

# Cover Crops for Soil Nitrogen Cycling

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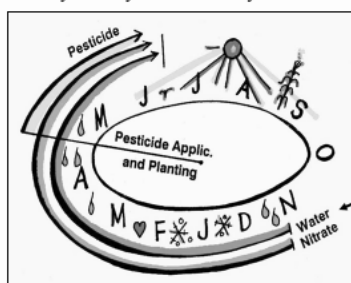
Cover crops can provide many benefits for soil and water quality and crop production. One of the important benefits of cover crops is their impact on soil nitrogen cycling. Generally we would characterize cover crops as either a scavenger of soil N or a producer of soil N, although legumes will do both.

## Scavenging N

Non-legume cover crops will scavenge or “trap” soil nitrate that would otherwise move out of the rootzone into tile drains or groundwater. Even with well-managed corn and soybean production, there is always some leaching of nitrate that originates either from residual fertilizer N or from the natural decomposition of soil organic matter. Our annual cropping systems are “leaky” because there are long fallow periods between crop maturity in September and the active growth of the next cash crop in May. Most of the net downward flow of water to the drains occurs precisely during this long fallow period, when there is nothing to take up the nitrate. Cover crops actively take up nitrate during a portion of that fallow season, reducing the losses that occur to tile drains and recycling the nitrogen for later use.

### Rationale of cover crops for water quality:

Corn-soybean system normally fallow from Oct – April.



A winter cover crop “traps” some of the nitrate that otherwise leaches out during fallow season

Majority of drainflow and N-loads occur in fallow season

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Illustration by Lou Jones/ E. Kladviko

### 7 Month “Brown Gap” for soybean and corn, fallow period

Cover crop grows and takes up N during some of that normally fallow season. This would shrink the “brown gap” and keep the land green for longer time.

Tile drain studies in Midwest consistently show reduction in nitrate leaching with cover crops

This scavenged N goes into YOUR soil N bank account!

Typical scavenger cover crops include grasses such as cereal rye and annual ryegrass, and brassicas such as daikon radish. Legumes will also scavenge residual N before producing their own N, but because of their slower establishment they are not normally planted for the primary purpose of scavenging N.



The amount of N scavenged depends on the amount of growth of the cover crop and the amount of N available in the soil. Fields with manure applications have greater available N and a greater need for a cover crop to trap the N. Typical corn/soybean systems without manure may have 10 to 40 lbs N/A trapped in the above-ground portion of the cover crop, while fields with manure may have 80 to 100 lbs/A or more. Cover crops also trap substantial amounts of N in their roots.



Brassicas

It is important to remember that non-legume cover crops are not producing or fixing N, they are simply scavenging or trapping N from the soil that would otherwise be subject to losses by leaching or denitrification.

### Producing (or “fixing”) N

Legume cover crops fix atmospheric N for their own growth. The amount of N fixed depends on the amount of growth and the particular species. A challenge for inclusion of legumes in a corn-soybean system is the limited time available for growth and N-fixation. Legumes fit well after wheat, when not double-cropped, since there is more time for growth of the cover crop. Legumes must be inoculated before they will fix N. Typical legume cover crops include crimson clover, hairy vetch, and Austrian winter pea.

### Availability of the N scavenged or produced

How much of the N that was scavenged by a trap crop or fixed by a legume, becomes available for the next cash crop, and when? These are very challenging questions and there is no simple answer. The rate and extent of N release from the decomposing cover crop depends on many factors, including the age/stage of the plant when terminated, the nitrogen percent, carbon to nitrogen (C:N) ratio, plant composition, and weather (temperature and moisture). Plants in the vegetative stage have higher N concentrations than those in the reproductive stage and will decompose faster. The C:N ratio of the cover crop residues determine the general timing of release of N from the residues. With high C:N ratios (greater than 25:1), the decomposing cover crop residues will first immobilize N from the soil or recent fertilizer N additions. Only after some period of time will the N start to be released, or mineralized. When managing grass cover crops (cereal rye, annual ryegrass, triticale, wheat), terminating the cover crop while it is still in the vegetative stage is generally the preferred strategy if growing a high N-user cash crop such as corn. If the cover crop gets into the reproductive phase before termination, there will be more N immobilization after termination and a good application of starter N fertilizer should be used.

Not all the N scavenged by the cover crop will be available the next season, so overall fertilizer N rate should not immediately be reduced by the amount of N kept out of the drain

#### C:N ratios of common organic residues

Organic material	C:N ratio
Newspaper	120:1
Wheat straw	80:1
Corn stover	57:1
Rye cover crop, anthesis	37:1
Rye cover crop, vegetative	26:1
Hairy vetch cover crop	11:1
Soil microbes (average)	8:1

Source: Adapted from Carbon to Nitrogen Ratios in Cropping Systems (2011), USDA-NRCS

C:N ratios wider than 25:1 cause N immobilization for some time period. If utilizing covers with wide C:N ratios, then should either:

- allow time for decomposition before high N-using crop (corn)
- apply extra starter N
- don't choose high C:N covers before corn

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or contained in the above-ground biomass, for example. Some of the scavenged N goes towards building soil organic matter. After multiple years of cover crops and an increase in soil N content and organic matter, there will likely be the possibility to reduce fertilizer N rates for a similar crop yield. This is an active area of experimentation by producers and researchers.

Brassica cover crops such as daikon radish will winter-kill in most years. This “early termination” of the cover crop, combined with the relatively lower C:N ratio, means that the radish will decompose quickly in early spring and release N earlier than when the next cash crop can use it. A two-way cover crop mix of daikon radish with a winter-kill grass such as spring oats, is an effective way to scavenge N but keep the N in the soil longer in the spring, while still removing the management challenge to the producer of termination timing in spring.

Legume cover crops and most of the grasses, while in the vegetative stage, have C:N ratios around 10:1 to 15:1. These decompose and release N rapidly after termination. Roughly about half of the N in the above-ground biomass will be available over a time window of around 1 to 2 months, depending on the weather. If a legume is terminated too early, some of the N may be lost before the cover crop can use it.

### Summary

Cover crops can have important effects on soil and water quality by scavenging available N from the soil profile and recycling it. The recycled N helps build soil organic matter and some of it becomes available to succeeding crops. Legume cover crops fix atmospheric N, and upon termination, roughly half of the fixed N becomes available over a several month period. While there are many challenges remaining to fully integrate cover crops into nitrogen management strategies, they should be considered as an important part of increasing overall soil biological activity and soil health.

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