Cornell University
Cooperative Extension

Agronomy Fact Sheet Series Fact Sheet 43

Nitrogen Benefits of Winter Cover Crops

Cover crops have received increasing interest from farmers in recent years. The reasons vary from erosion control and nutrient uptake to improved soil quality and increasing organic matter. As fertilizer prices continue to increase and producers aim to reduce nitrogen (N) loss to the environment, producers are asking about the N fertilizer replacement value (NFRV) of winter cover crops for corn.

We conducted a literature review to (1) identify cover crops most suitable for use as winter crop crops in corn cropping systems in the Northeast and (2) evaluate and summarize studies on (a) the NFRVs of winter cover crops for the next corn crop, (b) N accumulation by the cover crops, and (c) environmental and management variables that most affect NFRVs, N uptake capacity, and synchronization of N release with N needs of the next corn crop.

In this factsheet we summarize our review of many years of cover crop research with particular emphasis on the Northeast. We present findings on the N benefits of winter cover crops that can help corn producers choose and manage winter cover crops to best meet their cropping system needs and environmental management goals.

Cover Crops Suitable for the Northeast

In the Northeast, the cold winter period from November to March reduces fall and spring growing time for winter cover crops and winter survival compared to warmer regions of the United States, so it is important to understand basic cover crop options.

Crops examined for use as winter cover crops in the Northeast include legumes such as various vetch and clover species, as well as small grains and grasses including wheat, barley, and cereal rye.

Reports on cold hardiness of seedlings of these species vary. One reason for varying winter survival may be the effect of establishment date (Table 1). Establishment varies in the Northeast where Plant Hardiness Zones 3-8 are represented (USDA 1990); warmer locations in the Northeast can seed toward the later end of the range, but cooler locations should plan on seeding toward the earlier end of the range.

As can be seen in Table 1, ideal establishment times for most legume cover crops precede corn grain and soybean harvest. These cover crops typically are most effectively established if seeded after winter cereals or corn silage, interseeding into standing soybeans in 30-inch row spacing or into corn when it is 12-24 inches tall, or aerial seeded at tasseling in August. Cereal Rye is the most cold tolerant among small grain cover crops and may still be established after corn grain or soybean harvest, depending on time of harvest and fall weather.

Table 1: Recommended seeding rate and establishment dates for winter cover crops most commonly used on dairy farms in the Northeastern US, adapted from Clark (2007) and Duiker (unpublished data).

Cover crop	Seeding rate	Seeding window
	lbs/acre	
Hairy vetch	13-18	Aug. 1–Sept. 30
Crimson clover	9-13	Aug. 1–Sept. 30
Red clover	7-9	Feb. 1–June 15[b]
Wheat	55-110	Sept. 15–Nov. 1
Barley	45-90	Sept. 15–Oct. 15
Cereal Rye	55-110	Sept. 15–Nov. 15

[a] Red clover will not have an appreciable nitrogen fertilizer replacement value for corn if not established early in the year preceding spring plowdown or kill.

Nitrogen Fertilizer Replacement Value (NFRV) of Cover Crops for Corn

- Cover crop studies surveyed in the literature review include hairy vetch, bigflower vetch, crimson clover, red clover, arrowleaf clover, and cereal rye.
- More than half the studies on hairy vetch indicated a NFRV >70 lbs N/acre while 80% of the studies found NFRVs >50 lbs N/acre.
- Most studies that included a direct comparison between vetch and clover indicated greater NFRV for vetch.
- Cereal rye often showed negative NFRVs, most likely due to N immobilization resulting from decomposition of the high C:N cover crop residues.
- For N deficient situations, N immobilization upon cereal rye or small grain incorporation or chemical kill could be overcome by (1) delaying corn planting until 2-3 weeks after cover crop kill and/or (2) addition of fertilizer N or manure directly following cover crop kill/turnover. Immobilization of soil N will not be an issue when the residual inorganic soil N pool at cover crop termination is large (e.g., heavily manured fields).
- Tillage decisions (conventional tillage versus no-till systems with chemical kill of the cover crop) can impact both moisture and N dynamics. The limited research available in the literature indicates that chemical kill without incorporation tends to result in slower decomposition and more gradual N release than when tillage is used to terminate and incorporate the residue. But, additional research is needed.
- If legumes are established following small grains or interseeded into standing corn or soybean, fall N accumulation can be substantial. If seeded after corn silage or grain harvest, N accumulation in the fall is generally considerably lower for legumes than for cereal grains and grasses.

Winter Cover Crops as Catch Crop for End-of-Season Residual N

- High levels of residual N following corn harvest can occur due to limited crop uptake of fertilizer N in dry summers, inadequate accounting for manure N when calculating crop N needs, poor timing of N application with respect to crop uptake, and/or fall mineralization of soil organic matter and crop residues.
- If cover crops are seeded to capture residual N from the soil profile, cereal grains or grasses are recommended. This capture does not appear to result in an N credit to the following crop, but presumably contributes to accumulation or maintenance of soil organic N. For N-deficient situations, legumes are more appropriate winter cover crops.

In Summary

The NFRV for vetch was greater than for clover, while the NFRV of cereal rye was often zero or negative, reflecting N immobilization in soils with limited residual N. This immobilization could be overcome by allowing 2-3 weeks between kill and planting or by N addition following cover crop kill/turnover. A few studies suggest chemical kill results in slower decomposition and more gradual N release over time than cover crop plow-down. Research is inconclusive regarding the effect of tillage on NFRVs of cover crops. Cereal rye was most effective in uptake of residual (fall) N and is recommended as a catch crop in situations of excess N. For N-deficient situations, legumes are more appropriate winter cover crops.

Additional Resources

- "Managing Cover Crops Profitably". 3rd Edition. Handbook Series Book 9. Published by the Sustainable Agriculture Network, Beltsville, MD. http://www.sare.org/publications/covercrops/covercrops.pdf.

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Quirine M. Ketterings, Sheryl Swink, Sjoerd Duiker, Karl Czymmek, Doug Beegle, and Bill Cox

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