

Plant Nutrients from Manure

Introduction:

Manure is rich in nutrients, including trace elements necessary for crop growth. Approximately 70-80% of the nitrogen (N), 60-85% of the phosphorus (P), and 80-90% of the potassium (K) in feeds are 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 including 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 by a crop is also influenced determined by soil and climate conditions which affect microbial activity responsible for decomposition of manure and other sources of organic matter in the soil.

Manure Nitrogen Credits and Availability:

Manure contains unstable (inorganic) and stable (organic) forms of nitrogen. The inorganic N is initially present in urine as urea in animal manure, and may account for about 50% (70% in poultry) of the total N. Urea converts rapidly to ammonium then to ammonia gas as pH 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.

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**

| 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 more stable organic N that occurs in the feces will be gradually released into the soil, providing a steady supply of nutrients 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 thus 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, and like stable organic N they must be mineralized before it becomes available. Conserving N in manure increases the P efficiency for crop growth by reducing total application of manure and therefore reducing excess P that can become a water pollutant.

The following table demonstrates the average nutrient content of several animal manures. However, nutrient content of manure varies widely thus it is advisable to have a manure and soil sample tested before application to a field in order to determine nutrient needs for crop growth.

| Animal Type | % Dry Matter | Analysis Unit | N | P ₂ O ₅ | K ₂ O |
|--------------------|--------------|---------------|----|-------------------------------|------------------|
| 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 |
| Beef cattle | | | | | |
| Cow and calf | 12 | lb/ton | 11 | 7 | 10 |
| Steer | 8 | lb/ton | 14 | 5 | 8 |
| Swine | | | | | |
| Gestation | 4 | lb/1000 gal | 30 | 35 | 15 |
| Lactation | 2 | lb/1000 gal | 25 | 20 | 15 |
| Nursery | 6 | lb/1000 gal | 40 | 40 | 25 |
| Grow-finish | 7 | lb/1000 gal | 50 | 55 | 25 |
| Farrow to feeder | 4 | lb/1000 gal | 40 | 35 | 15 |
| Sheep | 25 | lb/ton | 23 | 8 | 20 |
| Horse | 20 | lb/ton | 12 | 5 | 9 |

Adapted from the Penn State Agronomy Guide.

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 correct rate and uniform application. Applying and incorporating manure too early for the crop, as in the fall or early winter, or saturated soils in high rainfall areas, 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 in 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 2009-2010. 2009. <<http://agguide.agronomy.psu.edu/>>.

UMass Extension, Crops Dairy, Livestock Equine Publications. "Manure Inventory". Factsheet 08-20. <<http://www.umass.edu/cdl/BMPs/Manure%20Inventory%2008-20.pdf>>.

UMass Extension, Crops Dairy, Livestock Equine Publications. "Manure Spreader Calibration." Factsheet 08-27. <<http://www.umass.edu/cdl/BMPs/Manure%20Spreader%20Calibration%2008-27.pdf>>.

For more information visit www.umass.edu/cdl Factsheets in this series were prepared by Stephen Herbert, Masoud Hashemi, Carrie Chickering-Sears, and Sarah Weis in collaboration with Ken Miller, Jacqui Carlevalle, Katie Campbell-Nelson, and Zack Zenk.

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