Managing N and P in Manures and Biosolids in Virginia

G.K. Evanylo and G.L. Mullins

VirginiaTech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Virginia Cooperative Extension
Knowledge for the CommonWealth

CSREES Mid-Atlantic Regional Water Quality Program

Introduction

- Accurately estimating N and P availability from organic residuals is critical for protection of surface and ground water.
- Nutrient management guidelines employed by State agencies are often based on out-dated and/or incomplete data.
- Virginia Tech researchers/extension specialists have developed updated N and P guidelines for application of residuals as a result of multi-state research efforts.

Objective

To illustrate recently developed N and P management guidelines for land-applying biosolids and manures.

Approach to developing improved N mineralization factors for biosolids

- ❑ Corn and tall fescue field studies were conducted at sites throughout U.S.
- ❑ Relationships between crop N concentration or uptake and fertilizer N rates were used to establish calibration curves used to estimate plant available N (PAN) in 36 different biosolids applied to the plots.
- ❑ Estimated PAN from laboratory incubation tests were compared with PAN estimates from field studies.
- ❑ The computer model DECOMPOSITION (Gilmour, 1998) predicted mineralization in the field using average weather data.

Application sites and experimental protocols

1998

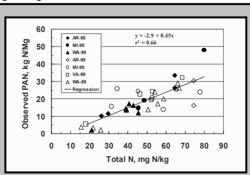
Arkansas	4 N rates (50-200 lb N/ac), 4 biosolids
Michigan	4 N rates (50-200 lb N/ac), 3 biosolids
Washington	5 N rates (45-223 lb N/ac), 8 biosolids

1999

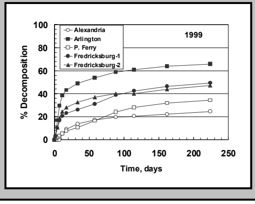
Arkansas	4 N rates (50-200 lb N/ac), 3 biosolids
Michigan	4 N rates (50-200 lb N/ac), 6 biosolids
Virginia	4 N rates (100-400 lb N/ac), 4 biosolids
Washington	5 N rates (45-223 lb N/ac), 8 biosolids

Biosolids PAN was calculated from crop N uptake results in N calibration studies.

Observed biosolids PAN released during the growing season versus biosolids total N.



Differences in lab mineralization of biosolids (Fredericksburg & P. Ferry = anaerobic; Alexandria & Arlington = lime stabilized).



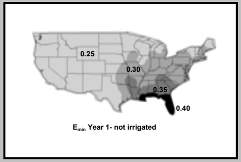
Computer simulation

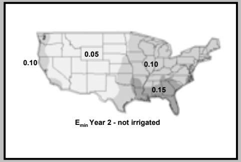
N mineralization rates from field studies & **DECOMPOSITION** model were similar for all types of freshly-stabilized biosolids.

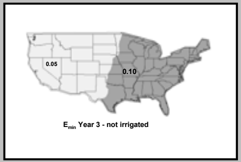
Plant responses were used to determine portion of total biosolids organic N mineralized during the growing season. This amount was termed the "effective mineralized N," or E_{min}.

E_{min} Values for the Continental U.S.

Climate-based GIS maps illustrating the expected mineralized PAN released during the 1st, 2nd, and 3rd growing seasons following biosolids application.







Recommendations

Major changes from those suggested in the 1995 U.S. EPA Process Design Manual:

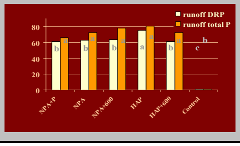
- Differences among biosolids based on N concentration rather than on biosolids types (except for highly stabilized composted or lagooned biosolids).
- PAN estimated for a typical growing season using E_{min} rather than K_{min}.
- E_{min} adjusted for average weather conditions in different U.S. climatic zones.

Effects of P Sources on P Loss Potential

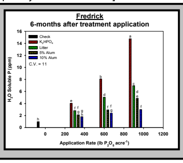
Objectives

- Evaluate effects of phytase and/or high available P corn as diet supplements for turkey production on P losses in runoff from soils receiving applications of turkey manure.
- Evaluate capability of alum to reduce the bioavailability of P in poultry litter land-applied in Virginia.
- Estimate P availability factors for manures and biosolids.

