How Can Cover Crops Benefit My Nutrient Management Plan?

Q. What are cover crops?

Cover crops are generally grown between cash crop cycles. However, they can be intercropped with cash crops to cover bare ground and they can be planted in the absence of a typical crop in fallow ground. Cover crops can be annual, winter annual, biennial, or perennial species. Grass cover crops include rye, wheat, triticale, barley, oats, and annual ryegrass. Winter rye is one of the most common cover crops because it is winter hardy and can be planted late into the fall. Legume cover crops include hairy vetch, clovers, and field peas. Other broadleaf plants that may be used as cover crops include the Brassicas (mustards, radishes, and rapeseed), buckwheat, and sunflowers.

Q. What are the benefits and purposes of cover crops?

Cover crops are generally planted for one or more of the following purposes or benefits:

- To reduce erosion
- To maintain or increase soil health and organic matter content
- To minimize soil compaction
- To improve soil water infiltration
- To suppress weeds (e.g., winter annuals such as henbit or marestail)[1]
- To provide nutrient management
  - » Help to build reserves of nitrogen (N)
  - » Help to scavenge immobile nutrients from deeper in the soil profile, bringing them closer to the soil surface where they are more accessible for the roots of the following cash crop
  - » Help to minimize nutrient losses from leaching or runoff

Q. How can grass cover crops benefit my nutrient management plan?

Cereal grains or grasses are generally recommended if the cover crop is planted to capture residual nitrogen from the soil profile, as these plants can contribute to the accumulation or maintenance of soil nitrogen. Grasses can recycle existing soil nitrogen and other nutrients, while potentially reducing losses due to leaching. The National Library of Medicine published a meta-analysis which analyzed the data from 28 previous studies. The meta-analysis of the combined data found that non-legume cover crop mixtures reduced nitrate leaching by an average of 56%.[2] Grass cover crops may also prevent nitrate-nitrogen (NO3-N) from reaching nearby streams by scavenging and retaining that nutrient in the soil.

Phosphorus (P) retention in the soil may be improved with a grass cover crop because the crop can also help to a reduce the potential for soil erosion. Non-legume cover crops such as rye, ryegrass, triticale, barley, and wheat can reduce soil loss from 31% to 100% compared to fields without a cover crop.[3]

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Q. How can legume cover crops benefit my nutrient management plan?

Cover crops in the legume family can produce nitrogen for subsequent crops to use and may be a more appropriate choice than grasses for nitrogen-deficient situations. Legumes can capture nitrogen from the air and convert it to ammonia ($NH3^-$) in the soil, where it is quickly changed to ammonium (NH4) and eventually to the plant-available form, nitrate ($NO3^-$).

How much nitrogen credit can be made for a legume cover crop? Studies from Ontario, Michigan, Iowa and Wisconsin indicate that a clover or mature alfalfa cover crop may enable a corn grower to reduce N rates by 50 to 100 lb per acre. The amount and timing of N availability to a subsequent corn crop can be influenced by 1) the amount of N produced by the legume cover crop and 2) the decomposition rate of the cover crop. The decomposition rate is itself influenced by termination timing, whether tillage was used to incorporate the cover crop, soil moisture, soil temperature, and by the C:N ratio of the species planted.[4] Because multiple factors may influence how much N can be credited to a cover crop, there is a wide range of values for N credits, as indicated in Table 1.

Table 1. Total nitrogen from some common cover crop species[5]

Cover Crop	Lb per acre of N*
Mustard	30-120
Radish	50-200
Rapeseed	40-160
Berseem Clover	75-220
Cowpea	100-150
Crimson Clover	70-130
Field Pea	90-150
Hairy Vetch	90-200
Red Clover	70-150
Sweetclover	90-170
White Clover	80-200

**From Michigan State University.*

Incorporating the legume cover crop with tillage allows the N in the biomass to be more accessible to microbes. This enables the soil microbes to break down the biomass and release N in a plant-available form; however, tillage also increases the potential for soil erosion. Terminating the cover crop with herbicides will retain all of the biomass on the soil surface; however, the biomass will take longer to decompose. Soil microbes are most active with warm, moist soil conditions, which help to break down the biomass quicker than in cool conditions.

