Phosphorus Fertilizer Equivalents in Cattle Manure Compost

Lawrence J Sikora
Collaborator
USDA-ARS
Henry A Wallace Beltsville Agricultural Research Center

Introduction

- Application of P to land in any form should be carefully scrutinized because P from nonpoint sources contributes to eutrophication.
- States have adopted P site indices that are designed to reduce P enrichment of waterways.
- P fertilizer content of composts has not been evaluated as extensively as N.
- Studies were initiated to evaluate P fertilizer content of composts in comparison to triple super phosphate. This study reports on growth chamber studies evaluating cattle manure compost.

Composting Mixture and Conditions

- Separated Dairy Solids (60 %)
- Maternity barn manure (10%)
- Bedding (straw/sawdust) (20%)
- Feed (10%)
- Windrow composting for 10 weeks
- Windrows turned 5 times
- Compost stacked and stored for 6 months

Growth Chamber Study Methodology

- Codorus soil was amended with equal amounts of N fertilizer totaling 125 kg N ha^{-1} soil based on N mineralization rates of cattle manure compost (CMC) determined in incubation study
- P amendments, TSP or CMC, ranged from 0 to 150 kg P ha^{-1}soil.
- Mixtures were placed in 15 cm pots, moisture adjusted to – 33kPa, fescue was planted, pots were placed in a growth chamber and harvested 3 times over 94 days.
- Clippings were analyzed for P and N content.

N mineralization study methodology

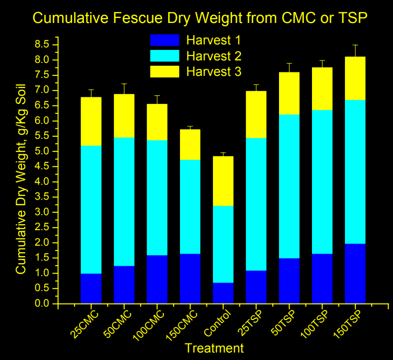
- 100 g of Codorus soil was mixed with 1 g of CMC and lime, placed into 250 cc biometer flasks and water added to adjust moisture to -33 kPa.
- Flasks were incubated at 25 C covered with parafilm.
- Flasks were sampled at 0 and 7 days and analyzed for water and Mehlich-3 soluble P and 2 M KCl extractable N

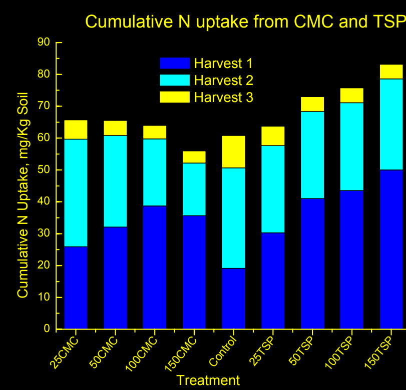
Composition of soil and compost

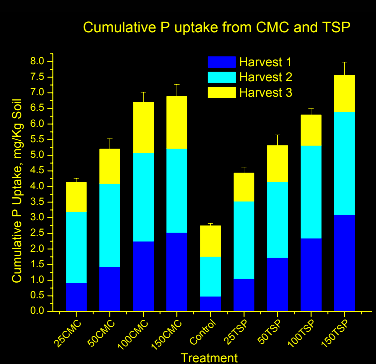
Table 1. Analyses of Codorus Soil and Poultry Litter Compost

Element	Soil	Cattle Manure Compost
pH	5.7	7.47
Total C	12.6 mg g^{-1}	225 mg g^{-1}
Total N	1.01 mg g^{-1}	22.0 mg g^{-1}
Carbon: Nitrogen ratio	12.5	10.2
Total P	0.37 mg g^{-1}	6.65 mg g^{-1}
Mehlich 3 extractable P	9.25 mg kg^{-1}	0.55 mg g$^{-1¥}$
Water extractable P	0.214 mg kg^{-1}	0.100 mg g$^{-1¥}$
Cation exchange capacity	7.4 meg kg^{-1}	---------

¥ difference between soil and compost-amended soil immediately after mixing.





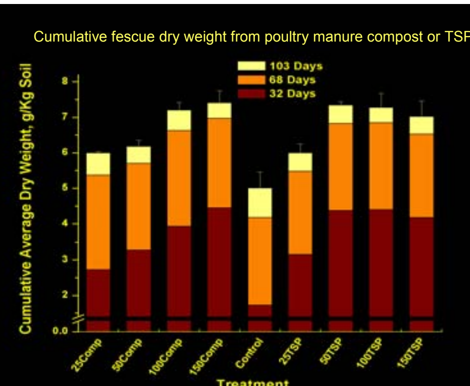


Model regression equations of combined treatments CMC and TSP

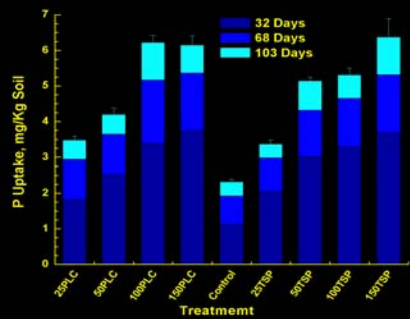
Parameter	Model	Significance
Yield	4.88 + 0.066 x rate – 0.0004 x rate^2	0.0001 R^2 = 0.75
P uptake	2.44 + 0.0695 x rate – 0.000266 x rate^2	0.0001 R^2 = 0.95

Extractable P and N in soils at conclusion of study.

Treatment	Mehlich 3 extractable P	KCl extractable N
Control	6.79	5.27
25 CMC	8.50	4.15
50 CMC	13.91	3.63
100 CMC	21.67	3.86
150 CMC	32.02	3.99
25 TSP	9.02	5.03
50 TSP	10.12	4.80
100 TSP	19.70	4.30
150 TSP	30.16	4.22



Cumulative P Uptake from PLC or TSP



Model regression equations describing poultry litter compost and TSP effects on fescue dry weight and P uptake

Fertilizer	Plant Factor	Model	Pr > F
Poultry Litter Compost	Dry Weight	5.3 + 0.028 x rate – 0.000102 rate^2	0.0001
Triple Super Phosphate	Dry Weight	5.0 + 0.063 x rate - 0.000335 x rate^2	0.0001
Combined	P uptake	2.28 + 0.060 rate – 0.000239 rate^2	0.0001

Discussion on P availability in composts.

- Crop uptake of N versus P is approximately 7:1 (Buckman and Brady, 1969).
- Ratio in manures and composts is 3:1
- Plant available N however is reduced during composting and, as shown in these studies, P plant availability is not altered after composting.
- Thus, the imbalance between the fertilizer requirements of the plant and those available in composts is exacerbated.

Application strategies for composts to comply with nutrient management plans

- Apply compost to satisfy the P requirements of the crop and use supplemental N fertilizer to satisfy the crop's N needs. **Note** that blending compost with urea results in N losses because composts and manure contain ureases.
- Amend manures prior to composting with P binding metals such as Fe and Al which reduces P availability. Dao et al (2001), Codling et al (2000) and Delaune et al (2000) give examples of industrial byproducts that may be used for this purpose.

Conclusions

- P in cattle manure compost is as available to plants as triple super phosphate.
- Similar results were obtained with poultry manure composts.
- Interaction of compost with soil, primarily the effect of biological activity and organic matter content of compost and their influence on soil binding and release of P influence these findings..

Compost Research Facility at Beltsville Agricultural Research Center