

# **Cover Crops to Reduce Nitrate Losses from Soils**

Eileen Kladvko  
Purdue University

## **Abstract**

Planting cover crops is a traditional soil-building practice that deserves new consideration in our modern cropping systems. A new era for cover crops is being driven in part by higher fertilizer and energy prices, water quality concerns, soil compaction, and declines in soil quality and organic matter. Winter cover crops grown after corn and soybeans can build soil tilth and trap nitrate that would otherwise leach out of the soil into drain tiles during fall, winter, and early spring. Water quality is thereby improved by keeping nutrients in the soil rather than in drainage waters. Some of the nitrate taken up by the cover crop will be recycled to the next crop, while some will help build soil organic matter over a longer term. The amount of N trapped by the cover crop depends on the particular plant as well as the amount of growth that occurs in fall and/or spring. The amount of N released for the next crop depends not only on the uptake but also on the timing of cover crop termination, the age/stage of the cover crop at termination, and subsequent weather. Specific recommendations for potential changes in nitrogen fertilizer rates as a result of growing trap crops require more research and demonstration results across a number of soils and years.

## **Introduction**

Planting cover crops is a traditional soil-building practice that deserves new consideration in our modern cropping systems. Although cover crops may have seemed to be unnecessary after the advent of widespread commercial fertilizer use, there has been renewed interest over the past several years in re-evaluating the role of cover crops. This new era for cover crops is being driven in part by higher fertilizer and energy prices, water quality concerns, soil compaction, and declines in soil quality and organic matter. Producers want to make sure they are gaining as much as possible from the inputs they use, and cover crops can be one part of this system. At the same time, concerns about water quality, both locally and for hypoxia in the Gulf of Mexico, give extra impetus to reducing losses of nutrients from agricultural lands. Cover crops can also reduce soil erosion, increase soil organic matter, improve soil physical and biological conditions, reduce compaction, and suppress weeds. This presentation will discuss some general considerations for using cover crops as part of a cropping system, and then focus on their use for reducing nitrate losses from our soils.

## **Purposes of Cover Crops**

There are many different purposes that cover crops can serve, and no one cover crop will serve all of them. A traditional use of cover crops is to “cover the soil” to protect against erosion by both water and wind. Cover crops help improve soil aggregation, especially fibrous-rooted crops that enmesh soil particles and hold them together. Root exudates feed the soil microorganisms, which then produce polysaccharides that “glue” soil

particles together. Tap-rooted cover crops can break up compacted layers and increase macropores in the soil, leading to greater water infiltration, aeration, and rooting of the main crop. The rooting system of the cover crop can also provide additional strength to the soil for improved trafficability during wet conditions.

Cover crops also contribute to increased soil biological activity. By having plant growth during time periods that are normally fallow (September-November, March-April), there is more “food” available for soil organisms. Soil organisms provide many important functions in soil including nutrient recycling, pest suppression, structure formation, and organic matter maintenance. Providing more food for the organisms keeps them active longer and is thought to contribute to improved soil health. There is a great need for more research on soil biological activity and its impacts on soil and crop productivity. Cover crops help increase soil organic matter content with time. The production of above- and belowground plant material during normally fallow periods contributes carbon to the soil, some of which is converted to humus.

Cover crops can also be used as a “trap crop” to take up nutrients that would otherwise be lost during the fallow period. By having a living cover during fallow periods, we are extending the active growing season and the period of nutrient uptake from soils. This nutrient uptake can be particularly significant to reduce nitrate leaching through the soil into drainage tiles. In many areas in the Midwest, much of the tile drainage occurs in the fall, winter, and early spring, when there is normally no crop growing. A vigorous cover crop can take up nitrate and significantly decrease both the concentration and total load of nitrate in drainage waters. Cover crops can also reduce losses of phosphorus and other constituents that are lost in eroded soil by increasing infiltration and reducing runoff. Deep-rooted cover crops can translocate nutrients from deeper in the subsoil. The rest of this paper focuses on use of cover crops to trap nitrate, both to improve water quality and to recycle some of that nitrogen back into subsequent crops.

### **Trapping and Releasing Soil N**

When the main purpose of a cover crop is to trap nitrate that would normally leach away, the key factors are a good stand and rapid growth. The amount of N taken up depends on plant growth, both above and below ground. Although legumes will also “trap” residual soil N before fixing significant atmospheric N, crops like cereal rye, annual ryegrass, wheat, oats, or barley are more commonly used. They can grow vigorously during the fall and will trap significant amounts of N, depending on the weather. The choice of a cover crop that will winterkill vs. overwinter will affect spring management options, as well as the potential for further N uptake in early spring. Cover crops can be especially important in systems where animal manure is applied after harvest of the main crop. New technology has been developed that simultaneously seeds the cover crop while injecting slurry (Harrigan et al., 2007), which will improve timeliness of cover crop establishment and make the manure-cover crop system more practical and efficient. The nutrient benefit of the manure will be more fully realized with a cover crop taking up nutrients in the fall and holding them until the next season.

The amount of N released by the cover crop, and the timing of release the following season, are difficult to predict. If the cover crop overwinters successfully, it will start to grow and take up N again in the spring. The amount of spring top growth and the age/stage of the plant at the time of cover crop termination, along with the weather, will affect the decomposition rate of the cover crop. In general, the younger plants will have a narrower C:N ratio and release the N more quickly. Older plants with more lignin and a wider C:N ratio may tie up additional soil N as they decompose. Killing the cover crop early will likely lead to more rapid recycling of a smaller amount of N, whereas killing later may trap more N but then take longer to recycle back to the cash crop. The rate of buildup of soil organic matter will also be affected by these same management decisions and how they affect the partitioning of plant photosynthate between top growth and root growth.

Research studies have shown a wide range in reduction of nitrate loads from cropped fields by the use of cover crops. Reported reductions in nitrate losses range from 13% in Minnesota to 94% in Kentucky (Kaspar et al., 2008).

## **Conclusions**

Cover crops can be a useful tool to trap residual soil nitrate and reduce nitrate loads to drainage waters. Good establishment and rapid growth are key for significant N uptake in fall. Some of the trapped N is recycled to the next cash crop and some is used in the slow buildup of soil organic matter. Both management practice decisions and weather will affect the timing and rate of N release, so it is difficult to give precise recommendations.

## **References**

The new Web site for the new regional group on cover crops, the Midwest Cover Crops Council, has compiled information from all the Midwestern states plus the province of Ontario, for easy access to extension information from around the region as well as to the national SARE website and book on cover crops.

[www.mccc.msu.edu](http://www.mccc.msu.edu)

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Harrigan, T., S. Snapp, R. Leep, D. Mutch, N. Rector. 2007. Manure slurry-enriched seeding of cover crops. pp.2-3 in ASABE Resource magazine, February 2007.

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