Phosphorus in Compost and Risks to Water Quality

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Phosphorus and Water Quality

- A very real problem for US waters
- Triggers growth of cyanobacteria (Blue Green Algae)
- Can be caused by:
  - Agricultural application of manure and fertilizer
  - Waste water treatment and septic systems
  - Lawn fertilizers
  - Storm water runoff

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Compost Contains Phosphorus

- Compost when applied based on Plant Available N, can result in "excessive" applications of Phosphorus
- Unlike chemical based fertilizers, Phosphorus cannot easily be removed from composts (and other organic based products)
- Composts are being regulated under state regulations intended for "Phosphorus containing fertilizers"

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Compost

Part of the problem?

or

Part of the solution?

How can we use compost without risk to Phosphorus contamination of water?

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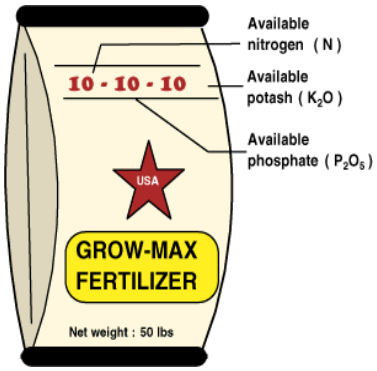
How much Phosphorus is in Compost?

- Total Phosphorus?
- Phosphorus as P or as P2O5?
- Water Soluble (Water Extractable Phosphorus)?
- Plant Available Phosphorus?



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Compost Testing

Feedstocks	Total P % dw	P2O5 % dw	Total P ppm dw
Leaf/yard wastes	0.15	0.34	1,485
leaf/yard wastes	0.18	0.42	1,830
leaf/yard wastes/food	0.18	0.42	1,817
leaf/yard wastes/food	0.19	0.43	1,873
Biosolids/wood chips	0.34	0.78	3,424
Biosolids/wood chips/Yard wastes	0.35	0.81	3,537
Biosolids/wood chips	0.70	1.60	6,991
Biosolids/Yard wastes/WTR	0.73	1.67	7,293
Biosolids/wood chips	0.82	1.87	8,183
Yard wastes/Gelatin residuals	0.96	2.19	9,581
Biosolids/wood shavings	1.05	2.41	10,524
Biosolids/wood chips	1.59	3.65	15,939

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Water Soluble Phosphorus (Water Extractable)

Feedstocks	WEP ppm dw	% of total P
leaf/yard wastes	122.8	7.0%
leaf/yard wastes	124.6	8.4%
leaf/yard wastes/food	134.0	7.4%
leaf/yard wastes/food	126.9	6.8%
Biosolids/wood chips	703.0	20.5%
Biosolids/wood chips/Yard wastes	430.5	12.2%
Biosolids/wood chips	1,559.1	22.3%
Biosolids/Yard wastes/WTR	336.5	4.6%
Biosolids/wood chips	633.7	7.7%
Yard wastes/Gelatin residuals	195.4	2.0%
Biosolids/wood shavings	1,397.8	13.3%
Biosolids/wood chips	287.30	1.8%

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Phosphorus per Cubic Yard

Feedstocks	P2O5 lbs/cy	WEP lbs P205/cy	
leaf/yard wastes	1.4	0.16	
leaf/yard wastes	2.4	0.12	
leaf/yard wastes/food	2.6	0.19	
leaf/yard wastes/food	3.0	0.21	
Biosolids/wood chips	3.0	0.60	
Biosolids/wood chips/Yard wastes	5.5	0.66	
Biosolids/wood chips	5.4	1.21	
Biosolids/Yard wastes/WTR	7.3	0.37	
Biosolids/wood chips	7.3	0.57	
leaf/yard wastes/Gelatin residuals	10.7	0.23	
Biosolids/wood shavings	9.5	1.38	
Biosolids/wood chips	13.9	0.25	

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Phosphorus per lb. OM

	P2O5	WEP	
Feedstocks	**lbs/100 lb OM**	**lbs P205/1,000 lb OM**	
leaf/yard wastes	0.8	0.64	
leaf/yard wastes	1.3	0.86	
leaf/yard wastes/food	1.2	0.87	
leaf/yard wastes/food	1.5	1.05	
Biosolids/wood chips	0.9	1.83	
Biosolids/wood chips/Yard wastes	1.3	1.53	
Biosolids/wood chips	2.0	4.35	
Biosolids/Yard wastes/WTR	3.2	1.31	
Biosolids/wood chips	2.3	1.79	
leaf/yard wastes/Gelatin residuals	6.3	1.26	
Biosolids/wood shavings	3.2	4.26	
Biosolids/wood chips	5.5	0.98	

