

COVER CROPS AND NITROGEN CREDITS

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Introduction

With dramatic fluctuations in feed, fuel, and fertilizer prices, much attention is again being paid toward use of cover crops in agricultural systems. Cover crops provide benefits to agricultural systems such as reductions nitrogen (N) loss and potential reduction in N fertilizer need to maintain crop yields. Cover crops in Wisconsin's agricultural systems are most often used prior to corn following a short season crop such as winter wheat, potatoes, or vegetables. There are two main types of cover crops used in Wisconsin: (1) cool-season grasses and (2) legumes. Cool-season grasses are primarily used to provide ground cover in cropping systems that leave little residue after harvest in effort to reduce soil erosion. Leguminous cover crops are used to add N into the soil system through biological fixation of atmospheric N. When these legumes are incorporated into the soil, this "fixed" N becomes plant available as the soil tissue decomposes. Legume crops are grown for one season or less, and incorporated into the soil without harvesting, are referred to as green manures. Current UW recommendations are to take N credits when utilizing green manures such as alfalfa, sweet clover, red clover, and hairy vetch (Table 1). However, several field studies conducted in the past decade indicate that cool-season grasses and other green manures such as berseem clover, crimson clover, and medic also impact the economic optimum N fertilizer rate (i.e., the N fertilizer rate that maximizes the economic return to N based on the price ratio of N fertilizer and corn). This paper summarizes recent research related to both cover crop types in Wisconsin.

Table 1. Green manure N credits in A2809

| Crop | <6" growth | >6" growth |
|--------------|---------------|------------|
| | lb N/a credit | |
| Alfalfa | 40 | 60-100† |
| Red clover | 40 | 50-80† |
| Sweet clover | 40 | 80-120† |
| Vetch | 40 | 40-90†‡ |

† Use upper end of range for spring seeded legumes, lower end of range for fall seeded

‡ For vetch >12" of growth, use 110-160 lb N/a

Cool-season grasses

Cool-season grasses, such as rye, oat, and triticale, are used in Wisconsin to provide ground cover to reduce soil erosion following potato and vegetable crops on the Central Sands region of Wisconsin. Outside of the Central Sands region, these grasses are used to establish ground cover following corn silage removal. These grasses establish quickly, providing adequate ground cover in a short amount of time. They have also been referred to as "catch" crops, as they can take up N during the non-growing season, reducing N leaching losses. For example, it has been shown that cover cropping with rye is a valuable management tool in reducing nitrogen (N) losses during winter months on tile drained land in Indiana (Kladivko et al., 2004). While cover crops have

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many positive soil conservation and water quality effects, consistent economic gains relative to corn yield or reduced N rates have not been discovered. However, recent research by Andraski and Bundy (2005) provide evidence that the use of rye, oat, and triticale in the Central Sands have a positive economic return relative to a reduction in N rates, an increase in corn yields, or both (Table 1). In this 3-year study (2001–2003), cover crops were planted in late August following harvest of sweet corn, and incorporated in May prior to planting of field corn. In 2 of 3 years, the economic optimum N rate (EONR) was between 22 and 35 lb/a and in 2 of 3 years, cover crops led to a corn yield increase between 20 and 32 bu/a (EONR determined at a N-fertilizer to corn price ratio of 0.10). The authors concluded that the potential yield increase from cool-season grasses as cover crops on the Central Sands is the most practical benefit, as a reduction in N fertilizer rates is risky on these soils with high leaching potential. Therefore, no N credits should be taken when using rye, oat, or triticale as cover crops, even when incorporated.

