Cornell University
Cooperative Extension

Agronomy Fact Sheet Series Fact Sheet #120

Sulfur Fertilizer Value of Liquid Dairy Manure

Introduction

Sulfur (S) is an essential nutrient for plant growth, crop yield, and crop quality. Fields that are not able to meet plant S needs are increasingly more common in New York as atmospheric deposition of S has decreased over the past several decades. Currently S deposition is estimated to be 1 to 2 pounds per acre annually, well below crop S uptake for most field crops. Deficiencies are more common in coarse textured soils with low organic matter, as these soils have a limited soil S supply (Figure 1). Dairy manure is an excellent source of S in addition to other nutrients and organic matter. This factsheet has information about S content of liquid dairy manure and crediting S from manure for field crops in New York.

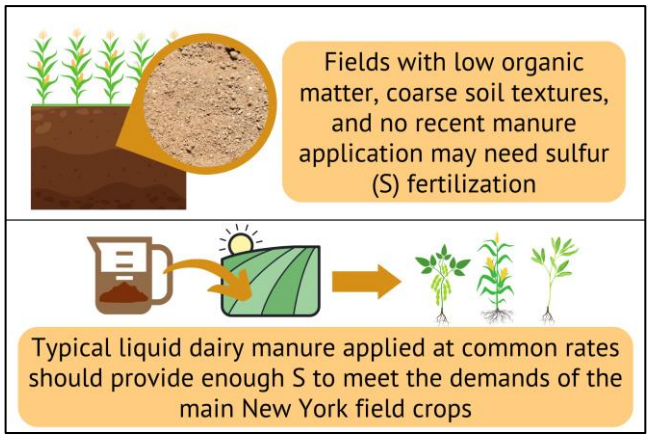

Figure 1. Dairy manure application can supply sulfur (S) to meet the demand of typical New York field crops.

Crop Sulfur Uptake

Sulfur uptake by common New York crops and yields (corn silage, shell corn, alfalfa hay, grass hay, grass haylage, soybeans) are shown in Table 1. Typically, S removal ranges from 6 to 14 pounds S per acre. Soil mineralization and atmospheric S deposition, while reduced compared to several decades ago, still contribute S to growing plants so not all soils will be S deficient for crop growth.

Sulfur in soil is mainly stored in soil organic matter and, in minor amounts, in S-mineral forms. Fields low in soil organic matter with coarse textures (sandy soils), and no recent (within the last two years) manure applications are most likely to show S deficiencies. Those fields should be the priority when making S application decisions.

Table 1. Sulfur (S) removal for typical New York yields in different crops (adapted from Agronomy Fact Sheet 34).

Crop	Sulfur removal	Average yield per acre in NY	Sulfur removal in average yield (pounds per acre)
Corn silage	0.7 lb S/ton of silage	20 ton at 35% DM	14
Shell corn*	0.05 lb S/bu of grain	165 bu at 85% DM	8
Alfalfa hay	4.9 lb S/ton of hay	2.3 ton at 90% DM	11
Alfalfa haylage	1.7 lb S/ton of silage	7.5 ton at 35% DM	13
Grass hay	3.1 lb S/ton of hay	2.3 ton at 90% DM	7
Grass haylage	1.4 lb S/ton of silage	4 ton at 35% DM	6
Soybeans*	0.16 lb S/bu of soybean	50 bu at 87% DM	8
Grass hay	3.1 lb S/ton of hay	2.3 ton at 90% DM	7

*Total plant uptake can be up to twice the amount of S removed by the harvested grain.

Sulfur Content of Manure

Manure contains all the essential plant nutrients, including S. Sulfur in manure can be grouped into four categories: sulfates, sulfides, elemental S, and organic S (Figure 2).

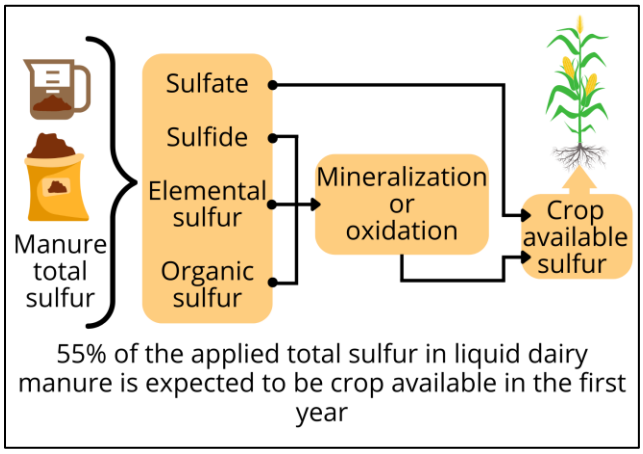

Figure 2: Manure contains sulfur (S) in different forms.

