



# Frost Seeding Red Clover in Winter Wheat

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## Grow your own nitrogen

If you plant winter wheat, you have an opportunity to "grow" your own nitrogen (N) to help manage input costs and accrue soil quality benefits. The age-old practice of green manuring, especially in conjunction with wheat, can produce significant creditable N for corn the next year. It also protects the soil and may be eligible for cost share under local and Federal conservation programs.

Multi-year research in Wisconsin has demonstrated that red clover (*Trifolium pratense*) is the most productive and reliable legume choice for green manuring if interseeded into winter wheat in early spring (table 1). Interseeded red clover captures the entire growing season which helps maximize nitrogen credits. Seeding clover or other forage legumes after wheat harvest is more risky due to the potential for dry conditions and a shorter growing season. Delayed germination and slow growth frequently limit seeding year yield and N production when seeded after wheat harvest. Adequate rainfall in August is critical for producing acceptable yield for summer seedings (figure 1). Red clover offers the additional advantage of being a non-host for soybean cyst nematode, a problem with many of the other legume cover crop options.

Figure 1. Impact of August rainfall on clover biomass yield.  
Stute, 2009

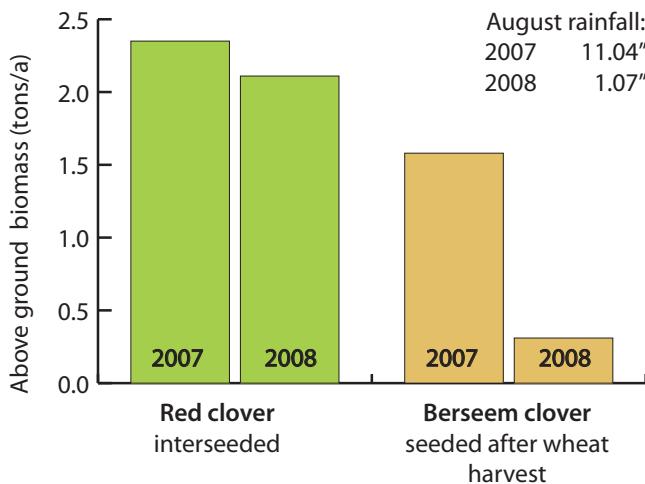


Table 1. Above ground biomass yield for cover crops seeded with or after winter wheat in Wisconsin, 1991-2008. Various sources, published and unpublished data from WI, 1991-2008.

Legume	Above Ground Biomass Yield Mean* (tons/a)	Range	Site Years of Data
<b>Interseeded</b>			
Red clover	1.70	0.33 - 3.26	24
<b>Seeded after harvest</b>			
Hairy vetch	1.37	0.67 - 2.16	10
Crimson clover	0.83	0.69 - 0.97	2
Berseem clover	1.00	0.31 - 1.58	9
Annual sweetclover	0.88	0.18 - 1.72	3
Annual medic	1.00	0.51 - 1.94	8
Chickling vetch	0.49	0.39 - 0.59	2
Annual alfalfa	0.39	0.38 - 0.40	2

\*N yield does not necessarily correspond to creditable N.



Red clover in September. In addition to nitrogen credits, it provides season-long soil cover.

For more information, contact Kevin Shelley at (800) 994-5853.

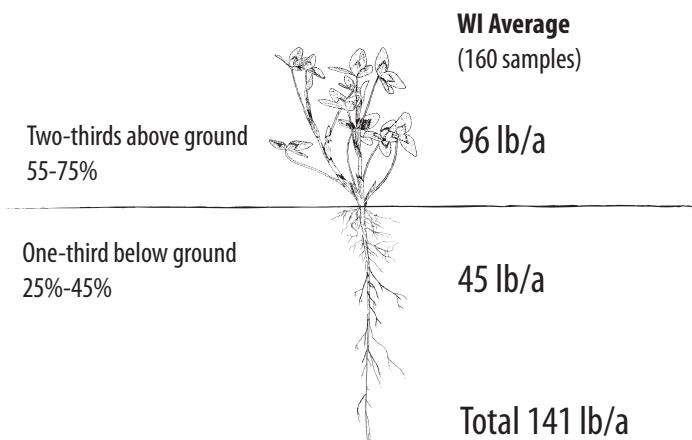
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phone: (608) 265-2660 website: [ipcm.wisc.edu](http://ipcm.wisc.edu) I-0209-3C



