Vol. 9 No. 1 January 2004

Michigan Dairy Review

http://www.mdr.msu.edu

Recycling Nutrients for Crops

Carrie Laboski
Dept. of Crop and Soil Sciences

Manure is good stuff! Manure contains nitrogen (N), phosphorus (P), potassium (K), sulfur (S), and micronutrients. Manure applications over time improve soil quality (e.g., nutrient supplying capacity and soil tilth). Taking credit for manure nutrients may reduce your fertilizer bill. Also, proper crediting of manure nutrients will reduce the potential environmental impacts of excess nutrients on water quality.

Manure can adequately supply nutrients to crops. Thus, there should be no concern that crops will be under-fertilized if all or most of their nutrients come from manure. Let's focus on how to take manure nutrient credits and examples of manure's equivalence to fertilizer.

The first step to taking manure nutrient credits is to obtain representative manure samples as the manure is going to the field. These samples should be sent to a laboratory and analyzed. The analyzed nutrient concentrations on the laboratory report, in addition to information from your records such as application rate and method, are needed to take credit for manure nutrients.

Nitrogen Key Element for Crop Production

Nitrogen is a key element necessary for crop production found in manure. The total N in manure is made up of ammonium-N (NH_4-N, an inorganic form) and organic N (N associated with carbon). Nitrogen from manure is not 100% available to crops because a portion of it is in an organic form that is not immediately available, and NH_4-N is subject to losses through volatilization. Laboratory reports of N from manures may vary. Some may report only total N, while other reports may give total N and NH_4-N. It is best to get both total N and NH_4-N concentrations.

Ammonium-N is immediately available to crops. However, NH_4-N may be lost to the atmosphere depending upon application method and incorporation into soil. Thus, the concentration of NH_4-N on the laboratory report must be adjusted based on method of application and incorporation. Table 1 (page 2) shows the amount of NH_4-N retained. For example, if you broadcast your manure and incorporate it two days later, 40% of the NH_4-N would be retained and 60% will

Pages 26-27: Presenting early 2004 educational programs of the MSU Extension Dairy Team.

MICHIGAN STATE UNIVERSITY

MSU Extension Dairy Agents

Ben Bartlett **906-439-5880**
(bartlett@msue.msu.edu)
The Upper Peninsula

Dann Bolinger **989-224-5240**
(bolinged@msue.msu.edu)
Clinton, Gratiot, Shiawassee

Phil Durst **989-826-1160**
(durstp@msue.msu.edu)
NE-MI-(North & East of US-127 & I-75)

Ira Krupp **616-846-8250**
(krupp@msue.msu.edu)
Muskegon, Montcalm, Newago, Oceana, Ottawa

Kathy Lee **231-839-4667**
(leek@msue.msu.edu)
NW-MI- (Osceola, Lake, Mason, Mecosta, North & West of US-127 & I-75)

Mike McFadden **989-772-0911 E-302**
(mcfadden@msue.msu.edu)
Isabella, Clare, Gladwin, Midland, Saginaw

Roxanne Pillars **517-439-9301**
(pillarsr@msue.msu.edu)
Branch, Hillsdale, Jackson, St. Joseph

Bill Robb **269-673-0370**
(robb@msue.msu.edu)
Allegan, Berrien, Cass, Kent, Kalamazoo, Van Buren

Dean Ross **517-546-3950**
(rossd@msue.msu.edu)
Genesee, Ingham, Monroe, Macomb, Livingston, Oakland, Lenawee, Washtenaw, Wayne

Phil Taylor **517-543-2310**
(taylorp@msue.msu.edu)
Barry, Calhoun, Eaton, Ionia

Craig Thomas **810-648-2515**
(thomasc@msue.msu.edu)
Sanilac, Huron, Lapeer, St. Clair, Tuscola

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Table 1. Ammonium-N (NH_4-N) retention and loss factors after broadcast to incorporation.

Days to Incorporation	NH_4-N Retained	NH_4-N Lost
Injection	100%	0%
0-1 day	70%	30%
2-3 days	40%	60%
4-7 days	20%	80%
>7 days	10%	90%

Source: Midwest Plan Service (2).

Table 2. Manure application methods impact corn yields (4).

Treatment	Corn yield* (bushels/acre)
Control - no manure	99[a]
Broadcast - incorporation after 7 days	113[b]
Vertical knife injection	120[c]
Horizontal sweep injections	126[c]

*Yields with different letters are significantly different from one another.

be lost. So, you multiply the NH_4-N concentration from your laboratory report by 0.40 to get the NH_4-N credit. Table 2 provides an example of how various spring pre-plant manure application methods impacted corn yield (4). In this study, manure was either from dairy or swine. Researchers found that the differences among treatments were a result of different amounts of available N in the soil as measured by a soil test. Injection of manures into soil resulted in greater yields because more NH_4-N was retained compared with broadcast applications.

