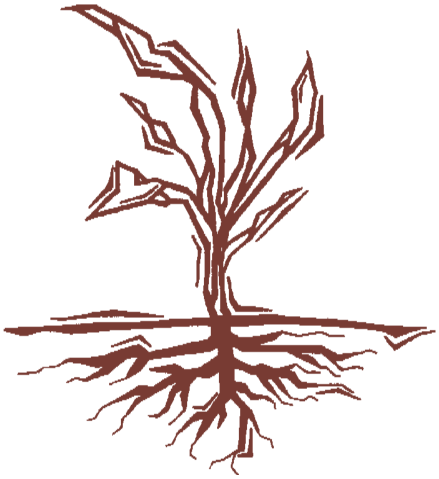

SOIL

Organic Materials as Nitrogen Fertilizers no. 0.546

by K.A. Barbarick[1]

Quick Facts...

Organic materials usually are added to soils to provide such plant nutrients as nitrogen and to improve the physical nature of the soil.

Organic residues that have a low nitrogen content can cause nitrogen deficiencies in plants as microorganisms decompose the organic compounds.

Inorganic nitrogen must be added with some organic fertilizers to prevent nitrogen deficiencies in crops.

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Crop residues and organic wastes commonly are added to soils as sources of plant nutrients and to improve the physical properties of the soil. These materials do not contain the same quantity of nutrients. In fact, incorporating some organic materials into the soil can induce nitrogen deficiencies in plants. The composition of the added material determines whether nitrogen is released for plant growth or tied up in an unavailable form by the microorganisms that decompose the organic fertilizers.

Ratio of Carbon to Nitrogen

An important property of an organic residue that influences the immediate availability of nitrogen is the ratio of carbon to nitrogen (C:N). The addition of an organic fertilizer provides carbon that can serve as an energy source for most soil microorganisms. The residue not only will increase microbial activity but also nitrogen needs of the organisms. The microbes use the carbon to build cells and the nitrogen to synthesize proteins. If the organic residue has a C:N less than about 20:1 (high nitrogen content), then the microorganisms will obtain adequate nitrogen for their needs and will convert the excess organic nitrogen to ammonium (NH_4^+). This conversion is called mineralization and is summarized in the following equation:

$$\text{organic N (e.g., protein)} \text{ ----> microbial activity ----> } NH_4^+ \quad (1)$$

Ammonium is a form of nitrogen that plants can absorb; organic nitrogen cannot be used by plants. If the organic material has a C:N greater than approximately 20:1 (low nitrogen content), then the microorganisms whose activity increases because of the addition of the carbon will not obtain enough nitrogen from the residue. Consequently, the microbes absorb the plant-available sources of nitrogen in the soil. This process probably would cause a nitrogen deficiency in plants where a high C:N compound had been added to the soil. The loss of plant-available nitrogen is called immobilization, which can be represented by the equation below:

$$NO_3^- \text{ or } NH_4^+ \text{ ----> microbial activity ----> organic N (unavailable nitrogen)} \quad (2)$$

Immobilization could tie up the nitrate (NO_3^-) and ammonium (NH_4^+) for a number of months. After this time, the nitrogen will be released by mineralization of the organic nitrogen found in the residue and microbial tissue.

To prevent a possible nitrogen deficiency when adding residues with a C:N greater than 20:1, nitrogen fertilizer should be added to the organic material or to the soil when the residue is incorporated. The following example illustrates how to calculate the additional fertilizer that is needed to prevent immobilization (see equation 2) of plant-available nitrogen.

Other Considerations

Other important considerations when adding organic compounds to soils are the rates of decomposition and the addition of toxic materials.

- *Sawdust and wood chips decompose much more slowly than crop residues or animal manures.*
- *Some wood materials release toxic compounds upon decomposition.*
- *Biosolids such as sewage sludges could contain toxic metals and organic compounds; therefore, they must be managed carefully when applied to soils.*
- *Animal manures could increase soil salinity and could add large amounts of weed seeds to the soil.*

If managed properly, however, organic waste material can provide a significant source of plant nutrients as well as a means to improve soil tilth and water-holding capacity.

Example

Assume that you have 1 dry ton of sawdust. Sawdust has a very high C:N of 400:1 and contains about 40 percent carbon.

1. Calculate the pounds of carbon in the sawdust:
   2,000 lbs x 0.40 = 800 lbs C.
2. Calculate the pounds of nitrogen in the sawdust:
   800 lbs C x (1 lb N / 400 lbs C) = 2 lbs N.
3. You need a C:N of 20:1 to prevent immobilization. Calculate the pounds of nitrogen needed to lower the C:N to that level:
   800 lbs C x (1 lb N / 20 lbs C) __= 40 lbs N.
4. The sawdust contains 2 pounds N; therefore, 38 pounds of nitrogen must be added.
5. Calculate the pounds of a common nitrogen fertilizer to be added. Assume you will use urea (46-0-0):
   38 lbs N x (1 lb fertilizer / 0.46 lb N) = 83 lbs of 46-0-0 needed.

Table 1 provides the C:N and nitrogen fertilizer required for certain organic fertilizers to prevent immobilization of plant-available nitrogen in the soil. When selecting a nitrogen fertilizer, use the one that is the most economical on a pound nitrogen basis.

Table 1: Carbon/nitrogen ratios and nitrogen fertilizer requirements.

Material	Estimated C:N[1]	Pounds N/dry ton[2]	Pounds 33-0-0[3]	N/dry ton 46-0-0[4]
Sewage sludge	12:1	-	-	-
Alfalfa	13:1	-	-	-
Sheep manure[5]	17:1	-	-	-
Beef cattle manure	17:1	-	-	-
Swine manure	17:1	-	-	-
Poultry manure	18:1	-	-	-
Dairy cattle manure	25:1	8	24	17
Horse manure	50:1	24	73	52
Small grain straws, corn stalks	80:1	30	91	65
Sawdust, wood chips	400:1	38	115	83

[1]A C:N less than 20:1 probably would not result in immobilization of the soil nitrogen.
[2]This calculation assumes an average of 40 percent carbon for all of the materials listed.
[3]33-0-0 is ammonium nitrate or NH_4NO_3.
[4]46-0-0 is urea or $CO(NH_2)_2$.
[5]All animal manures are assumed to be dry and to contain **no bedding material.** If bedding material were present, C:N would be even higher and more nitrogen fertilizer would be needed.

[1]*Colorado State University professor, soil and crop sciences.*

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