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

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Introduction

Water quality impairment related to nitrogen (N) is a concern in Iowa, including meeting nitrate (NO_3) 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% NO_3-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 the fall 2013 and 2.0 bushels/acre 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

Aerial inter-seeding rye into standing soybean resulted in a less-uniform stand compared with the previous study with rye drilled after crop harvest. As the rye was terminated at a 6-8 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, 2-ft spring soil profile NO_3-N samples collected from cover crop plots at rye termination averaged 15 lb NO_3-N/acre, versus 40 lb NO_3-N/acre with no cover crop. Corn population was not affected by the cover crop.

Over the years of the study at the Southeast Research Farm, Crawfordsville, tillage increased grain yield by 10 bushels/acre with or without rye cover crop, but starter N reduced yield by 7 bushels/acre; yields only for 2015-2016 due to a tillage error in 2014 (Table 1). Perhaps because of only two years of data, the small amount of rye biomass, and waiting two weeks to plant corn, there was no significant effect of the 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 negative yield 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 significant ($P > 0.10$). Although yield response to the 2 x 2-placed high N starter fertilizer 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 fertilizer applied as a sidedress. 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.

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Table 1. Effect of rye cover crop (RCC), tillage, and starter N on corn yield (Southeast Research Farm, Crawfordsville, IA, 2015-2016).

	RCC			No RCC			Tillage mean		Starter
Starter	**Till**	**No-till**	**Mean**	**Till**	**No-till**	**Mean**	**Till**	**No-till**	**mean†**
	- bu/acre -								
Starter	208	202	205	213	202	207	210	202	206a
No starter	217	201	209	220	213	216	219	207	213b
Tillage mean†	213	201		216	208		214a	204b	
RCC mean			207			212			

†Means followed by different letters (tillage and starter fertilizer) are significantly different, $P \leq 0.10$.

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).

	RCC			No RCC			Tillage mean		Starter
Starter	**Till**	**No-till**	**Mean**	**Till**	**No-till**	**Mean**	**Till**	**No-till**	**mean**
	- 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, $P \leq 0.10$.