Sequential Fractionation and Water-Soluble Phosphorus Methods to Investigate Soil Phosphorus in a Long-term Manure Application

Kaliana Moro Tanganelli, J. Clemn Turner ,Jeffory A. Hattey and Jason G. Warren
Department of Plant and Soil Sciences, Oklahoma State University
kaliana@okstate.edu

Introduction

- Animal manure is an important source of plant nutrients and organic matter
- However, animal manure is based on crop N requirements which can build up soil P, including water-soluble phosphorus (WSP) which has the potential to be transported into waterways via erosion or runoff
- Estimation of nutrients in animal manure is important to determine relative abundance of plant available P forms in the soil solution

Objectives

- Investigate soil P in a long-term manure application study using sequential fractionation method with H_2O, $NaHCO_3$, NaOH, weak HCl and concentrated HCl extracts
- Evaluated how bioavailable P and WSP levels from long-term manure applications in calcareous soil were affected when different N sources (Beef manure, Swine effluent and N-fertilizer) were utilized

Material and Methods

- Research conducted at Oklahoma Panhandle Research and Extension Center (OPREC) Goodwell, OK
- Plots (4.5x9 m^2) established in 1995 on Gruver clay loam
- Soil samples were collected in 2008 from 0 -120 cm depth in a continuous cropped, conventionally tilled maize (*Zea mays L.*) production experiment
- N sources included : beef manure (BM), swine effluent (SE), N-fertilizer
- N applied at 0, 56, 168 and 504 kg ha^{-1}
- Sequential extraction procedure modified by Warren et al. (2008) to determine organic and inorganic P concentrations and their solubility
- ANOVA results from a RCBD experiment were used to determine differences in P concentrations for the various extraction methods

Figure 1. Swine effluent application on the surface of maize crop

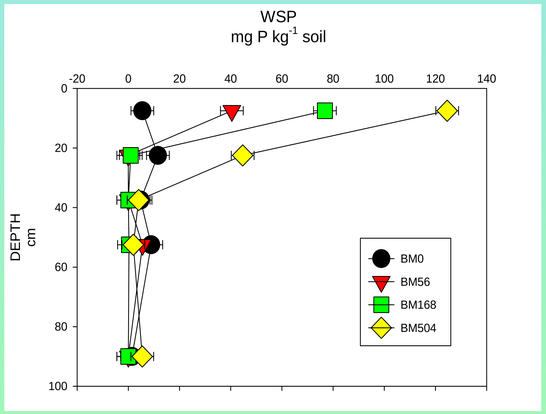

Figure 2. Effect of beef manure on water-soluble phosphorus. Inorganic phosphorus concentration decreases from the surface to the subsurface soil horizons

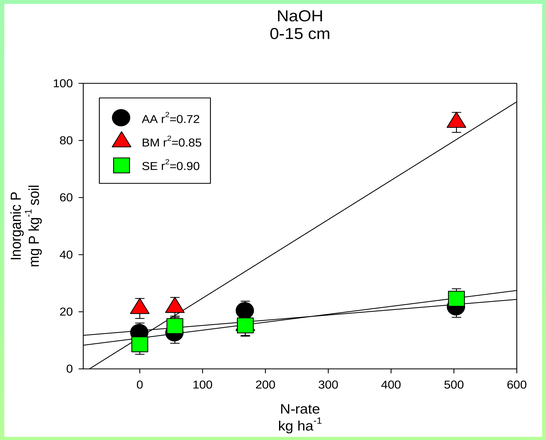

Figure 3. Linear regression for NaOH. Inorganic P concentration is highly affected by the highest N-rate at 504 kg ha^{-1} of beef manure

