Should I Apply Nitrogen to Break Down Corn Residue?

Overview

The rate at which crop residue decomposes in the field is influenced by a number of factors including climate, soil water content, soil temperature, the type of residue, residue management, the status of soil nutrients, and the microbial population in the soil.[1]

Q. How many pounds of residue is produced for each bushel of corn harvested, and what is the composition of crop residue?

Nearly 50 pounds of residue is produced for each bushel of corn harvested.[2] Corn residue is composed of lignin, cellulose, hemicellulose, and macro- and micro-nutrients.[3]

Q. What role do soil microorganisms play in the residue breakdown process?

Soil microbes have an important role in a number of processes. One major role is that of decomposing crop residue by breaking down lignin, pectin, and hemicellulose. In addition, microbes are critical for nutrient cycling, sequestering carbon, enhancing soil structure, and helping suppress soilborne disease pathogens.

Q. How does the nitrogen (N) cycle facilitate the residue decomposition process?

Within the N cycle, the residue decomposition process relies on immobilization and mineralization; microbes participate in both processes. In the immobilization process, microbes consume N. This can cause a temporary shortage of N for a growing crop. Mineralization is the release of N that generally happens upon the death of soil microbes. Nitrogen within residue is tied up (immobilized) until decomposition is complete and is released by soil microbes through mineralization.

Q. What role does the carbon to nitrogen (C:N) ratio play during residue decomposition?

The C:N ratio indicates the balance between the two soil elements essential for crop growth and microbial health. The C:N ratio of crop material provides an indication of how quickly the material can be decomposed and its N released by microorganisms. Crop residue with a low C:N ratio decomposes faster than residues with higher C:N ratios.

There is wide variation in the C:N ratios among crop residues. Legume crops such as alfalfa, soybean, or hairy vetch have C:N ratios of about 11:1 to 25:1, while corn is about 57:1 and wheat straw is about 80:1. These high C:N ratios result in microbes requiring higher amounts of N to decompose the residue. Microbes try to maintain an equilibrium of around 10:1 in the soil. Material with a C:N of 24:1 is considered to be ideal for microbes as it provides an N-neutral diet.[4,6]

Q. How do soil moisture and soil temperature influence the decomposition of residue?

Soil microbes are most active when soil moisture is near field capacity and soil temperature is in the range of 90 to 95 °F (32.2 to 35 °C). Decomposition essentially stops when soil temperature is below 50 °F (10 °C) or above 105 °F (40.5 °C). Soil moisture content below 40% water-filled pore space slows the rate of decomposition, while saturated soils lacking adequate oxygen to support microbial activity can also inhibit decomposition. Other factors that may advance the decomposition of residue include cutting residue into smaller pieces and maximizing contact between the residue and the soil.[1]

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Q. How crucial is soil biological health for the crop residue breakdown process?

In healthy soil, crop residue can break down rapidly. Established practices to stimulate soil health include continuous no-till; returning organic materials such as crop residue, manure, and compost to the soil; a diverse crop rotation; and cover crops during fallow periods.

Q. Does tillage affect crop residue breakdown?

Three years of field and laboratory studies by Iowa State University demonstrated no significant differences in the decomposition or percent residue that remained among strip-tillage, deep-tillage, and no-till systems.[3]

Q. How crucial is fall N application for residue decomposition?

During the immobilization process, N deficiency symptoms can develop in the growing crop. However, research has not consistently shown a benefit to fall N application intended to assist in residue decomposition. The effectiveness of fall N applications is related to timing and temperatures and/or moisture conditions. Higher rates of spring-applied N may be applied since the N from the typical rate may be immobilized by microbes for residue decomposition during the growing season.

In a two-year study by Iowa State University researchers, three rates of 32% urea ammonium-nitrate (UAN) were applied at 0, 30, and 60 lb N/acre immediately after harvest. The rate of decomposition was monitored every three months for one year. Their results indicated that applying N fertilizer to accelerate the rate of decomposition was not effective.[3] Similar work was done by researchers in Colorado on wheat stubble. They applied 32% UAN solution to wheat residue and while there was a trend for increased residue decomposition, the increase was small and not statistically significant.[1]

Q. Why does my continuous corn look yellow at V3 to V4 growth stage?

This situation is familiar to many corn growers with continuous corn operations. Under these circumstances a buildup of organic matter from multiple years of corn-on-corn production can result in the C:N ratio being more than double the optimal ratio for microbes to decompose the crop residue. Because of this, the microbes must use the available soil N for their metabolisms to stay alive. This results in a lack of plant-available N, which causes corn seedlings from VE to the V3 to V4 growth stage to turn yellow. Even if a grower has applied N during the previous fall or at spring planting, soil microbes are able to out-compete seedling corn plants for N whenever excess C is present. The heavy residue will cause soil to be colder and wetter than areas of less residue, which could also cause young corn to be chlorotic.[5]

Q. Can I avoid yellow corn seedlings in the spring by applying 10 to 15 gallons/acre of UAN the previous fall?

Remember that the most important factors for residue decomposition are temperature and soil moisture, not the amount of available N. Therefore, as the research above concluded, applying more N is not necessarily the best way to avoid N immobilization and ensure that the plants have the amount of N they need in the spring.

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