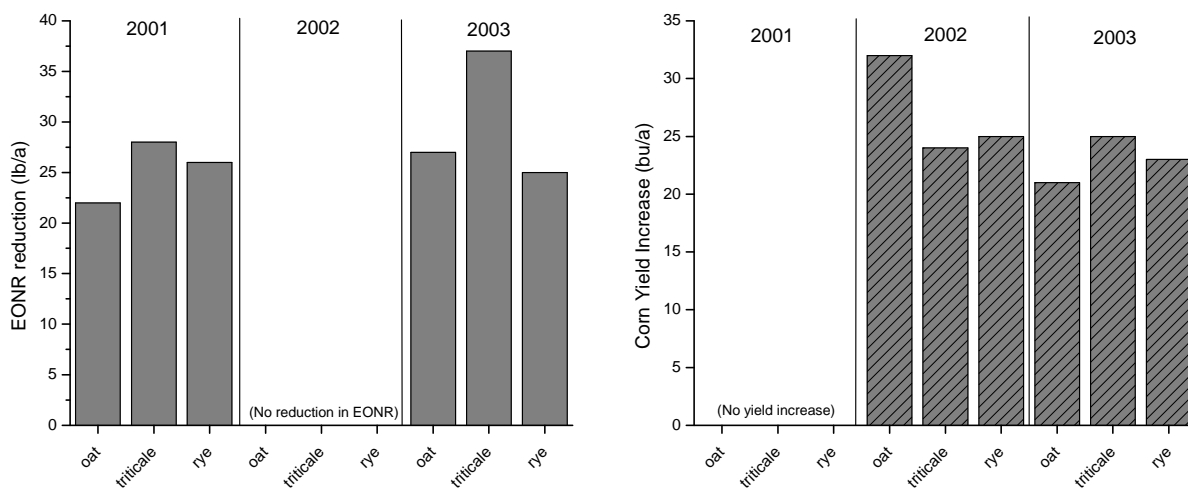


Figure 1. Reduction in the economic optimum nitrogen rate (EONR) (a) and increase in corn yield (b) attributed to use of cool-season grasses as winter cover crop. (Data adapted from Andraski and Bundy, 2005).

Legumes (Green Manures)

The value of green manuring in Wisconsin is most beneficial when legumes are planted after short-season crops such as vegetables and winter wheat and before high N demand crops such as corn. There are five main establishment practices associated with these crops: (1) frost seeded into winter wheat, (2) companion seeded with small grains, (3) spring-seeded (on fallow soil), (4) seeded after pea harvest (June-July), and (5) seeded after small grains (July-August). It is often most beneficial to allow as much above ground production as possible before chemically killing the crop in late fall (prior to freezing conditions). After the cover crop has been incorporated into the soil and corn has been planted, N mineralizes from green manure in synchrony with corn N uptake (Fig. 2).