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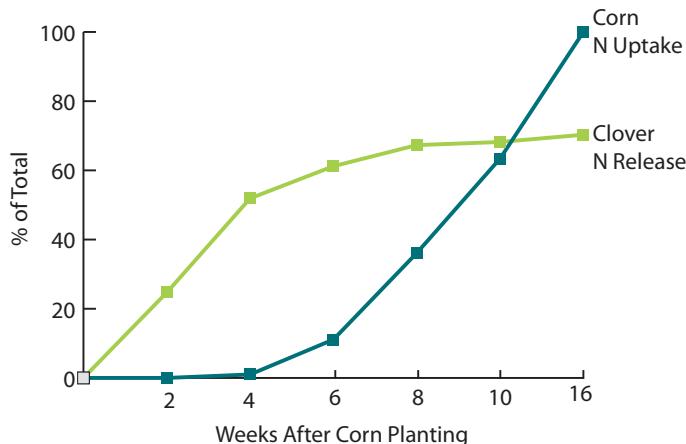
**Figure 2.** Nitrogen distribution in unharvested red clover biomass.



### How much nitrogen?

Current UWEX recommendations suggest that unharvested red clover green manure can supply 50 to 80 lb N/a to a following N-demanding crop such as corn, depending on stand quality. These "nitrogen credits" are based on plant biomass production including above ground parts as well as roots which contribute significantly to total N production (figure 2). Higher biomass production will result in higher N credits and the need for less fertilizer N. Whole-plant carbon to nitrogen (C:N) ratios for red clover range from 11:1 to 17:1. This is low enough to allow rapid decomposition of clover residue, releasing plant-available N for corn uptake. Wisconsin data suggest that approximately 70% of whole-plant N will become available in the first year following the clover, most released before corn begins its period of rapid uptake (figure 3).

Using the recommendations outlined below will help produce creditable N at the high-end of the range if not beyond. Table 2 demonstrates how this on-farm, organic source of N can be cost competitive with purchased fertilizer sources of N.



**Figure 3.** Relationship between clover nitrogen release and corn nitrogen uptake under conventional tillage. Adapted from Stute and Posner (1995) Agron. J. 1063-1069.

**Table 2: EXAMPLE – Cost of Red Clover N (\$/lb) at a range of seed costs (\$/50 lb bag) versus fertilizer N (\$/lb) at a range of fertilizer prices. Assumptions: Clover credit = 80 lbs N/ac; Clover seeding rate = 12 lbs/ac.**

Red clover (\$/50 lb)	82-0-0		28-0-0		
	(\$/ lb N)	(\$/ton)	(\$/ lb N)	(\$/ton)	(\$/ lb N)
80	0.24	600	0.37	200	0.36
90	0.27	700	0.43	250	0.45
100	0.30	800	0.49	300	0.54
110	0.33	900	0.55	350	0.63
120	0.36	1000	0.61	400	0.71
130	0.39	1100	0.67	450	0.80
140	0.42	1200	0.73	500	0.89

### The Cropping System

Properly managed, interseeded red clover will not reduce wheat yield or interfere with harvest, but will capture 90 days of sunlight which is normally wasted. Nitrogen and carbon will be fixed and added to the soil after the clover is killed and plants decompose. Fewer herbicide options for broadleaf weed control is the only limitation of this practice on wheat production.