Organic-N in manure is slowly available to crops over a 4-year period. The amount of organic-N that becomes available to crops (by mineralization) during the growing season varies with carbon-to-nitrogen ratio, soil moisture, and soil temperature among other things. Available N from organic-N is determined by multiplying the organic-N content by the mineralization factor given in Table 3. For example, if you have solid dairy manure containing bedding, the mineralization factor is 0.25. The amount of organic-N on your laboratory report would be multiplied by 0.25 to arrive at the amount of N that will become available to crops from manure during the first growing season after application. Residual organic-N from manure will supply N to crops during the 2nd, 3rd, and 4th years after initial application. These mineralization factors are 50 %, 25 %, and 12.5 %, of that mineralized during the first year for 2nd, 3rd, and 4th years after initial application, respectively.

Total available N is the sum of available NH_4-N plus available organic-N (current year) plus available organic-N (previous years). Table 4 provides an example comparison of 4 tons/acre of dairy manure applied at planting to N fertilizer applied at planting (1). Actual values will differ depending upon the type of manure (e.g., liquid, with bedding, etc.) and the actual laboratory analysis. In all 3 years of this study, dairy manure treatments resulted in yields that were equivalent to fertilizer applied at rates of 100 to 150 lb N/acre .

Table 3. Organic-N mineralization factors.

Species	Manure Type	Mineralization Factor
Dairy	Solid without bedding	0.35
	Solid with bedding	0.25
	Anaerobic liquid	0.30
	Aerobic liquid	0.25
Beef	Solid without bedding	0.35
	Solid with bedding	0.25
	Anaerobic liquid	0.30
	Aerobic liquid	0.25
Swine	Fresh	0.50
	Anaerobic liquid	0.35
	Aerobic liquid	0.30
Poultry	Deep pit	0.60
	Solid with litter	0.60
	Solid without litter	0.60
Sheep	Solid	0.25
Horse	Solid with bedding	0.20

Source: Midwest Plan Service (2).

Phosphorus Recommendations

When soils test above 60 lb P/acre for corn and soybeans or 80 lb P/acre for wheat and alfalfa, there is no agronomic need for P fertilizer. The fertilizer recommendations when soil tests are over 60 to 80 lb P/acre will be small to nil. On these soils, P from manure is considered to be 100% available. If the soil tests less than 60 lb P/acre, then using an availability factor of 80% will insure adequate P is supplied for crop growth – this is the **Laboski Rule of Thumb**. Remember though, this will tend to increase the soil test levels of P. In a Wisconsin study, dairy manure or fertilizer was applied in spring at approximately the same amounts of total P and total N (3). Table 5 shows the results of this study, which was done over

Table 4. Manure supplies crop N needs for corn grain production equal to fertilizer.

	Corn yield*(bushels/acre)		
Treatment	1986	1987	1988
0 lb N/ acre	59[a]	45[a]	45[a]
50 lb N/ acre	107[b]	97[b]	75[b]
100 lb N/ acre	119[c]	108[c]	92[c]
150 lb N/ acre	113[c]	113[c]	100[c]
Dairy manure 4 T/acre	110[bc]	103[c]	100[c]

* Yields within a year (column) with different superscript letters are significantly different from one another.

Table 5. Manure supplies crop P needs for corn grain production in Wisconsin equal to fertilizer.

	Corn yield (bushels/acre)					
Treatment	Fall River		Sun Prairie		Baraboo	
	1982	1983	1982	1983	1982	1983
Fertilizer	110	132	119	110	103	110
Manure	113	130	103	108	103	107

2 years at three locations each year. There were no differences in yield when all of the P was supplied by manure compared with fertilizer. Note that soil test P levels were above optimum at Fall River and Sun Prairie and were optimum at Baraboo.

Potassium from manure is 100 % available to crops. Use the K concentrations directly from your manure analysis to determine how much K was applied to each field.

Use Computer Programs to Take Nutrient Credits

Taking nutrient credits can be time consuming, particularly for N. However, there are computer programs that can help you with this. One is Michigan State University's MSUNM Nutrient Management Program and another is Purdue University's Manure Management Planner. Contact your county extension agent if you are interested in obtaining one of these programs or visit Michigan Agriculture Environmental Assurance Program on the web at http://www.maeap.org/resources.htm. These programs will make the necessary calculations to determine nutrient credits based on information you provide regarding manure analyses and manure application practices.

They are a worthy investment for the amount of money that a farm could potentially save on its fertilizer bill by properly using and taking credit for manure N and P.

Summary

Manure can supply crop nutrient needs. Taking these credits for N, P and K will improve the environmental and economic sustainability of your farm.

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