Understanding the Carbon-Nitrogen Ratio

by Crow Miller

There are two chemical elements in organic matter which are extremely important, especially in their relation or proportion to each other; they are carbon and nitrogen. This relationship is called the carbon-nitrogen ratio. To understand what this relationship is, suppose a certain batch of organic matter is made up of 40 percent carbon and 2 percent nitrogen. Dividing 40 by 2, one gets 20. The carbon-nitrogen ratio of this material is then 20 to 1, which means 20 times as much carbon as nitrogen. Suppose another specimen has 35 percent carbon and 5 percent nitrogen. The carbon-nitrogen ratio of this material then would be 7 to 1. Anyone who handles organic matter, who mulches, or who composts, regardless of which method is used, should have some idea about the significance of this ratio.

Carbon is important because it is an energy-producing factor; nitrogen, because it builds tissue. We are familiar with carbon in the form of charcoal. In that form it is practically pure carbon. A diamond is another form of pure carbon. In a plant it takes an entirely different form. Limestone is usually over 90 percent calcium carbonate (CaCO₃), a compound made up of two partners — calcium and carbon. If you eat a radish or take bicarbonate of soda, you are consuming carbon.

We found that earthworms feeding on oat straw composted with fish meal yielded a carbon-nitrogen ratio from 23 to 11 during a period of two years, while the soil microorganisms alone reduced it to about 18 during the same period. This means that the earthworm is an even more efficient user of nitrogen than microorganisms.

So you can see how widely distributed carbon is. It can be a gas, an acid or other form of compound. I need not say much about nitrogen here; it is a term with which every grower is familiar with. A certain amount of is essential for plant health. Too much is undesirable. When organic matter decays, the carbon is dissipated more rapidly than the nitrogen, thus bringing down the carbon-nitrogen ratio.

Before I go further and cover the significance of this ratio, we should first look at some figures, examples of typical materials and their specific carbon-nitrogen ratios:

- Alfalfa hay — 12:1
- Composted Manure — 20:1
- Cornstalks — 60:1
- Straw — 80:1
- Sawdust — 400:1

Note the high carbon-nitrogen ratio of sawdust. Such a material would be considered highly carbonaceous, and has a very low nitrogen content. If much of it is put into the soil, there would not be enough nitrogen, the food of bacteria and fungi, which aid in the function of decomposition. They would thus have to consume soil nitrogen, the food of bacteria and fungi, falls between 4:1 to 16 percent of protein is nitrogen, we can see that the microbes bodies will have a very high proportion of nitrogen to carbon. Usually the tissues of bacteria are richer in protein than fungi.

When a lot of raw organic matter is applied to a soil, the microorganisms will multiply rapidly, but in the process of working they have to consume nitrogen. That is an absolute necessity to their existence. If the material that is tilled under has a low carbon-nitrogen ratio (that is, it is low in nitrogen), the soil organisms decomposing it will have to look for their nitrogen in places other than in the decomposing substances. They will draw on the soil’s store of nitrogen, thus depleting it, with a depress-
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We've seen that the carbon-nitrogen ratio of tilled under organic matter is important to the conservation of the soil's store of nitrogen. It is also important to the general operation of soils. Mainly, it is a matter of having enough nitrogen available. There is a difference in the way a low carbon-nitrogen ratio works, depending on whether it is raw organic matter or humus.

We've discussed the dynamic action of organic matter and showed that organic matter applied to the soil represents nitrogen on the move. In a finished compost, it is in a more static condition. Less is given off. In terms of the carbon-nitrogen ratio, we can express it in the following manner. In the application of raw organic matter, the extent of nitrogen movement depends on its carbon-nitrogen ratio. If it is high, as in sawdust, there will be no movement. But if it is a material like young sweet clover (12:1), there will be a very satisfactory rate of nitrification.

In humus, however, although the carbon-nitrogen ratio is low, let us say 10:1, there is a resistance to rapid decomposition. The movement is slower and will take place over a longer period of time. This is of some value as it means the nitrogen is stored for future use. In the case of fresh organic matter with a low carbon-nitrogen ratio, not only is there a fast movement, but much carbon is given off in the form of carbon dioxide. Many entomologists believe this may kill off some of the larvae of destructive insects.

As rainfall goes down, the carbon-nitrogen ratio also declines. The higher the rainfall, the lower the nitrogen. The carbon-nitrogen ratio of arid soils is always lower than those in regions of higher precipitation. In a soil which had a rainfall of 15 inches per annum, the carbon-nitrogen ratio was 13:1. Where it was 10 inches or less of rain, the carbon-nitrogen ratio was about 11:1. It has also been found that the higher the temperature, the lower the carbon-nitrogen ratio. So in general, higher rainfall means a higher carbon-nitrogen ratio; higher temperature tends to lower the carbon-nitrogen ratios; and higher acidity raises the carbon-nitrogen ratio.