

Haim Time

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C:N Ratio: The Critical Factor in Soil Microbial and Plant Nutrition

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Simply stated, the C:N (carbon to nitrogen) ratio is the ratio of the mass of carbon to the mass of nitrogen in a substance. As such, a C:N ratio of 10:1 indicates that there are ten units of carbon for each unit of nitrogen in the substance. Since C:N ratios vary widely with residual organic matter in soil, understanding their significance is critical to crop management.

As with all the major soil transformations, the driver of soil C:N ratios is the microbial population with their C:N ratio being approximately 8:1. Because carbon is lost during microbial respiration, the soil microorganisms require a diet of 24 parts carbon to 1 part nitrogen (a C:N ratio of 24:1). This ratio has been described as “ruling the soil”.

How so? Simply because the populations of soil microorganisms are the first in line to satisfy their nutritional needs. Thus, if wheat straw with a C:N ratio of 80:1 is added to the soil, the greater proportion of carbon than the 24:1 demanded by the microorganisms will drive these populations to find additional nitrogen to balance the excess carbon needed to attack the wheat straw. This nitrogen will be stripped from

any source available until the 24:1 ratio is met, capturing (immobilizing) this nitrogen in the microbial cells and possibly creating a nitrogen deficit for subsequent crop needs.

Accordingly, adding a Hairy Vetch cover crop with a C:N ratio of 11:1, i.e., with less carbon than the 24:1 ratio that microorganisms require, will result in the microbes consuming the Vetch and leaving the excess nitrogen in the soil for future crop needs or additional microbial soil transformations. In effect, materials added to the soil with a C:N ratio greater than 24:1 will induce a temporary nitrogen deficiency, and those with a C:N ratio less than 24:1 will provide a temporary surplus.

While the immediate consequences of the disregard of C:N ratios may be felt in crop returns, no less significant are the effects of C:N ratios of crop residues left on the soil surface. As important as crop residues are in maintaining soil cover against destructive elements, their C:N ratios must allow for adventitious microbial assault and nutrient recycling. Thus, for example, a wheat straw cover (C:N ratio of 80:1) resulting from continuous wheat cultivation, might best be served with the addition of a rotation of hairy vetch (C:N

C:N Ratios of Selected Crop Residues

Wheat straw	80:1
Corn Stover	57:1
Mature alfalfa hay	25:1
Rotted barnyard manure	20:1
Legume hay	17:1
Hairy Vetch Crop	11:1
Soil microbe population	8:1
Microbial populations need	24:1

ratio of 11:1). This would allow for the break-down of the wheat straw more quickly. Effective crop management clearly takes into account the C:N ratios of crop residues.

In summary, materials with low carbon and high nitrogen levels will result in a more rapid soil microbial organic nutrient release, “mineralization”, for plant nutrition. High C:N ratios (over 25) will result in nutrient “immobilization” and deficiencies.

Ref. USDA NRCS

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