Corn and Soybean Production with a Winter Rye Cover Crop

John Sawyer, professor
Jose Pantoja, graduate assistant
Daniel Barker, assistant scientist
Department of Agronomy

Introduction

Objectives of this project were to study corn nitrogen (N) fertilization requirement and corn/soybean yield response when grown in a rye cover cropping system. Multiple rates of N fertilizer were applied, with measurement of corn yield response to applied N and soybean yield with and without a fall planted winter rye cover crop. The study was conducted at multiple research farms, with the intent for comparison of with and without a cover crop system across varying soil and climatic conditions in Iowa.

Materials and Methods

The first year of the study was in 2009. Sites are the Ag Engineering/Agronomy Research Farm, Ames (Webster silty clay loam); Armstrong Research Farm, Lewis (Marshall silty clay loam); Southeast Research Farm, Crawfordsville (Mahaska silty clay loam); and the Northeast Research Farm, Nashua (Floyd loam). In 2011 an additional site was added at the Northwest Research Farm, Sutherland (Primghar silty clay loam). Each site was in a no-till corn-soybean rotation.

For all years, the winter cereal rye cover crop ("Wheeler" variety) was no-till drill planted at 1 bu/acre in the fall after soybean and corn harvest (Sept. 17 earliest and Oct. 29 latest, most late September through early October). The rye cover crop growth was controlled with Roundup in the spring, with the targeted control at least 7 days before corn planting and at or within one week of soybean planting (earliest Apr. 6 and latest May 20, most late April through early May). The corn and soybean crops were no-till planted in 30-inch rows. Rye control and corn/soybean planting occurred on a timely basis and as soil conditions allowed.

Fertilizer N rates were applied sidedress within two weeks after planting as urea-ammonium nitrate (UAN) solution (0, 40, 80, 120, 160, and 200 lb N/acre). The UAN was coulter-injected on 60-inch spacing. The corn hybrid and soybean variety were early season adapted for each site. Pest management practices were those typical for the region and rotations. Corn and soybean were harvested with a plot combine and yields corrected to standard moisture.

Results and Discussion

Rye growth and aboveground biomass production varied due to several factors, including site, spring conditions, and previous crop (Table 1). The Ames and Crawfordsville sites had the greatest rye biomass, which increased with increasing prior-year N rate applied to corn at those sites. Rye total N uptake corresponded to the amount of biomass (Table 2), but generally was low. Rye N uptake increased with increasing prior-year N rate at all but the Sutherland site.

For all sites, soybean yield was not affected by the rye cover crop (Table 3). Across sites and years, average yield was 59.1 bu/acre with rye and 59.0 bu/acre without.

The five-year average economic optimum N rate (EONR) was similar with or without the rye cover crop (Figure 1); a 6 lb N/acre higher EONR with the rye (157 vs. 151 lb N/acre). The corn grain yield at the EONR was 9 bu/acre lower (4.6%) with the rye cover crop (179 vs.188 bu/acre). Across all N rates, the corn yield was 7.6% lower with the rye cover crop, indicating the greater yield difference across low N rates. The general lack of difference in corn N fertilization need between with and without the rye cover crop would be related to the low rye N uptake following the soybean crop.

Acknowledgments

Appreciation is extended to the farm superintendents and their staff for assistance with this project. This project was supported in part by the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, through funds appropriated by the Iowa General Assembly. This research is part of a regional collaborative project supported by the USDA-NIFA, Award No. 2011-68002-30190, "Cropping Systems Coordinated Agricultural Project (CAP): Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems." Project Web site: sustainablecorn.org.

Figure 1. Corn yield response to N rate across sites with and without a rye cover crop, 2009-2013. Open symbols indicate the economic optimum rate.

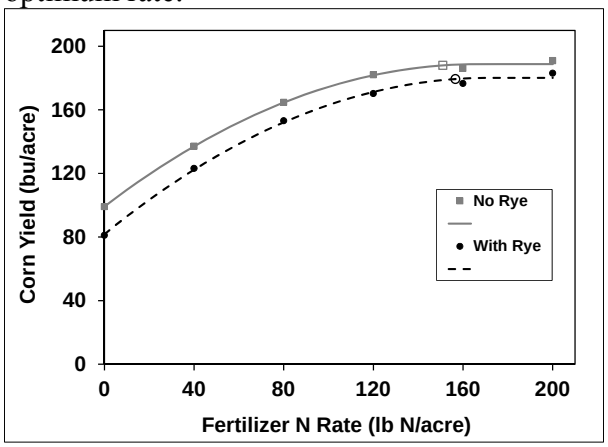

Table 1. Rye cover crop biomass dry matter before controlling growth with herbicide, 2009-2013.

Cover Crop	lb N/acre†	Ames	Crawfordsville	Lewis	Nashua	Sutherland
		- lb/acre -				
Before corn		726	840	585	384	214
Before soybean	0	1056c‡	1249c	766a	519b	635a
	120	1291b	1462b	880a	551ab	742a
	200	1750a	1989a	869a	724a	768a

† N rate applied to the prior year corn.

‡ Rye biomass amounts at a site followed by the same letter are not significantly different, $p \leq 0.10$.

Table 2. Rye cover crop total N uptake before controlling growth with herbicide, 2009-2013.

Cover Crop	lb N/acre†	Ames	Crawfordsville	Lewis	Nashua	Sutherland
		- lb N/acre -				
Before corn		20	26	18	14	8
Before soybean	0	18c‡	19b	16b	13b	13a
	120	25b	23b	22a	15b	17a
	200	42a	35a	24a	22a	19a

† N rate applied to the prior year corn.

‡ Rye total N amounts at a site followed by the same letter are not significantly different, $p \leq 0.10$.

Table 3. Soybean grain yield with and without rye cover crop, 2009-2013.

Cover Crop	Ames	Crawfordsville	Lewis	Nashua	Sutherland
	- bu/acre -				
With cover crop	54.4a†	58.5a	58.5a	61.2a	63.3a
Without cover crop	53.5a	59.0a	58.1a	62.4a	62.8a

† Yields at a site followed by the same letter are not significantly different, $p \leq 0.10$.