SOURCE EFFECTS ON PHOSPHORUS AVAILABILITY

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Potential Phosphorus Source Differences

- P availability to plants
- Effects on soil test P
- Effects on long-term productivity
- Effects on soil characteristics
- Effects on P losses in runoff

Manures as P Sources

All manures are not the same -

- Animal species & management
- Water soluble P content
- Mineralization rates of organic P component
- Constituents that may react with inorganic P

P Source Differences
(Plant availability of P)

- Goss & Stewart (1979)
  - Compared manure and superphosphate as P sources for alfalfa
  - Alfalfa grown with fertilizer P removed higher % of added P than with manure

P Source Differences
(Plant availability of P)

- Goss & Stewart (1979)
  - Alfalfa grown with manure P had greater yield increase/unit P uptake (efficiency).
  - Greenhouse yields higher with fertilizer, no yield difference in field experiments

Evidence for enhanced P availability with manure vs. fertilizer P

- During & Weeda (1973)
  - Manure at equiv. rates with P fert. decreased P sorption and increased recovery in pastures
- Abbott & Tucker (1973)
  - Residual effects of manure or fert. P in calcareous soils showed higher available P with manure
- Laboski & Lamb (2003)
  - Liquid swine manure P more available than fert. in 1 to 9 month incubation

Manure P Source Differences (Marshall & Laboski, 2004)

- Manure P effects on soil test P:
  - Dairy manure P less than fert. P
  - Swine manure P greater than fert. P
- Possible mechanisms:
  - Dairy manure constituents react with soil Fe & Al to increase P sorption
  - Swine manure constituents block retention sites in soil or displace sorbed P

Effect of manures and inorganic P on soil test P after 64-wk incubation

P Source	Manure P content (%)		Bray P1 (ppm)
	Total P	Water sol.	
Manure - high P diet	1.31	0.37	59b
Manure - medium P diet	1.09	0.21	55bc
Manure - low P diet	0.66	0.13	46d
Fiber fraction	0.28	0.03	34e
Whole manure	0.85	0.25	58b
Biosolids	3.97	0.22	52c
Fertilizer - $CaHPO_4$	--	--	70a
Control (no P added)	--	--	22

Ebeling et al. (2003). Soil test P values are averages from 3 P rates 90, 180, 360 lb/acre

P Source Differences
(Effects on long-term productivity)

- Edmeades (2003)
  - Manure & fertilizer effects on soil productivity & quality
  - 14 trials, 24 paired comparisons, long-term effects (20-120 years)
  - Includes classic experiments: Morrow, Sanborn, Magruder, Breton, Broadbalk (Rothamsted), others

Manure and fertilizer effects on soil productivity and quality (Edmeads, 2003)

	Effect	
Characteristic	Manure	Fertilizer
Organic matter	higher	
Soil microfauna	higher	
Topsoil P,K,Ca,Mg	higher	
Subsoil nitrate, Ca, Mg	higher	
Crop production	NS	NS
Soil quality	?	?
Runoff and leaching of P and N	higher	
Bulk density		higher
Hydraulic conductivity	higher	
Aggregate stability	higher	

Long-term P Additions and Forms of P in Soil

- Motavalli and Miles (2002)
  - Examined long-term (111-yr) effects of manure & fertilizer on soil P fractions in Sanborn Field
  - Continuous corn yields were consistently higher with fertilizer that with manure
  - Extraction methods identified differences in functional soil P pools

Long-term P source effects on inorganic P fractions from Sanborn Field continuous corn plots

Treatment	Avail-able	Labile	Slow	Occl-uded	Weather-able
	---------- ppm P ----------				
None	3	18	19	14	1
Fertilizer	54	55	76	39	25
Manure	56	181	149	41	23
Prairie	4	7	22	10	7

Adapted from Motavalli and Miles (2002)

P Source Differences
(Effects on P runoff losses)

- Kleinman et al. (2002)
  - Compared surface and incorporated DAP and manures, 90 lb P/acre
  - Simulated rainfall, runoff boxes, 3 soils

Runoff P from surface and incorporated P sources on a high P soil

	Surface-applied		Incorporated
Treatment	DRP	Total P	Total P
	---------- ppm ----------		
Control	0.2a	4a	5a
DAP	13b	20b	5a
Dairy manure	2c	3.5a	9b
Poultry manure	11b	21b	7ab
Swine manure	14b	16b	7ab

Adapted from Kleinman et al. (2002). Soil = Hagerstown.

