

2017

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Recommended Citation

Lundvall, John; Patel, Swetabh; and Sawyer, John (2017) "Enhancing Corn Yield in a Winter Cereal Rye Cover Crop System in Northwest Iowa," *Farm Progress Reports*: Vol. 2016 : Iss. 1 , Article 115.

DOI: <https://doi.org/10.31274/farmprogressreports-180814-1681>

Available at: <https://lib.dr.iastate.edu/farmprogressreports/vol2016/iss1/115>

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Enhancing Corn Yield in a Winter Cereal Rye Cover Crop System in Northwest Iowa

RFR-A1680

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Introduction

Water quality impairment related to nitrogen (N) is a concern in Iowa, including meeting nitrate (NO₃) drinking water standards and reducing the amount of N lost to the Gulf of Mexico. The Iowa Nutrient Reduction Strategy science assessment identified a rye cover crop as an important in-field management practice for reducing N and phosphorus (P) loss from fields (31% NO₃-N and 29% P), and for reducing soil erosion. However, the science assessment identified a corn yield reduction of 6 percent when grown following a rye cover crop. Lower corn yield with use of a cover crop is unacceptable to farmers, so it is important to identify practices that minimize impact on corn establishment, early-season growth, and yield. The objective of this project was to study production practices that might enhance corn yield when grown in a winter cereal rye cover cropping system.

Materials and Methods

The project was conducted in 2014-2016 at the Armstrong Research Farm, Lewis (Marshall silty clay loam); Southeast Research Farm, Crawfordsville (Mahaska silty clay loam); Northeast Research Farm, Nashua (Floyd loam); and the Northwest Research Farm, Sutherland (Primghar silty clay loam). Corn was rotated with soybean, with winter cereal rye before corn. The sites had a multi-year history of rye and no rye cover crop and no-till.

Production practices, compared in a split-split-split plot arrangement, were rye cover crop and no cover crop, no-till and spring disk/field cultivate for corn, and with or without starter N at 30 lb N/acre (urea placed 2 in. to the side and 2 in. below the seed at planting). Winter cereal rye (*Wheeler*) was inter-seeded by hand across the top of standing soybean prior to leaf drop in early-to-mid September. Rye seeding rate was 1.5 bushels/acre in fall 2013 and 2.0 bushels/acre in fall 2014–2015. Rye growth was terminated each spring with glyphosate in no-till and tilled treatments when rye reached 6 to 8-in. extended leaf height, and as soil conditions allowed. Spring tillage occurred after glyphosate application and corn planted at least two weeks after rye termination. The main N application was side-dress injected urea-ammonium nitrate solution, with total-N rate for all corn plots totaling 150 lb N/acre.

There was no rye cover crop preceding soybean, and soybean was grown with either no-till or fall chisel plow/spring disk-field cultivate tillage to maintain tillage systems. Adapted corn hybrids and soybean varieties were planted in 30-in. row spacing.

Results and Discussion

As the rye was terminated at a 6 to 8-in. height, the amount of rye biomass and N uptake was low across sites (546 to 922 lb dry matter and 12 to 25 lb N/acre). Nevertheless, two-ft spring soil profile NO₃-N samples collected from cover crop plots at rye termination averaged 15 lb NO₃-N/acre, versus 40 lb NO₃-N/acre with no cover crop. Corn population was not affected by the cover crop.

Over the years of the study at the Northwest Research Farm, Sutherland, neither tillage nor

starter fertilizer influenced corn yield. Only yields for 2015–2016 are shown due to a planting error in 2014 (Table 1). Perhaps because of only two years of data, the small amount of rye biomass at termination at the site each year, and waiting two weeks to plant corn, there was no corn grain yield reduction with the rye cover crop compared with no rye.

Across the three years of study at all sites, no-till and the rye cover crop resulted in lower corn yields relative to tillage and no rye cover crop (Table 2). The yield reduction effect from the rye cover crop was only 2 percent. The starter N fertilizer increased corn yield by 1 bushel/acre, a difference that was not statistically significant ($P > 0.10$). Although yield response to the 2 x 2 placed high N starter rate was not consistent at all sites (-7 to +11 bu/acre), starter N enhanced corn early growth and has potential to offset negative corn yield effects of a rye cover crop, especially with the main N sidedress applied. Although tillage before corn increased yield

(1 to 10 bu/acre, 3% across sites) with or without the rye cover crop, tillage needs to be carefully considered on sloping soils due to increased soil erosion potential offsetting benefits of the rye cover crop.

Acknowledgements

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 and Water Quality, State Soil Conservation Committee Research and Demonstration grant. Funding also provided through the 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.”

Table 1. Effect of rye cover crop (RCC), tillage, and starter N on corn yield (Northwest Research Farm, Sutherland, IA, 2015-2016).[†]

Starter	RCC			No RCC			Tillage mean		Starter mean
	Till	No-till	Mean	Till	No-till	Mean	Till	No-till	
----- bu/acre -----									
Starter	238	236	237	243	239	241	240	238	239
No starter	241	246	243	240	239	240	241	242	241
Tillage mean	240	241		242	239		241	240	
RCC mean			240			240			

[†]No main treatment effects, nor any treatment interactions, were statistically significant, $P \leq 0.10$.

Table 2. Effect of rye cover crop (RCC), tillage, and starter N on corn yield (across 10 site-years at four ISU research farms near Sutherland, Nashua, Lewis, and Crawfordsville, IA).

Starter	RCC			No RCC			Tillage mean		Starter mean
	Till	No-till	Mean	Till	No-till	Mean	Till	No-till	
----- bu/acre -----									
Starter	207	203	205	212	205	208	210	204	207
No starter	205	201	203	210	204	207	208	202	206
Tillage mean [†]	206	202		211	204		209a	203b	
RCC mean [†]			204b			208a			

[†]Means followed by different letters (rye cover crop and tillage) are significantly different, $P \leq 0.10$.