg P kg-1 as $NH_4H_2PO_4$. Each soil was initially analyzed for particle size, surface area, pH, Bray P1, exhangeable cations, dithionite-extractable Al and Fe, oxalate extractable P, Al, and Fe, PSI (oxalate P/oxalate Al + oxalate Fe, mol/mol), organic C, inorganic C, soluble P concentration (SPC; soil:0.01M $CaCl_2.2H_2O$, 1:25, shaken 24 hours at 120 epm (50% head space), with 0.1 ml chloroform added to suppress microbial activity), and cumulative mass of soluble P (CMSP; repeated extractions using soluble P procedure until P concentration in extract were < 6 ug P L-1 . After incubation, the soils were analyzed for Bray P1, PSI, and soluble P. We found that SPC exceeded 0.2, 0.5, and 1.0 mg P L-1 at PSI values of 0.19, 0.29, and 0.38, respectively. CMSP was most closely associated with Bray P1 values. Less than 4 mg P kg-1 CMSP was measured until Bray P1 exceeded 40 mg P kg-1, but approximately 65% of the increase in Bray P1 beyond 40 mg P kg-1 was extractable using the CMSP procedure. Only two soils in this data set exceeded 200 mg P kg-1, so soils from fields with previous histories of manure application were collected to validate the predictive capability of the relationships among soil properties and soluble P developed using the incubated soils. Ten soils were collected to approximately 80 cm depth in 10 cm increments and assayed for pH, Bray P1, exhangeable cations, SPC, and CMSP. Bray P1 was the single factor most closely associated with SPC and CMSP. Soluble P concentrations exceeded 0.2, 1.0, 2.0, and 5.0 mg P L-1 when Bray P1 levels reached approximately 75, 200, 500, and 1000 mg P kg-1, respectively. Less than 4 mg P kg-1 CMSP was measured until Bray P1 exceeded 60 mg P kg-1, but approximately 100% of the increase in Bray P1 beyond 60 mg P kg-1 was extractable using the CMSP procedure. Although potential P release in the soluble fraction is only one component to consider when evaluating the contamination potential of a field from a P loss perspective, the traditional Bray P1 soil test does appear to be well-related to soluble P loss potential in noncalcareous soils. Relationships among Mehlich III P and SPC and CMSP are currently under study.

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Dr. Gary Hergert
University of Nebraska-Lincoln
Institute of Agriculture and Natural Resources
West Central Research & Extension Center
Route 4, Box 46A
North Platte, NE 69101