Nitrogen Fertilization Requirement and Corn-Soybean Productivity in a Rye Cover Cropping System

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INTRODUCTION

Nitrogen (N) fertilizer application can result in significant residual nitrate (NO_3^-) in the soil profile. Concerns about NO_3^- as the main contributor of N loading to water systems has led to increasing need for alternative practices to reduce loss from corn and soybean fields. Cover crops have shown the potential to utilize residual NO_3^-; however, their impact to row crops and corn N fertilization needs investigation. Due to seed cost and winter hardiness, winter cereal rye has been a popular cover crop choice. Our objectives are to determine optimum corn N fertilization requirements and corn-soybean productivity in a no-till system when grown in sequence with winter rye.

MATERIALS AND METHODS

The study includes the Ames CSCAP project site and three other Iowa sites.

- Main plots are rye and no rye in no-tillage corn-soybean rotation.
- Sub-plots are six early sidedress coulter-injected urea-ammonium nitrate (UAN) rates applied to corn (0 to 200 lb N/acre in 40 lb increments).
- Rye drilled (1 bu/acre) after fall crop harvest and sampled in spring at time of herbicide control.
- Planned rye control at least 7 days prior to corn planting and at or within one week before planting soybean.
- Crop canopy sensing performed at the mid-vegetative (V10) corn growth stage with a Crop Circle ACS-210 sensor.
- Aboveground corn biomass collected at plant maturity.
- Soil samples for NO_3^--N analysis collected preplant and early June from no N fertilizer plots and post-harvest in three N rates (0, 120 and 200 lb N/acre).

Table 1. Aboveground winter rye biomass dry matter before control wit herbicide.

Year	Crop	Ames	Crawfordsville	Lewis	Nashua
		lb DM/acre			
2009	Before corn	150	85	310	35
	Before soybean	290	1,110	195	190
2010	Before corn	1,460	1,000	1,245	1,020
	Before soybean	765	2,345	590	665
2011	Before corn	550	1,200	380	245
	Before soybean	640	1,510	555	320

Table 2. Soybean grain yield with and without rye cover crop.

Year	Cover Crop	Ames	Crawfordsville	Lewis	Nashua
		bu/acre			
2009	Rye	58.4a†	69.0a	65.2a	56.5a
	No rye	54.2b	69.8a	66.0a	57.8a
2010	Rye	53.6a	63.1a	61.0a	64.9a
	No rye	53.1a	61.7a	62.9a	65.9a
2011	Rye	56.5a	49.4a	66.9a	61.5a
	No rye	55.7a	53.8a	66.0a	62.0a

† Yields with the same letter within a site and year are not significantl different, $p \leq 0.05$.

Table 3. Corn grain yield at the maximum N rate response with and withou rye cover crop.

Year	Cover Crop	Ames	Crawfordsville	Lewis	Nashua	Mean
		bu/acre				
2009	Rye	193†	207	208	185	198
	No rye	203	214	214	191	204
2010	Rye	107	172	171	216	167
	No rye	151	201	191	224	191
2011	Rye	191	179	172	196	184
	No rye	193	190	169	207	189

† Yield at the point of maximum N response for each site determined fror regression equations.

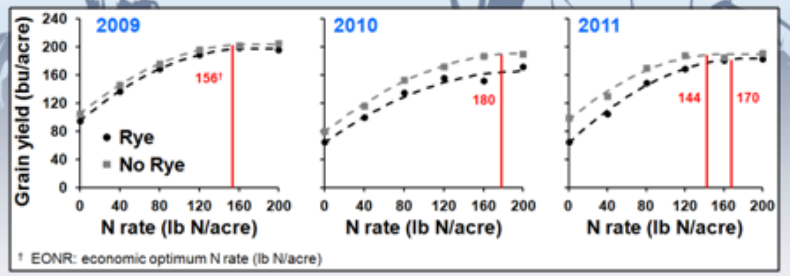

Fig. 1. Corn yield response to N rate across sites with and without rye.

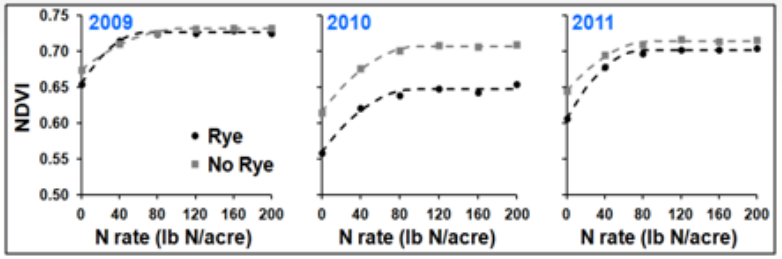

Fig. 2. Corn canopy normalized difference vegetative index (NDVI) response to N rate across sites with and without rye.

RESULTS AND DISCUSSION

Rye biomass varied due to differences in springtime conditions and control timing (Table 1). Rye N uptake was low in all cases (< 40 lb N/acre, data not shown). Profile soil NO_3^--N was low (< 5 ppm) at all sites and sampling times, with rye showing potential to reduce soil NO_3^--N in early spring (data not shown). Except for Ames in 2009, rye did not affect soybean yield (Table 2). Rye reduced corn grain yield (Table 3 and Fig. 1), with across site-years mean 13 bu/acre or 7% lower. The EONR was the same in two years, and 26 lb N/acre higher with rye in 2011 (Fig. 1). Across all site-years only 5 lb N/acre difference. The corn canopy NDVI at the V10 growth stage was reduced with the rye cover crop in 2010 and 2011 (Fig. 2), indicating a negative impact of the rye on corn establishment and early growth.

CONCLUSIONS

Including winter rye in the no-tillage corn-soybean cropping system did not affect soybean yield; however, corn early growth and yield were reduced. Across years, corn N fertilization requirement was the same with and without the rye cover crop. Data from a long-term period will help confirm these responses and the need for adjusting the N fertilization requirement in corn.

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