Phosphorus Phytoavailability as Affected by Application of N-Viro Soil and NureSoil Products to Cropland

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Abstract

Phytoavailability of P in soils amended with alkaline-stabilized biosolids (N-viro soil) and swine manure (NureSoil) were investigated in a three-year field study. East Lansing N-viro soil and alkaline NureSoil were surface applied once to a sandy loam soil at three rates each plus an untreated control. Field corn (*Zea mays* L.) and soybeans (*Glycine max* L.) were grown for 3 years. Soil $CaCl_2$-P and Bray-P1 were reduced with increasing rate of N-viro soil, but NureSoil did not reduce phytoavailable P. Plant P concentrations were similarly reduced at the high rate of N-viro soil but increased by NureSoil as application rates increased. At high rate, N-viro soil with greater equivalent liming load was shown to be a P-sink with reduced P phytoavailability rather than a P-source. The lower liming load of NureSoil caused P phytoavailability to increase with application rate.

Background

- Alkaline stabilized biosolids and manure meet the three main suitability criteria of 40 CFR Part 503 (USEPA, 1993), which are pathogen kill, pollutant metal concentrations, and vector attraction reduction.
- High rate of alkaline stabilized amendments can Increase soil pH above agronomic range (5.8 to 6.2).
- Alkaline amendments can precipitate soil P as calcium phosphates and reduce phytoavailable P.

Objective

The objective of the study was to evaluate P phytoavailability of alkaline stabilized biosolids (N-Viro) and manure (NureSoil)

Methods

- N-viro soil and NureSoil were surface applied to a sandy loam soil (Bray P1 = 550 mg kg^{-1}) once in October, 2001 at three rates each; 18, 130 and 269 Mg ha^{-1} for N-Viro soil, and 29, 58 and 224 Mg ha^{-1} for NureSoil. Untreated plots were included as a control.
- The seven treatments were arranged in a randomized complete block design and replicated 4 times
- The treatments were disked into the surface 15 cm depth of each plot (9.2 m x 15.2 m).
- Each plot was split into two equal areas and the subplots (4.6 m x 15.2 m) cropped with field corn (*Zea mays* L.) and soybeans (*Glycine max* L.) yearly between 2002 and 2004.
- Grain yields and P concentrations in plant diagnostic leaf, whole plant samples, and grains were determined for each growing season.
- Soil samples taken prior to planting of each growing season were analyzed for pH, Bray-P1, and $CaCl_2$-P.

Table 1. Nutrient loadings and equivalent lime loadings at the three rates of N-Viro soil and swine NureSoil.

Parameter	N-Viro (Mg ha^{-1})			NureSoil (Mg ha^{-1})		
	18	130	269	29	58	224
	kg ha^{-1}					
Total N	93	670	1300	340	660	2600
NH_4-N	7	52	110	110	210	810
PAN	27	190	400	78	160	600
P_2O_5	57	410	860	250	490	1900
K_2O	26	190	390	260	530	2000
Equiv. lime (Mg ha^{-1})	7	50	100	5	11	41
Lime : P ratio	123	122	116	20	22	22

Table 2. pH of soil samples taken during the study

Material Applied	Rate (Mg ha^{-1})	Sampling Period			
		2001†	2002	2003	2004
Control	0	6.5 ns	6.6 ab	6.7 ab	6.7 bc
N-Viro	18	6.5	6.9 ab	6.8 ab	7.0 ab
	130	6.0	7.3 a	7.2 ab	7.3 ab
	269	6.0	7.5 a	7.5 a	7.5 a
NureSoil	29	6.0	6.1 b	6.4 b	6.3 c
	58	6.5	6.8 ab	6.9 ab	6.8 abc
	224	6.4	6.8 ab	7.0 ab	7.0 ab

†Treatment means of same sampling period followed by the same letter are not different by Tukey's test at 5%.