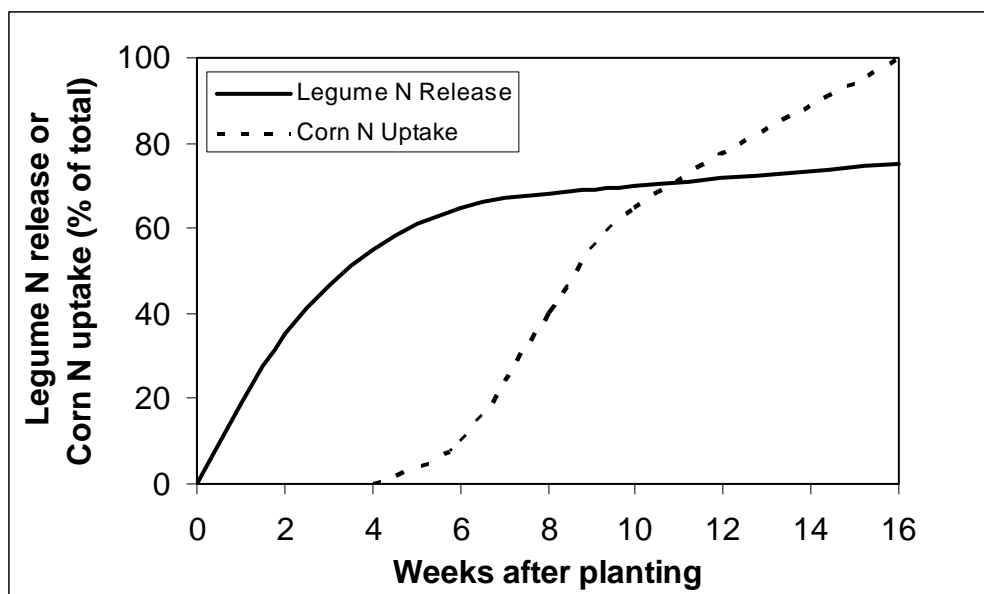


Figure 2. Synchrony between legume N supply and corn N uptake.

Table 2. Effect of cover crop type on economic optimum nitrogen rate (EONR) and corn yield at EONR at Lancaster, WI (N fertilizer to corn price ratio = 0.10) (Source: Stute et al., unpublished).

| Cover | 1999 | | 2001 | |
|----------------|-------|---------------|------|---------------|
| | EONR | Yield at EONR | EONR | Yield at EONR |
| | lb/a | bu/a | lb/a | bu/a |
| None | 105 | 204 | 96 | 140 |
| Hairy vetch | 86 | 209 | 27 | 145 |
| Alfalfa | +150† | 209‡ | 83 | 144 |
| Red Clover | +150† | 205‡ | 51 | 138 |
| Medic | +150† | 216‡ | 69 | 150 |
| Berseem clover | 84 | 207 | 84 | 149 |
| Crimson clover | 67 | 204 | 56 | 149 |

†The EONR is greater than the highest N rate in this study

‡The yield at the highest N rate in this study (i.e., 150 lb/a)

In Wisconsin, recent research has focused on the use of legumes following winter wheat. In 1999 and 2001, field studies were conducted at Lancaster, WI to reevaluate presently used cover crops (alfalfa, red clover, hairy vetch) and to evaluate new cover crops (berseem clover, crimson clover, medic) for EONR and corn yield. The experimental design was a randomized complete block, split plot with four replications. The main plot treatments were the six legume cover crops plus one treatment with no cover crop. The split plot treatments were six N rates (e.g. 1999: 0, 30, 60, 90, 120, and 150 lb/a; 2001: 0, 25, 55, 80, 100, and 135 lb N/a). In 1999, hairy vetch, berseem clover, and crimson clover reduced the EONR for corn compared to non-cover cropped systems (19, 21, and 38 lb/a, respectively) (Table 2). The EONR for three of the legume cover crops (alfalfa, red clover, and medic) were not maximized within the confines of

the experimental set up (i.e., yield increase was linear up to 150 lb/a). In 2001, a comparatively low yielding year, all legume cover crops reduced the EONR compared to the no cover crop system (range: 12 to 69 lb N/a) (Table 2). In contrast to results by Andraski and Bundy (2005), where cool-season grasses increased yields at the EONR, these green manure systems did not consistently or dramatically increase corn yields at the EONR. Therefore, the largest benefit of using legume cover crops for green manure is related to reduction in N inputs. While this is only two years of data, it does support the current UW recommendations for green manure N credits for corn.

Summary

Use of cover crops provides many agronomic and environmental benefits to agricultural systems in Wisconsin. Field research conducted over the past decades confirms the economic benefit of using cover crops in both the Central Sands and the Driftless regions of the state. Additionally, this research has discovered that berseem clover, crimson clover, and medic are equally effective of reducing EONR as more established green manures such as alfalfa, red clover, and hairy vetch.

For a complete listing of leguminous cover crops available for use in Wisconsin, see "Legume Cover Crops in Wisconsin: A Guide to Farmers" (Stute, 1996). It is important to remember that there are many factors that determine the effectiveness of cover crops. A given legume may or may not perform satisfactory under your soil conditions and management. Be aware that it may take a couple of years to find which legume works best on your soil.

References

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