Red clover is typically "frost seeded" in mid-March, after snowmelt, when cracks form on the soil surface. The frozen soil supports application equipment and broadcast seed falls into the cracks which seal upon thawing, resulting in good stands. Seed can be broadcast with an ATV or 3-point mounted spinner type seeder or it can be spread in conjunction with spring fertilizer applications using airflow equipment. This range in seeding options makes the practice "scale neutral", implementable on any size farm. Following wheat harvest, the clover grows into late fall and should be managed to maximize growth and creditable N. The following steps will help insure success with all components of this system.



Broadcast seeder mounted on a utility vehicle.

# Frost Seeding

Frost seeding is actually "cracked soil surface" seeding. Either freezing or drying will result in surface cracks on most soil types. Frost cracking occurs almost every year but spring rainfall often prevents dryness cracking. Seed falling into the cracks is placed at an ideal depth, resulting in stands similar to those produced by drilling. Seed can be broadcast until mid-April if cracks are present and the traditional frost-seeding window is missed. Seeding beyond mid-April has been done successfully, but is more risky because wheat becomes too competitive and the seedlings may not establish well enough to be productive after wheat harvest.

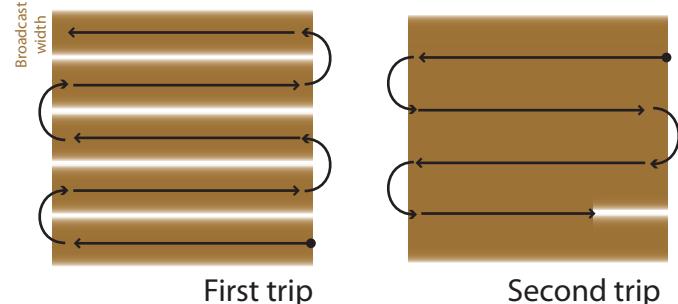
Usually, ideal conditions for frost seeding occur in mid to late March. Low overnight temperatures cause the surface to freeze and crack. Warm daytime temperatures thaw the surface, sealing the cracks. If daytime thawing occurs, the daily "window" for seeding lasts only a few hours, beginning at dawn. Driving on thawing soil will compact it and may injure the wheat. With subfreezing daytime temperatures, seeding can occur anytime during the day.

Ideal frost seeding conditions may only occur a few days each year so preparation and close monitoring of field conditions are essential for success. Seed should not be broadcast before mid-March even if conditions are ideal because extreme cold temperatures can still occur and may kill seedlings.

Broadcasting equipment will require calibration. Factors affecting seeding rate include the gate opening, broadcast width and ground speed. Most equipment manufacturers provide setting recommendations that can be used as a guide. Actual seed flow through the gate may vary due to seed size, condition of the seed (cleanliness), addition of inoculant or other seed coating and equipment wear. Broadcast width and travel speed are easier to measure and adjust. Some trial and error may be required. Begin cautiously to reduce the risk of wasting seed with an excessive rate and possibly running out of seed before the field is finished.

Double spreading at one-half the desired seeding rate will reduce or eliminate skips and aids calibration. Adjust the gate setting to the manufacturers recommendation for the one-half rate and broadcast seed using the specified ground speed for the first trip over the field, keeping centers as uniform as possible to minimize skips and overlap (figure 4). At the end, determine the amount of seed used and calculate the seeding rate based on acreage covered. Make necessary adjustments to either gate opening or travel speed and complete the second trip, splitting the centers of the first trip. Driving over these "seams" of the first application will eliminate skips.

Figure 4. Pattern for double broadcast-spreading over clover seed.



Recheck calibration by determining the amount of seed used on the second trip. To insure adequate coverage of field edges, reduce the gate setting and make a final lap around the field, spaced one-half the spread width from the field edge. Protective eye wear should be worn when operating broadcast equipment.

## Wheat

Optimize wheat production with variety selection, optimal planting date, recommended seeding rates and planting depth, and using recommended N fertilizer rates with proper application timing (check with your County UWEX office for wheat management recommendations). No-till establishment of wheat into soybean residue speeds planting and will result in more surface residue which may improve clover stands because it provides many small crevices where seed can fall and be protected. Watch planting restrictions due to previous herbicide applications. If wheat can be legally planted, there are no restrictions on red clover.