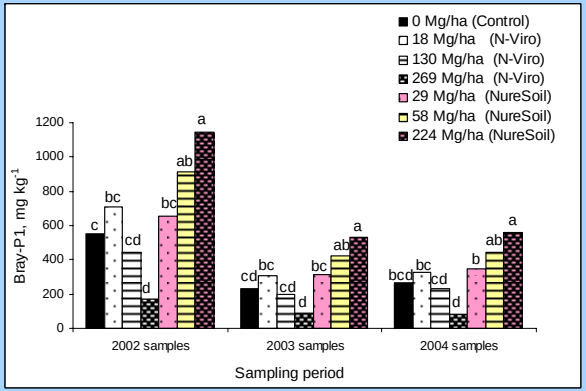

Figure 1. Bray-P1 in soil samples (0-15 cm) taken during the study. (Treatments within same sampling period with same letter are not different by Tukey's test at 5%)

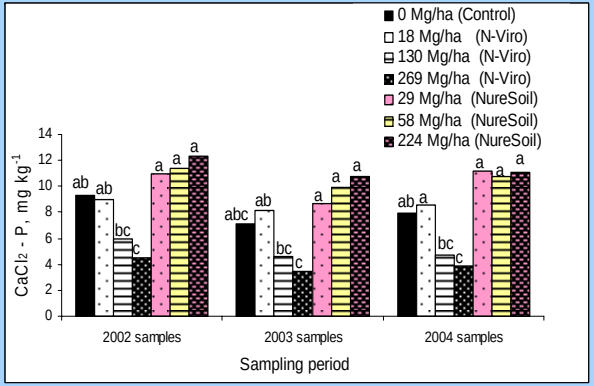

Figure 2. Soluble P ($CaCl_2$ -P) in soil samples (0-15 cm) taken during the study.
(Treatments within same sampling period with same letter are not different by Tukey's test at 5%)

Table 3. Phosphorus concentrations (%) in corn and soybean whole plant diagnostic samples taken during the study

Crop	Material Applied	Rate (Mg ha^{-1})	Sampling Period		
			2002†	2003	2004
Corn	Control	0	0.54 ns	0.62 a	0.68 ab
	N-Viro	18	0.55	0.54 ab	0.74 a
		130	0.52	0.40 bc	0.57 c
		269	0.51	0.27 c	0.51 c
	NureSoil	29	0.65	0.57 ab	0.74 a
		58	0.64	0.57 ab	0.75 a
		224	0.69	0.53 ab	0.75 a
Soybean	Control	0	0.39 bcd	0.47 ab	0.48 bcd
	N-Viro	18	0.40 bcd	0.51 ab	0.47 cd
		130	0.35 c	0.39 bc	0.32 d
		269	0.34 d	0.30 c	0.33 d
	NureSoil	29	0.43 b	0.54 ab	0.64 ab
		58	0.41 bc	0.53 ab	0.62 abc
		224	0.52 a	0.60 a	0.69 a

†Treatment means of same sampling period followed by the same letter are not different by Tukey's test at 5%

Results and Discussion

- Both N-viro soil and NureSoil increased soil pH.
- Reduction of soil $CaCl_2$-P, Bray-P1, and increased pH with increasing rate of N-viro soil suggest precipitation of P as calcium phosphate due to high lime additions.
- Extractable soil P level and plant P concentrations were reduced with increasing rates of N-viro soil, but NureSoil did not reduce phytoavailable P.
- Alkaline stabilized P sources applied to high soil test P can become P-sink at high lime additions.

Conclusions

- Alkaline stabilized soil amendments can be used as P-source or P-sink depending on the lime load and P rate.
- Phosphorus phytoavailability increases with increasing rate of alkaline stabilized P-sources with low equivalent liming load such as in NureSoil.
- High application rate of alkaline stabilized P-sources with high equivalent liming load can increase soil pH above 7, precipitate plant available P in the soil and reduce P phytoavailability.