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WEP; Fe, Al, and Ca Relationships

	WEP	Al	Fe	Al+ Fe	Ca
Feedstocks	**% of total P**	**ppm dw**	**ppm dw**	**ppm dw**	**ppm dw**
Biosolids/wood chips	1.8%	21,864	10,564	32,428	19,500
leaf/yard wastes/Gelatin residuals	2.0%	5,119	8,835	13,954	114,000
Biosolids/Yard wastes/WTR	4.6%	17,090	9,245	26,335	18,600
leaf/yard wastes/food	6.8%	7,614	13,983	21,597	14,400
leaf/yard wastes	7.0%	7,883	10,026	19,083	11,200
leaf/yard wastes/food	7.4%	5,533	7,966	13,499	14,000
Biosolids/wood chips	7.7%	2,489	8,152	10,641	17,000
leaf/yard wastes	8.4%	5,037	8,503	13,540	18,600
Biosolids/wood chips/Yard wastes	12.2%	5,550	10,245	15,795	9,700
Biosolids/wood shavings	13.3%	3,835	10,494	14,328	7,900
Biosolids/wood chips	20.5%	3,101	13,600	16,701	3,500
Biosolids/wood chips	22.3%	1,955	4,894	6,849	13,500

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Biosolids Treatment Effects

Feedstocks	Biosolids treatment	total P ppm dw	WEP ppm dw	WEP % of total P
Biosolids/wood chips	No P removal	3,424	703	20.5%
Biosolids/wood chips/Yard wastes	No P removal	3,537	431	12.2%
Biosolids/wood chips	No P removal	6,991	1,559	22.3%
Biosolids/wood chips	AD/No P removal	8,183	634	7.7%
Biosolids/wood shavings	Biological P removal	10,524	1,398	13.3%
Biosolids/wood chips	Chemical P removal	15,939	287	1.8%

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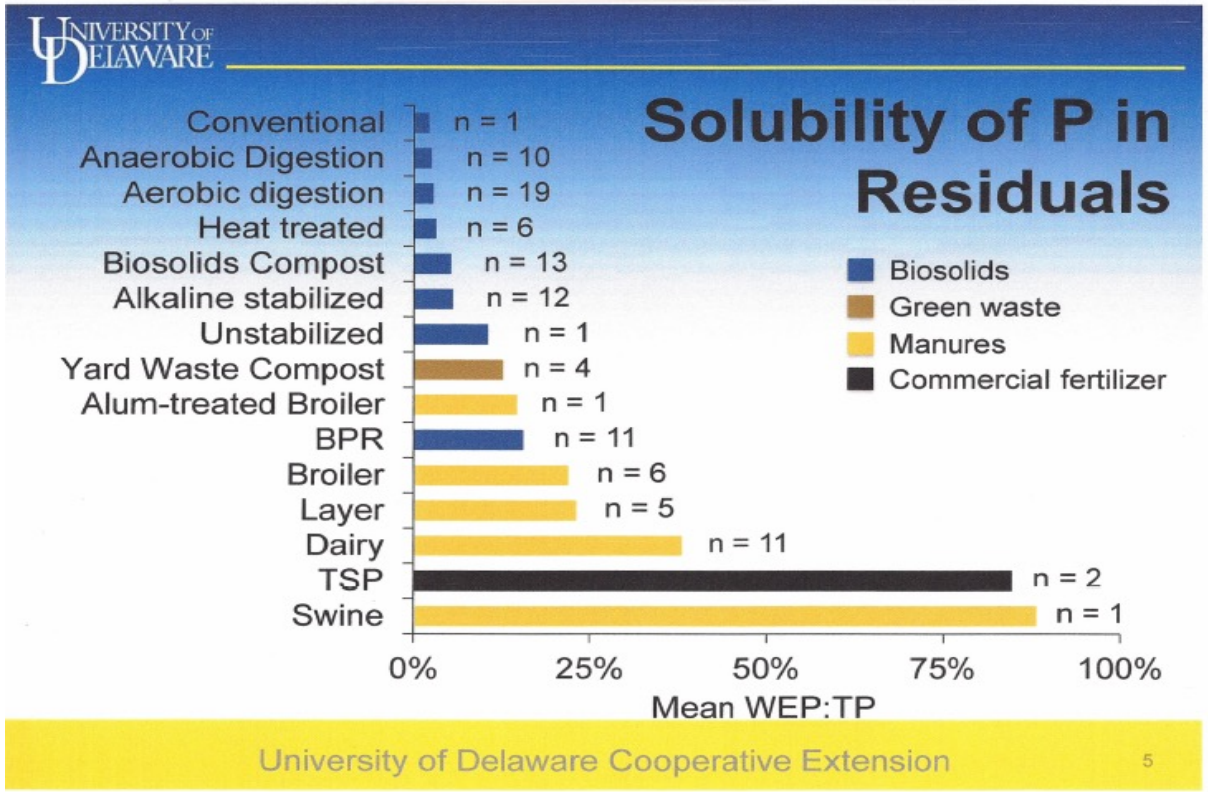
Comparison with other materials