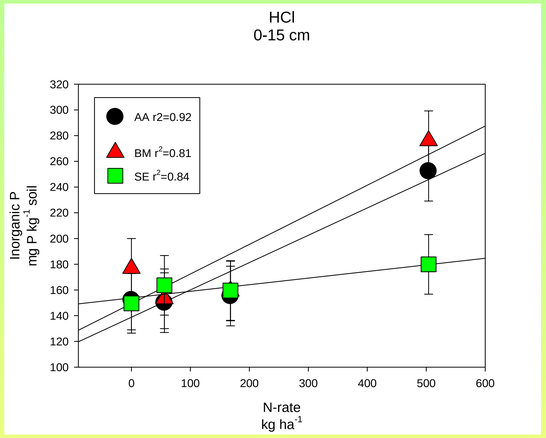

Figure 4. Linear regression for HCl. Inorganic P concentration is highly affected by the highest N-rate at 504 kg ha^{-1} of beef manure. Decreased on pH due to application of N-fertilizer, increased inorganic P

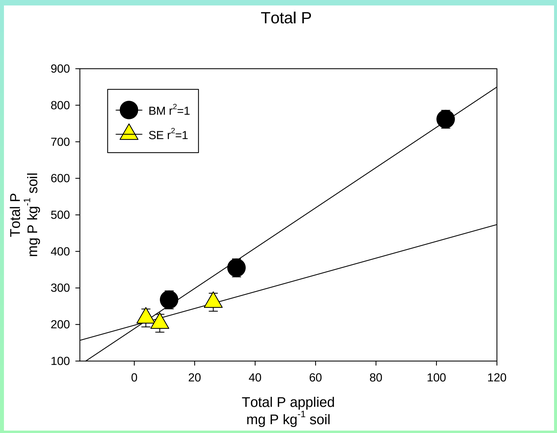

Figure 5. Linear regression for total P. Total P shows dependency on total P applied for animal manure application in all extracts

Table 1. Least significance difference at the surface (0-15 cm). Means followed by the same letter are not significantly different at the 0.05 alpha level among treatments at the same extract. Control is significantly different from other N-rates for beef manure. HCl extract has the highest inorganic P concentration due to strong P association with calcium phosphate

				0.5 M		0.1 M		1.0 M	11.3 M	
		H_2O		$NaHCO_3$		NaOH			HCl	
Nsource	Nrate	Pi	Po	Pi	Po	Pi	Po	Pi	Pi	Po
	kg ha^{-1}	mg kg^{-1}								
N fertilizer	0	13.23de	0a	11.13c	7.60a	12.56de	37.22ab	152.19b	17.93a	9.86ab
	56	6.51e	0a	7.47c	6.43a	12.45de	34.6abc	150.11b	20.16a	8.70ab
	168	2.84e	5.94a	14.85c	14.44a	20.21bcd	20.84bcd	155.30b	15.19a	11.12ab
	504	3.40e	6.15a	10.90c	22.83a	21.53bcd	20.18bcd	252.31a	19.10a	2.92ab
Beef manure	0	5.50e	0a	10.39c	6.24a	21.13bcd	48.90a	176.79b	27.14a	0ab
	56	40.46c	0a	28.69c	6.86a	21.51bcd	37.22ab	153.13b	23.57a	5.38ab
	168	76.81b	0a	68.97b	1.42a	20.48b	40.99a	159.21b	21.51a	10.05ab
	504	124.60a	3.69a	254.86a	46.72a	86.31a	37.54ab	276.02a	19.78a	20.24a
Swine effluent	0	3.26e	0.73a	4.83c	4.53a	8.58e	39.25a	149.59b	36.01a	0b
	56	0e	4.7a	8.78c	10.70a	14.98de	12.81d	163.62b	30.42a	0b
	168	0e	5.72a	8.78c	10.38a	15.20de	15.79d	159.55b	19.95a	1.11ab
	504	32.26cd	11.08a	10.09c	17.3a	24.55bc	18.22cd	179.90b	14.05a	10.82ab

Conclusion

- All increases for WSP in the surface were strongly correlated to the total P additions since 1995
- WSP from BM treatment responded to the P concentration more than SE due to the total P applied
- WSP control is significantly different from 504 kg ha^{-1} for both BM and SE
- Most of the applied manure P accumulations were strongly bound to Al, Fe and Ca phosphates as evident by increased concentrations of P_i in the $NaHCO_3$, NaOH and HCl extraction