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Enhancing Corn Yield in a Winter Cereal Rye Cover Crop System in Northeast 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, two-ft spring soil profile NO_3-N samples collected from cover crop plots at rye termination averaged 15 lb NO_3-N/acre, vs. 40 lb NO_3-N/acre with no cover crop. Corn population was not affected by the cover crop.

Over the three years of study at the Northeast Research Farm, Nashua, tillage increased corn grain yield relative to no-till, but starter N did not affect yield (Table 1). The 7 bushels/acre lower corn yield with the rye cover crop compared with no rye was not statistically significant ($P > 0.10$).

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 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 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 (Northeast Farm, 2014-2016).

	RCC			No RCC			Tillage mean		Starter
Starter	Till	No-till	Mean	Till	No-till	Mean	Till	No-till	mean
					bu/acre				
Starter	195	185	190	202	194	198	199	190	194
No starter	194	188	191	199	194	197	196	191	194
Tillage mean	194	186		201	194		198a	190b	
RCC mean			190			197			

†Means followed by different letters (tillage) 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 and demonstration 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, $P \leq 0.10$.