agKnowledge Spotlight
Shedding light on the concerns of your fields.

Understanding Crop Residue Decomposition

- Soil microbes help in the decomposition/breakdown of crop residue.
- Carbon (C) to nitrogen (N) ratio differs among crops and affects immobilization and mineralization processes.
- Decomposition of crop residue is largely influenced by biological processes.

Crop residue provides organic carbon and nitrogen to soil biology. The soil biological community needs carbon and nitrogen for food and energy. Additionally, crop residue physically protects soil from wind and rain erosion. Residue amount, size, and distribution are affected by agricultural practices. However, residue decomposition is controlled by biological processes being influenced by environmental and soil conditions.[1]

Nitrogen Cycle

In terms of the N cycle, the residue decomposition process relies on immobilization and mineralization, which both involve soil microbes (Figure 1). Soil microbes feed on the carbon in crop residues and require N to do so. Immobilization is when N is consumed by soil microbes. Mineralization is the release of N that generally happens upon the death of soil microbes. In other words, nitrogen within the residue remains tied up or immobilized until decomposition is complete and is released by soil microbes through mineralization.

Carbon to Nitrogen Ratio

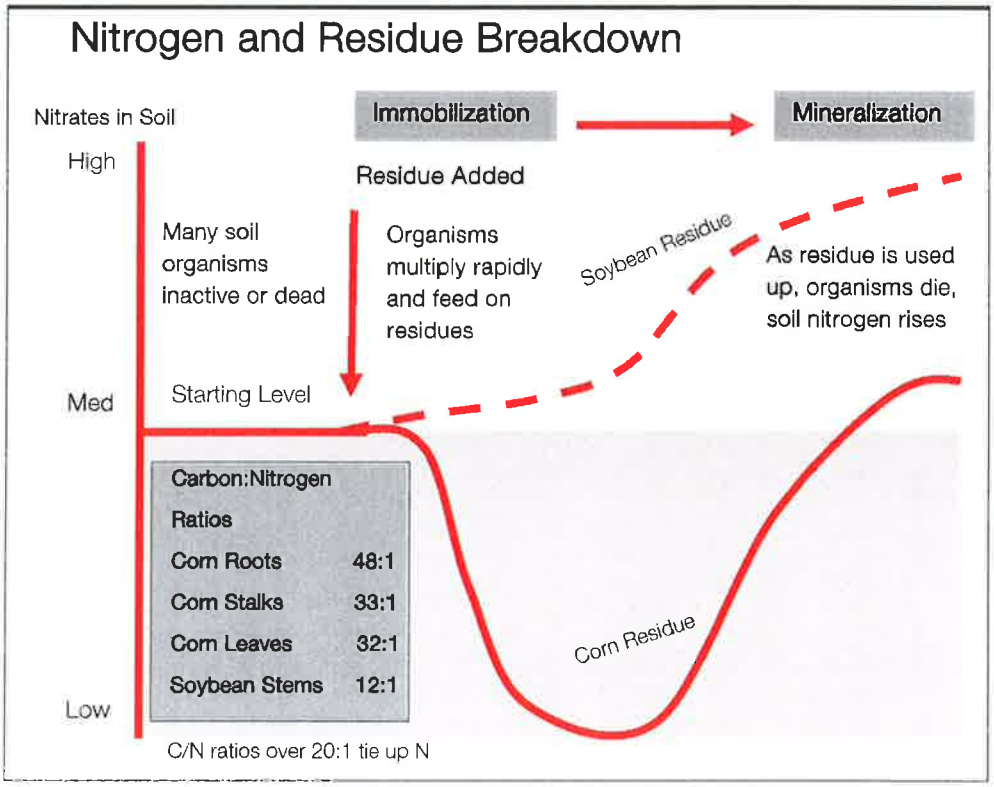
Microbes try to maintain a carbon to nitrogen (C:N) ratio of approximately 10:1 in soils.[2] Ratios among crop residues vary greatly; alfalfa, soybean, and other legumes generally have lower C:N ratios near 20:1, which usually results in quicker mineralization.[3] Corn has a higher C:N ratio (70:1) than soybean. Crop residues with higher C:N ratios take more time to decay and result in higher amounts of N being required by the microbes to decompose residues. If not taken into account, the microbe requirement for N can compete with a growing corn crop for available N to maintain their desired C:N ration of 10:1.[2]

Decomposition

Approximately 50 pounds of residue are produced for each bushel of corn harvested.[5] Crop residue is composed of lignin, cellulose, hemicellulose, and nutrients. Microoganisms breakdown these compounds, and the decomposition rate is largely affected by moisture and temperature. Some of the conditions that favor decomposition of residue include warm, moist weather, small pieces of residue, and maximized contact between residue and the soil.

Nitrogen deficiency symptoms can occur during immobilization; however, research has not consistently shown a benefit to fall N

Figure 1. The interaction between available nitrogen and microbial activity aids in decay of crop residue. (Adapted from Modern Corn and Soybean Production[4]).



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applications intended to assist in residue decomposition.[6] Timing, cooler temperatures, and/or dry weather might play a role in the effectiveness of fall N applications. Higher rates of spring-applied N may be an option since the amount of N normally applied may be immobilized by microbes for residue decomposition during the growing season.

Disturbing the soil with tillage may not increase residue decomposition. A recent three-year study evaluated the effect of tillage on residue breakdown. Field and laboratory results demonstrated no significant differences in the breakdown or percent residue that remained among deep tillage, strip-tillage, and no-till systems.[1]

Management

Residue can be managed by increasing the populations of soil microorganisms. Cover crops provide additional energy, carbon, and nitrogen to sustain activity of a wide range of soil microorganisms. A major portion of soil microbes live in a state of dormancy as they are under conditions of starvation, especially in tilled soils.[2] According to a three-year study in Iowa soils, corn residue was reduced to below 45 percent after 12 months in the field.[1] Crop rotation cycles that include legume crops with lower C:N ratios returns N back into soil more quickly and gives residue with higher C:N ratios (such as corn) more time to decompose.

Summary

Soil microorganisms use nutrients from crop residue and may immobilize plant available N before mineralizing the nutrient. Carbon to nitrogen ratio of crops is an indicator of how quickly residue can be decomposed and N released. Fall N applications and tillage are not sustainable economically or environmentally for all growers. Both practices bring additional management costs and can negatively affect water quality. Tillage could further deteriorate soil health and increase the risk of soil erosion on some fields. Rate of residue breakdown is aided by practices that enhance soil health and soil microorganism populations.

Sources:

[1] Al-Kaisi, M. 2014. Myths and facts about residue breakdown. Iowa State University. Integrated Crop Management News. http://www.extension.iastate.edu.

[2] Hoorman, J.J. and R. Islam. 2010. Understanding soil microbes and nutrient recycling. The Ohio State University. SAG-16-10.

[3] Mannering, J. and D. Griffith. Value of crop rotation under various tillage systems. Purdue University Extension. AY-230.

[4] Hoeft, R.G. et. al. 2000. Modern corn and soybean production. MCSP Publications. Champaign, Illinois. Pages 121-131.

[5] Lardy, G. 2011. Utilizing corn residue in beef cattle diets. North Dakota State University. AS1548.

[6] Al-Kaisi, M. 2007. Tillage challenges in managing continuous corn. Iowa State University. IC-498(1).

Web sources verified 9/30/15

Figure 2. Strip-till may be used to remove residue from the row for improved seedling emergence; however, it may not increase the rate of residue decomposition.