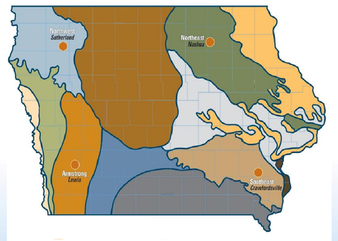
1339

Enhancing Corn Yield in a Winter Rye Cover Crop System

Swetabh Patel, John E. Sawyer, and John P. Lundvall
Department of Agronomy, Iowa State University



INTRODUCTION

Nitrate leaching from corn (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] is a major water quality concern, with the Iowa Nutrient Reduction Strategy identifying a 41% total-N reduction from agricultural production needed to meet the Gulf Hypoxia task force recommendation. Cover crops are a promising in-field management practice to reduce nitrate-N loss to water systems. Winter cereal rye (*Secale cereale* L.) is most often the cover crop of choice due to its availability, establishment options, and winter hardiness. However, the Iowa Nutrient Reduction Strategy also identified a corn yield reduction of 6% when grown following a rye cover crop (RCC). This yield reduction could play a key role in compromising the wide-scale adoption of RCC. The objectives of this research were to study the potential of agronomic practices to improve corn yield with a RCC system.

MATERIALS AND METHODS

This study was conducted in 2014 and 2015 at four Iowa State University research farms (see map inset), with a corn-soybean rotation. Rye (Wheeler variety) and no RCC were main plot, tillage and no-till split-plot, and starter and no starter the split-split plot; with four replications. Before initiation of this study, all sites were in a no-till corn-soybean rotation since 2009; also with the RCC treatment present. Statistical analysis was conducted across site-years (SAS Institute, 2012). Two sites in 2014 were not included in the analysis due to planting or tillage issues.

Winter cereal rye was aerial broadcast (125 kg ha^{-1}) in the fall into standing soybean before leaf drop. Tillage before corn was spring disk/field cultivate and before soybean fall chisel plow with spring disk/field cultivate. Starter was urea placed beside and below the seed (5 cm by 5 cm) at 34 kg N ha^{-1}. Urea-ammonium nitrate (UAN) solution was injected early sidedress to provide a total rate of 168 kg N ha^{-1}. Aboveground RCC biomass was determined in the spring at the time of rye control. Rye control was intended to not delay corn planting date, and would occur at 15-20 cm height. Corn was planted after two weeks following rye control. Corn plant population was determined at the V6 growth stage and corn canopy was sensed at V10 growth stage using a RapidSCAN CS-45 sensor (Holland Scientific) for normalized difference red edge index (NDRE). Corn grain yield reported at 155 g kg^{-1} moisture.

Table 1. Effect of cover crop, tillage, and starter on corn plant population (across site-years).

	RCC			No RCC			Tillage mean		Starter
Starter	Till	No-Till	Mean	Till	No-Till	Mean	Till	No-Till	mean
	plants ha^{-1}								
Starter	78423	82392	80407	79185	81787	80486	78804	82089	80447
No Starter	78939	81495	80217	79230	81248	80239	79084	81372	80228
Tillage mean	78681	81944		79208	81517		78944b	81731a	
RCC mean			80312			80363			

Only main treatment effects were significant, with different letters indicating significant differences ($P \leq 0.10$).

Table 2. Effect of cover crop, tillage, and starter on corn canopy NDRE index (across site-years).

	RCC			No RCC			Tillage mean		Starter
Starter	Till	No-Till	Mean	Till	No-Till	Mean	Till	No-Till	mean
	NDRE								
Starter	0.400	0.396	0.398	0.398	0.394	0.396	0.399	0.395	0.397a
No Starter	0.394	0.394	0.394	0.394	0.388	0.391	0.394	0.391	0.393b
Tillage mean	0.397	0.395		0.396	0.391		0.397	0.393	
RCC mean			0.396			0.394			

Only main treatment effects were significant, with different letters indicating significant differences ($P \leq 0.10$).

Table 3. Effect of cover crop, tillage, and starter on corn grain yield (across site-years).

	RCC			No RCC			Tillage mean		Starter
Starter	Till	No-Till	Mean	Till	No-Till	Mean	Till	No-Till	mean
	Mg ha^{-1}								
Starter	12.6	12.4	12.5	13.0	12.5	12.8	12.8	12.4	12.6a
No Starter	12.4	12.2	12.3	12.8	12.3	12.6	12.6	12.2	12.4b
Tillage mean	12.5	12.2		12.9	12.4		12.7a	12.3b	
RCC mean			12.4b			12.7a			

Only main treatment effects were significant, with different letters indicating significant differences ($P \leq 0.10$).

RESULTS AND DISCUSSION

- Across site-years, there was no interactive effects of RCC, tillage, or starter on corn early season plant population, mid-vegetative canopy sensing, and corn grain yield (Tables 1, 2 and, 3).
- Starter and RCC had no effect on early season corn plant population (V6 growth stage), however, corn population was greater with no-till than with tillage (Table 1).
- Corn canopy NDRE index (V10 growth stage) was greater with the N starter than no starter (across RCC and tillage) (Table 2), indicating a positive impact of starter fertilizer on corn early vegetative growth. The starter effect also translated to an increase in corn yield.
- Corn yield was greater with the N starter than no starter (across RCC and tillage), but corn yield was lower with the RCC than no RCC (across starter and tillage) (Table 3). Corn yield was also lower with no-till than with tillage.
- The RCC biomass (across site-years) was low due to poor rye stand in 2014, and due to the intent for RCC control at 15-20 cm rye height (Table 4). The RCC biomass was greater in the tilled versus no-till system. Despite the low amount of RCC, corn yield was reduced 2.4% in the RCC system, with the N starter helping to offset the yield reduction.

Table 4. Effect of tillage and starter on RCC biomass production (across site-years).

	Tillage		
Starter	Till	No-Till	Mean
	kg ha^{-1}		
Starter	272	220	246
No Starter	258	236	247
Mean	265a	228b	

Only main treatment effects were significant, with different letters indicating significant differences ($P \leq 0.10$).

CONCLUSIONS

While the RCC resulted in reduced corn yield, mid-vegetative canopy sensing NDRE index and grain yield was increased with the 5 cm by 5 cm placed N starter. This indicates that in a tilled or no-till RCC system with the main N applied sidedress, application of a high-N starter rate has the potential to offset potential negative RCC effects and improve corn yield.

ACKNOWLEDGMENT

Appreciation is extended to the Iowa State University research farm personnel for their assistance and timely coordination with the field work.

IOWA STATE UNIVERSITY
Department of Agronomy
Crop, Soil, and Environmental Sciences

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" sustainablecorn.org

SUSTAINABLE CORN.ORG
CROPS, CLIMATE, CULTURE AND CHANGE

USDA
United States Department of Agriculture
National Institute of Food and Agriculture