



Manure Part I. What is it?

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Introduction:

Livestock operations are increasing in size and impact in the Southern Minnesota sugar beet growing area. Many sugar beet producers own or have interest in these operations; thus have manure available to use on their fields. Manure research data concludes that manure has a positive effect on crop production from its effects on soil nutrient availability and soil physical properties. A concern has been raised about the effect of late season nitrogen mineralized from the manure on sugar beet quality. Grower observations indicate better growth in fields where manure has been applied. With the large amount of manure available the question has changed from whether to use manure to when in the sugar beet crop rotation should manure be applied to minimize quality concerns and realize benefits. The answer to this question may depend on the type of manure.

What is manure?

Manure is a very good nutrient source. It can consist of N, P, K, S, and many of the micro nutrients. Along with the nutrients, manure has organic materials that can improve the soil physical properties such as increased organic matter, water holding capacity, and water infiltration. The nutrient content availability can range from very available to plants to very slowly available. The amount of each nutrient availability depends on several factors: Animal source, age of animal, feed content fed to animal, storage system, and application method. This is particularly true for N.

Nitrogen in manure can be in organic N and inorganic N forms. Depending on the animal and the management system, manure can have a large amount of N in the organic form that is not directly available to the plant. An example of this is poultry manure. It is mixed with litter that will cause the N to be converted to organic N. This N fraction will have to go through mineralization, ie. the conversion from organic N to an inorganic form such as ammonium ($\text{NH}_4\text{-N}$). The inorganic forms, nitrate-N and ammonium-N can be used by the plant. Solid beef, solid dairy manure, and poultry litter can have a significant amount of N in the organic form. Liquid swine manure and the liquid portion of separated dairy manure are known to have a much larger amount of inorganic N.

What are the forms of N in manure how do they react in soil?

Organic N*

When manure is applied to soil, the organic N begins to convert to inorganic N, which is available to plants. This process is termed mineralization. Mineralization involves the action of soil microbes. Because of the microbes, the speed of the conversion is affected by temperature and moisture, as well as time. Warm, moist soils will have more organic N converted to plant available N with time than cool, dry soils. Between 25-50% of the organic N will be converted to ammonium-N each year after the manure is applied. This value is affected greatly by the method of application and temperatures during the year.

The residual effects of manure's organic N can last for several years. Second and third year contributions from the manure's organic N are significant. Assuming 50% of the organic N will become available each year and if a specific manure sample contains 50% organic N, the second year's N credit should be about 12% of the total N and the third year's N credit should be 6%.

Long-term residual effects from high rates of manure application can provide significant amounts of inorganic N for a very long time. A long-term study at the University of Minnesota's West Central Research and Outreach Center exemplified this. Plots were still reaching their top yields 12 years after manure applications ended from residual nutrients from the manure. While large amounts of manure applied in a short time frame might have agronomic value many years later, the environmental hazards associated with these applications must be addressed.

Inorganic N *

Besides the organic N fraction of manure, the other major portion of manure N is inorganic-N. The original conversion of organic-N to inorganic-N results in ammonium-N. Organic N converts to ammonium-N in the soil, which is now available to plants. Ammonium-N is relatively immobile in the soil and is not subject to loss. Ammonium-N can then be converted to nitrate-N through a process called nitrification. Eventually all ammonium-N can be converted nitrate-N. While nitrate-N is also available to plants, it is also susceptible to denitrification on fine-textured soils and to leaching on medium- or coarse-textured soils.

One other important N loss mechanism is volatilization. When manure is exposed to the atmosphere, the ammonium-N can chemically convert to ammonia-N and be lost. The loss is mainly a function of time. Incorporation, or injection, of manure into the soil minimizes this concern.

* These sections taken from "Manure Management in Minnesota" J.A. Hernandez and M.A. Schmitt Univ. Minn. Ext. Bull WW-03553 revised 2012.

<http://www.extension.umn.edu/agriculture/manure-management-and-air-quality/manure-application/manure-management-in-minnesota/>