The need for chemical weed control in wheat should be considered carefully. MCPA (amine formulation) is the only post emergence herbicide labeled for wheat underseeded with red clover. Follow label directions to minimize clover injury. Consult UWEX publication A3646 *"Pest management in Wisconsin field crops"* for more information (available at: <http://learningstore.uwex.edu/>).

## Red clover

Broadcast inoculated seed of the cheapest medium red clover available at a rate of 10-12 lb/a. Improved varieties are more expensive because they're primarily bred for stand persistence and multi-year forage yield, unnecessary traits for green manure. The seeding rate is based on approximately 50 seeds per square foot. Seeding rate should be increased if germination is less than 70%, assuming high purity seed. Most seed is preinoculated but raw seed can be inoculated with standard peat-based products just before spreading, using a "clover type" inoculant strain. The need for inoculant should be confirmed when ordering seed because it also may require



Clover clipped with a stalk chopper (left) and unclipped (right) in mid-October.

a special order. Preinoculated seed which is more than a year old, or that may have been stored under less than ideal conditions should have fresh inoculant applied before seeding.

### Clover management

Clover can be clipped to control weeds, remove diseased tissue, prevent or reverse flowering and to manage lush growth. Red clover is susceptible to powdery mildew and clipping in September results in new, healthy tissue while keeping plants vegetative and actively growing. This will also take care of pollinating common ragweed, which is frequently found in fields after wheat harvest. Most successful practitioners use either a rotary mower or stalk chopper for this purpose.

Clover should be terminated in the fall to aid subsequent field operations and prevent soil moisture depletion the next spring. A combination of glyphosate and growth regulator (such as 2,4-D or dicamba) herbicides should be used to ensure complete kill. As with most forage legumes, red clover is tolerant of glyphosate and high rates don't necessarily result in plant death. Consult UWEX publication A3646 for details. Fall tillage without chemical termination often results in incomplete kill. In no-till systems, residue can be fluffed in spring to aid soil drying and warming. A rotary harrow or hoe works well for this purpose. Nitrogen credits are the same whether the clover residue is incorporated with tillage or is left on the surface, following chemical burn down, for no-till planting.



Clover seedlings under maturing wheat. Their small size does not interfere with wheat harvest.

## Nitrogen management for the following corn crop

UW-Extension nitrogen rate recommendations for corn can be found in UWEX publication A2809, "Nutrient application guidelines for field, vegetable, and fruit crops in Wisconsin" (available at: <http://learningstore.uwex.edu/>).

The base N recommendation can be reduced according to the N credits from the clover cover crop. For clover seeded in the spring and killed after a full season of growth, the credit guideline is 80 lb N/a. Both clover biomass production and weather conditions the following spring will determine the level of creditable N. With favorable weather, good soil condition and optimal clover management, N credits may exceed this guideline. However, if total above ground growth for the season is less than 6 inches in height the N credit should be reduced to 40 lb N/a. Experience will help judge the level of biomass production and corresponding credits. Also, field studies have shown that N credits may be lower in years with a cool, wet spring that slow plant residue decomposition and N release. Early-season conditions should be considered when determining a nitrogen management program following clover. The preside-dress soil nitrate test (PSNT) can be used to guide applications of supplemental N, particularly when weather conditions suggest N release from the clover may be delayed. Details of the PSNT can also be found in UWEX publication A2809.

### Nitrogen application strategies

Fertilizer nitrogen can be applied early in the season (preplant or preemergence) or mid-season as a sidedress application. For early-season applications, subtract the estimated N credit from the base N rate to determine the application rate. For sidedress applications, either the credit method or PSNT can be used to determine rate. When planning on mid-season application, use of starter fertilizer at planting will help insure adequate early-season N availability, especially if conditions delay clover decomposition and N mineralization. Up to 20 lb N/a can be applied as starter.



Corn no-till planted into red clover residue.