Manure as a Nutrient Resource

Introduction

Manure is rich in nutrients, including trace elements necessary for crop growth. Approximately 70-80% of nitrogen (N), 60-85% of phosphorus (P), and 80-90% of potassium (K) found in feeds is excreted in the manure. These nutrients can replace fertilizer needed for pasture or crop growth, eliminating the need to purchase fertilizers. Plants do not distinguish between sources of nutrients. However, compared to commercial fertilizer, manure contains organic carbon which is the key to maintaining soil health, including the characteristics of cation exchange capacity, soil tilth, and water holding capacity.

The nutrient value of manure depends on many factors. These include animal species, feed ration, the amount of bedding and water added or lost, the method of manure collection and storage, and the method of land application. The availability of nutrients and efficiency of utilization of these nutrients by a crop is also influenced determined by soil and climate conditions. These conditions affect the microbial activity responsible for decomposition of manure and other sources of organic matter within the soil.

The total available manure N for plant growth is derived from 3 sources:

- **ammonium N from current application**
- **mineralized stable N from current application**
- **mineralized organic N from past applications**

Manure Nitrogen Credits and Availability

Manure contains unstable (inorganic) and stable (organic) forms of nitrogen. The inorganic N is initially present in urine and as urea in animal manure. It may account for up to 50% (70% in poultry) of the total N. Urea converts rapidly to ammonium then to ammonia gas as *p*H increases and manure begins to dry. If not lost, the ammonium from urea in manure is readily available for plant growth. However, ammonia is extremely volatile resulting in N loss. Nearly all the ammonium N can be lost from surface applied manure if it is not incorporated within a few hours.

Application Method	Ammonia-N Loss (%)
Injection	0
Surface application	100
Incorporated within 1 day	20
Incorporated within 2 day	50
Incorporated within 3 day	60
Incorporated within 4 day	70
Incorporated within 5 day	80

Liquid dairy manure contains, on average, 10-12 pounds of ammonium N per 1,000 gallons. Therefore, incorporation of 8,000 gallons of manure per acre on the same day can save up to 70 lbs of N fertilizer compared to surface application with no incorporation.

The stable organic N that occurs in the feces will be gradually released into the soil, providing a steady supply of nutrients which will be available to the crop throughout the growing season. Approximately 40-50% of the stable organic N in dairy manure will be available the first year, 12-15% the following year, 5% in the third year, and 2% in each subsequent year. The total available manure N for plant growth comes from 3 sources: Available N = (ammonium N from current application) + (mineralized stable N from current application) + (mineralized organic N from past applications).

Manure Phosphorus and Potassium Credits and Availability

Manure is an excellent source of P and K. When manure is applied at a rate to meet the N need of a crop, the P and K will likely be in excess of the crop requirement. Essentially all of the K is available for plant growth the year manure is applied. However, some of the P may be in the form of insoluble inorganic compounds or as organic P. Like stable organic N these compounds must be mineralized before they become available. Conserving N in manure increases the P efficiency for crop growth by reducing the total application of manure and therefore reducing excess P that can become a water pollutant.

The following table demonstrates the average manure nutrient content of varying stages of the dairy herd. Nutrient content of manure varies widely, so it is advisable to have a manure and soil sample tested before application to a field in order to determine specific nutrient needs for crop growth.

Animal Type	% Dry Matter	Analysis Unit	N	P_2O_5	K_2O
Dairy cattle					
milking cows, liq.	<5	lb/1000 gal	28	13	25
milking cows, sol.	12	lb/ton	10	4	8
Dry cow		lb/ton	9	3	7
Calf and heifer		lb/ton	7	2	7
Veal	4	lb/1000 gal	36	27	55

Adapted from the Penn State Agronomy Guide.

Application Considerations

Timing and method of manure application determine the efficiency of nutrient recycling. Also, manure must be spread uniformly to achieve consistent results. Proper calibration of a manure spreader will help insure the correct rate and uniform application. Applying and incorporating manure too early for the crop, in the fall or early winter, or in overly saturated soils could result in significant N leaching and groundwater contamination. Likewise, surface runoff and soil erosion must be controlled to protect surface waters. A cover crop, such as winter rye, planted early (late August to early September) can be effective in reducing nitrogen leaching through plant uptake, and can help with controlling surface erosion.

Resources

Cornell University Cooperative Extension. 2009. Cornell Guide for Integrated Field Crop Management. www.fieldcrops.org .

Manure Analysis Form for the University of Maine Analytical Lab: http://anlab.umesci.maine.edu/soillab_files/forms/Manure.pdf.

Pennsylvania State University. The Agronomy Guide 2011-2012. http://agguide.agronomy.psu.edu/.

For more information visit www.umass.edu/cdl

Factsheets in this series were prepared by, Masoud Hashemi, Stephen Herbert, Carrie Chickering-Sears, Sarah Weis, Carlos Gradil, Steve Purdy, Mark Huyler, and Randy Prostak, in collaboration with Jacqui Carlevale.

This publication has been funded in part by the Massachusetts Department of Agricultural Resources and the Massachusetts Farm Bureau Federation, Inc.