Growers should consider terminating a legume cover crop at least seven days prior to planting a corn crop.[4]

Q. How can other non-legume cover crops benefit my nutrient management plan?

Non-legume cover crops, like the Brassicas, work much like the grasses to scavenge or gather nutrients that are already present in the soil. The roots of radishes, for example, can penetrate deep into the soil profile, which gives the plant the opportunity to pull nitrogen and immobile nutrients—such as phosphorus and potassium (K)—closer to the surface. As a result, the roots of the cash crop are more likely to come into contact with those nutrients and allow for uptake by the crop. One study found as much as 170 lbs per acre of nitrogen was captured by a radish cover crop.[6]

Q. Why is it important to consider the carbon to nitrogen (C:N) ratios of cover crop residues?

All cover crops can provide nutrients and organic matter to the soil. Cover crops can help to increase soil organic matter by adding residue above and below the surface. Understanding the C:N ratios of various cover crop species is important in managing crop residue and nutrient cycling. Soil microbes use nitrogen as an energy source in the process of breaking down carbon-based plant material. Cover crop residue with a low C:N ratio will decompose much faster than residue with a high C:N ratio. Residues with a 24:1 C:N ratio

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provide what is considered to be a balanced, nitrogen-neutral diet for soil microorganisms. A rye cover crop in its vegetative stage has a C:N ratio of about 26:1. When rye begins to flower, the plants increase their carbon content, increasing the C:N ratio to a more difficult-to-decompose level of 37:1 or greater. At C:N ratios above 25:1, microbes need to find additional nitrogen—which they source from the soil around them—to consume the residue, temporarily depleting soil nitrogen content. Terminating a grass cover crop no later than the late joint to early boot stages of growth and 2 to 4 weeks before planting the next crop permits maximum growth and uptake of residual nutrients by the cover crop. This also allows sufficient time for the decomposition of the vegetation and for the release of nutrients.

Legume cover crops can be very high in nitrogen content. Hairy vetch has a C:N ratio of 11:1, allowing soil microbes to deposit excess nitrogen in the soil as they quickly break down the soft stems and leaves. Legumes killed while succulent decompose more rapidly than grasses, so terminating a legume cover crop 1 to 2 weeks prior to planting the cash crop is usually sufficient. Radishes have a fleshy composition and a low C:N ratio, causing the plant material to decompose easily and the nutrients to become available for the following crop. Therefore, a low C:N ratio cover crop containing legumes and/or Brassicas could follow a high C:N ratio crop like corn to help the residue decompose and allow nutrients to become available to the next crop.[7] Table 2 shows the C:N values that the United States Department of Agriculture (USDA) and Natural Resource Conservation Service (NRCS) uses for commonly grown crop species.

Table 2. C:N ratios of various crops

Crop material	C:N Ratio
Rye straw	82:1
Wheat straw	80:1
Oat straw	70:1
Corn stover	57:1
Rye cover crop (anthesis stage)	37:1
Rye cover crop (vegetative stage)	26:1
Mature alfalfa	25:1
IDEAL MICROBIAL DIET	24:1
Crimson clover	21:1
Legume hay	17:1
Young alfalfa hay	13:1
Hairy vetch cover crop	11:1

Source: USDA NRCS[8]

Q. How do you select the best cover crop(s) to plant?

The selection of a cover crop depends on when it can be planted and the goal for its use. A combination of cover crops may be beneficial for diversity, quick establishment, improved nutrient utilization, erosion control, or other functions to meet the needs of your farm. Since growing conditions, requirements, and performance of cover crops vary widely among geographic regions, growers should consult their local extension office, regional cover crops council, seed company, or retailer to determine the best cover crops and appropriate planting times for their area.

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Web sources verified 6/28/2023

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