Amy Shober Univ. of Delaware



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How do Composts compare with "Fertilizers"?

It depends on the test methods that are used

- When WEP is tested, fertilizers (e.g. TSP) have high % WEP (about 85%) in comparison with composts (2 to 20%).
- When composts were tested using methods used to determine plant available Phosphorus in fertilizers (Neutral Sodium Citrate extraction) 100 % of the total Phosphorus in the compost was extracted.

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Is the Phosphorus in Compost Plant Available?

- 100 % of WEP is potentially plant available
- Availability will depend upon reactions in soil i.e. binding with Fe, Al, Ca and soil pH
- When compost is tested with methods to determine plant available P in soil (i.e. Mehlich-3) results show 5% to 44 % of total P is extracted

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Soil Testing Guidance

- Soil testing methods are used to address plant availability; e.g. response to added Phosphorus
- Soil tests are, by themselves, poor predictors of how much Phosphorus will be lost through either leaching or run-off
- Phosphorus Saturation Index (PSI) is a better predictor of leaching of Phosphorus from soil than conventional soil tests

$$PSI = P_{(mol)} / Fe_{(mol)} + Al_{(mol)}$$

Oxalate or Mehlich-3 extraction

- If PSI is low enough (<0.1) soluble P maybe absorbed and retained
- Addition of Water Treatment Residuals high in Al and Fe can reduce PSI and reduce leaching of P
- PSI however may <u>not</u> be applicable to P bound with Ca or calcareous soils

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What are risks to water?

Studies with composts are limited

- Composts can reduce P lost in runoff through changes to soil properties that result in increased infiltration (Spargo et al. 2006. *J. Environ. Qual.* 35:2342–2351.)
- Application of dairy manure composts to turf show no increased loss of P (Johnson et al. 2006. *Soil Sci. Soc. Am. J*. 70:2114-2121) from run-off and no increased P in soil below root zone (compared to no compost).
- Study with dairy, swine composts (Easton and Petrovic 2004. *J. Environ. Qual*. 33:645–655). Most leaching and runoff in 1st year; highest with composts. No significant difference in P leaching in 2nd year (compared with fertilizers).
- Bare soil results in greatest losses of P (primarily through run-off)

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What are risks to water?

- Maintaining dense vegetative growth reduces loss of nutrients due to runoff

- Rapid establishment of vegetative cover prevents loss of nutrients
- Using compost to reduce compaction and improve infiltration reduces soil and nutrient losses from runoff
- Leaching losses will depend on type of compost and soil characteristics

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Summary Guidance

- Compost amendments are effective in improving soil properties which reduce runoff, loss of soil, and P in runoff
- Compost should be used to raise levels of soil organic matter (SOM)
- Composts will increase levels of soil P and thus the potential for leaching of P particularly in sandy soils
- Leaching is highly dependent on soil chemistry and measurements of WEP and Phosphorus Saturation Index and should be used to evaluate risk (not total P in compost)
- Repeated applications of compost to provide nutrients may not be justified where P losses are of concern

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Summary Guidance

0		Soil Test Results for Phophorus	
% Soil Organic Matter		Below Optimum -	Above Optimum +
Low	-	Use compost to reach adequate Organic Matter Reduce fertilizer based on compost nutrient levels	Consider site risk factors use Low P composts Eliminate fertilizer
Adequate	+	Stop compost applications Use fertilizers based on soil test	Stop compost applications Eliminate fertilizer

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Thank you to:

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