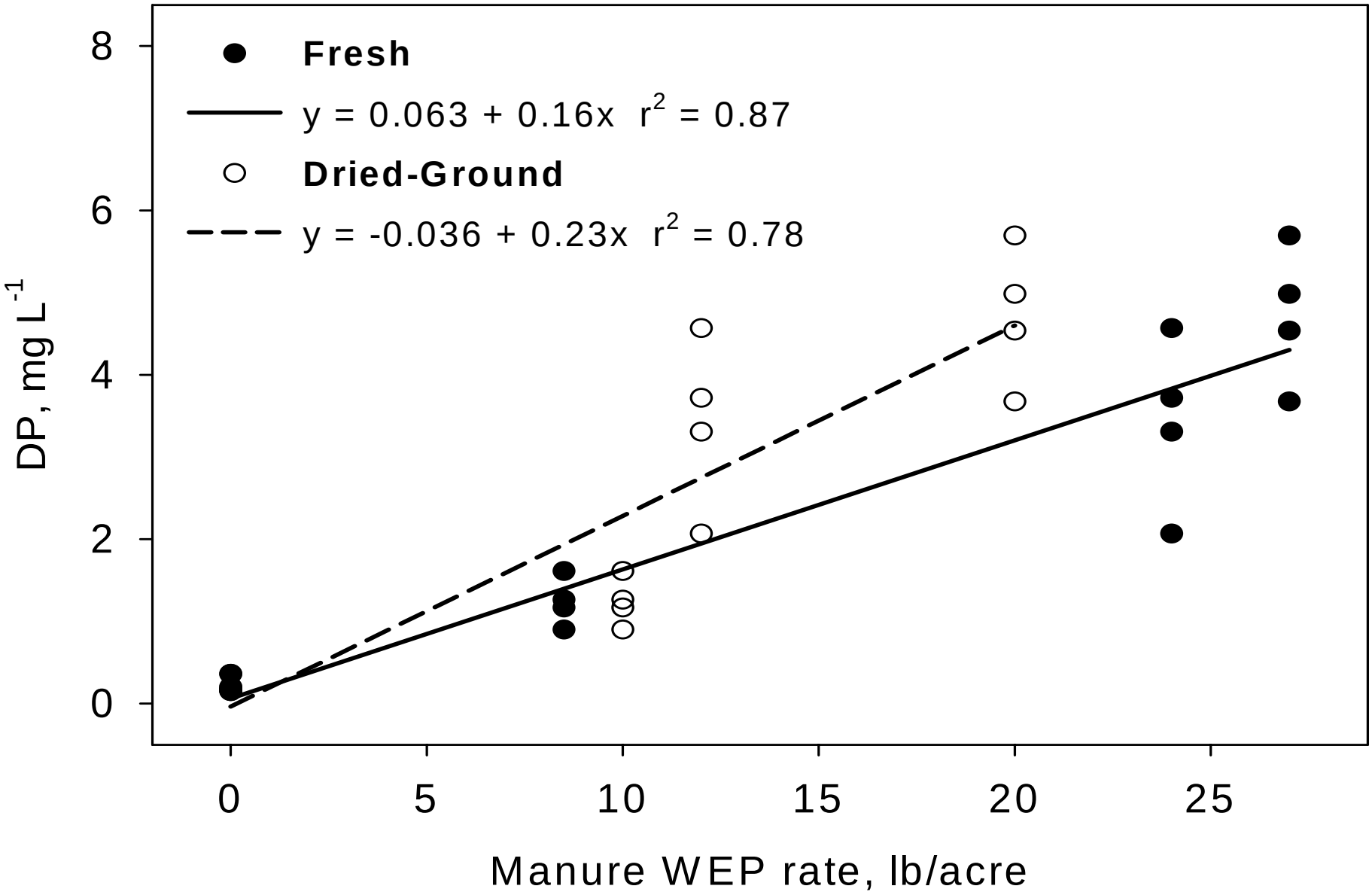
Manure type effects on P losses

Arlington, WI 2004

Manure	Avail. P_2O_5	Run-off	Total P	
			Conc.	Load
	lb/a	mm	ppm	g/ha
Control	0	9 b	1.36b	130b
Chicken 2.7 t/a	60	7 b	2.60b	188b
Dairy, semi-solid, 31.1 t/a	60	20 ab	8.51a	2086a
Dairy, slurry, 17,340 gal./a	60	35 a	6.88a	2463a

Andraski and Bundy, unpublished (2004).

Relationship between manure WEP rate and DP in runoff for fresh and dried/ground manure samples (dairy semi-solid, dairy slurry, and poultry) applied at 100 lb P_2O_5/acre at Arlington, 2004.



Summary

- P availability from manures can be greater or less than fertilizer P
- Manure P availability is influenced by:
  - Organic P mineralization
  - Initial microbial immobilization
  - Reaction of manure constituents with soil or P
  - Manure soluble P content

Summary

- Manure vs. fertilizer P effects on long-term productivity indicate no clear advantage to manure
- Soil quality parameters and potential for nutrient loss may be increased with long-term manure applications

Summary

- Long-term manure and fertilizer applications influence organic and inorganic P fractions
- Differences in runoff losses between manure and fertilizer are often due to placement method and the dry matter and soluble P content of manures