Sulfate is readily available for plant uptake, but sulfides, elemental S, and organic S need to be transformed into sulfate to become available for plant uptake. Animal feeding practices and the way manure is managed once it is excreted by the cow can impact the amount and forms of S in manure. For example, S can be lost to the environment during manure collection, storage, treatment, and land application.

The S content of liquid dairy manure tends to increase with nitrogen (N) content of the manure, but liquid dairy manure typically supplies between 3 and 5 pounds of total S per 1,000 gallons of manure (Table 2).

Table 2. Relation between nitrogen (N) and sulfur (S) content of 224 liquid dairy manure samples in New York.

Nitrogen	Sulfur average	Sulfur average
% as received	% as received	lbs per 1,000 gallons
<0.25	0.03	2.27
>0.25	0.05	3.96

While book values like those shown in Table 2 give a ballpark estimate of S content, manure analysis in a laboratory will be needed to determine the S content of a specific manure source. Most commercial laboratories that conduct manure analyses will include sulfur analyses if requested by their clients. Results can be reported in percent, pounds per 1,000 gallons, or pounds per ton. See Agronomy Fact Sheet #122: Reading and Interpreting Dairy Manure Analyses for more information.

Similar to nitrogen (N), not all S in manure is plant available. Estimates of S availability from dairy manure is typically around 55% for liquid dairy manure and 53% for dairy solids (Wisconsin Extension).

Assuming a manure S content of 4 pounds of S per 1,000 gallons and an estimated S availability of 55%, an application of 5,000 gallons of manure will supply about 11 pounds of S per acre (Box 1). This calculation shows that when manure is applied, S deficiency is highly unlikely.

Box 1. Example of estimation of the amount of plant-available sulfur applied in liquid dairy manure.

- Manure application rate: 5,000 gallons per acres
- Manure sulfur content: 4 pounds per 1,000 gallons
- Plant-available sulfur in manure: 55%

$$\text{Available manure S}\left(\frac{\text{lbs}}{\text{acre}}\right) = \frac{5{,}000\left(\frac{\text{gallons}}{\text{acre}}\right) \times 4\left(\frac{\text{lbs S}}{1{,}000\ \text{gallons}}\right) \times 55\%}{1{,}000} = 11\ \text{lbs S/acre}$$

Sulfur Availability from Manure Over Time

Sulfur in sulfate form is directly plant-available. Thus, a S deficiency in the year of manure application is highly unlikely. However, sulfate is very mobile in the soil, so it is easily leached from the soil profile if not taken up by plants. While some of the manure S applied in year 1 will become plant-available in year 2, carryover into additional years is minimal.

Based on limited carryover of S benefits of manure, sandy soils that are low in soil organic matter and where no manure has been applied in the past two years could become S deficient. Fields that received manure in the past two years at 5,000 gallons or more per acre, are unlikely to benefit from additional S fertilizer.

In Summary

Sulfur is a macronutrient essential for crop growth, yield and quality. Typical S removal by field crops in New York ranges between 6 and 14 pounds of S per acre. Coarse textured (sandy) fields that are low in soil organic matter and that have not received manure in the past two years could be S deficient. However, liquid dairy manure can offset any S fertilizer needs in the year of application and the following year.

Additional Resources:

- NSMP Factsheet #34: Sulfur for Field Crops. 2007. http://nmsp.cals.cornell.edu/publications/factsheets/factsheet34.pdf.
- Schulte, E. and Kelling, K. 2004. Soil and Applied Sulfur, A2525. University of Wisconsin-Extension. http://corn.agronomy.wisc.edu/Management/pdfs/a2525.pdf.

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of discharge levels from agricultural land.

For more information

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Nutrient Management Spear Program
http://nmsp.cals.cornell.edu

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