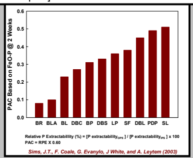
turkey manure applied at 50 kg total P/ha [NPA=Industry Diet and HAP=high available P corn with or without supplemental P (+P) or phytase (+ 600)].



Water soluble P in soil 6 months after incubation. [K_2PO_4 = inorganic P fertilizer; Litter = non-amended poultry litter; 5% Alum = poultry litter+5% alum; 10% Alum = poultry litter+10% alum.]



P availability coefficients based on relative solubility of 11 P sources evaluated in an incubation study. [BR=biosolids+Fe; BLA=broiler litter+alum; BL=broiler litter; DBC=dairy/beef compost; BP=biosolids+lime+Fe; DBS=dairy/beef semi-solids; LP=biosolids+lime; SF=fresh swine manure; DBL=dairy/beef liquid; PDP=deep pit poultry; SL=swine liquid.]



Virginia Contribution to National P Runoff Project

Objective

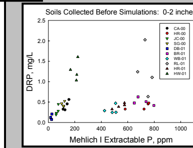
Develop database for relationship between soil test P level and surface runoff P for benchmark Virginia soils that pose potential P enrichment risks to surface water.

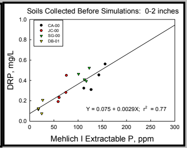
Methods

Protocols for the National Phosphorus Runoff Project (http://www.soil.ncsu.edu/sera17/publications/National_P/National_P_Project.htm) were applied to selected soils of the Shenandoah Valley. Project was implemented in producers' fields using a standardized rainfall simulator and plot size to evaluate P runoff. Various soil test procedures for predicting potential surface runoff losses of P from soils were assessed.

Portable Rainfall Simulator Setup

DRP in surface runoff vs Mehlich 1 extractable P in surface 0-2 inch (0-5 cm) soil layers of selected agricultural fields.





Development of a Virginia P-Index

- ❑ The P Index is a mass-based indexing tool that assesses the potential for P loss by summing the risk of P transport via eroded sediment, surface runoff, and by subsurface flow.
- ❑ The Virginia P Index was based on the Iowa State University Index using Virginia conditions, including annual rainfall data, cropping systems, topography, soils, etc.
- ❑ Input for each section of the Index is based on site-specific evaluation of source and transport factors.
- ❑ Numerical weightings for each component of the Index were derived from research data for regional soils and scientific literature.

Version 1.2 of the Virginia P-Index.

Risk Factor										Value
Erosion Risk Factor	=	Edge of field soil loss (million lbs/ac)	X	Sediment P delivery factor (dimensionless)	X	Sediment total P factor (ppm)		=		
Runoff Risk Factor	=	Runoff from field (million lbs/ac)	X	Runoff P delivery factor (dimensionless)	X	Runoff DRP* factor (ppm)	+	Applied fertilizer DRP* factor (lb/ac)	=	
Subsurface Risk Factor	=	Percolation (million lbs/ac)	X	Soil texture/drainage factor (dimensionless)	X	Subsurface DRP* factor (ppm)		=		
Phosphorus Risk = Sum of Erosion, Runoff and Subsurface Risk Factors:										
Scaling Factor:										X 6.3
P Index:										

*DRP is dissolved reactive orthophosphate.

Summary:

Phosphorus Risk = Erosion Risk Factor + Runoff Risk Factor + Subsurface Risk Factor

P Index = 6.3 * Phosphorus Risk

Summary Interpretation of Phosphorus Index

P Index Value	Potential Water Quality Impact	Phosphorus Management Guidance Based on Proposed Management Practices
0 – 30	Low	Phosphorus application according to N-based nutrient management is acceptable.
31 – 60	Medium	Phosphorus applications for this site should not be more than 1.5 times crop removal.
61 – 100	High	Phosphorus applications should not be greater than crop removal.
> 100	Very High	No phosphorus should be applied.

Expected Impact

Data from the runoff and bioavailability studies will be incorporated into the Virginia P Index to assist us in better evaluating the risk of P loss from sediment and P-amended soils.