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Field Crops Research

Side-dressing Corn following a Winter Rye Cover Crop

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http://bit.ly/pfi_fieldcrops

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In a Nutshell

- Annually cover crop acres in Iowa are growing exponentially.
- The Iowa Nutrient Reduction Strategy has galvanized many farmers to search for bundles of in-field practices, which can reduce losses of both nitrogen and phosphorus from their fields.
- Side-dressing nitrogen and cover crops together is a common bundle being investigated by Iowa farmers concerned about soil health, water quality and return on investment of cover crops.

Project Timline:

2010; 2012; 2013

Tim Smith applying side dress nitrogen fertilizer on May 31, 2012.

Background

Cover crops are a rising trend with corn and soybean farmers due to their ability to retain soil structure (Scott et al. 1987), minimize soil organic matter loss (Wagger et al., 1988), reduce nitrogen leaching (Kaspar et al., 2007) and loss of phosphorus (Iowa Department of Agriculture and Land Stewardship et al., 2012). Winter rye is one such cover crop. Many times, nitrogen fertilizer is applied at the time of corn planting to maximize crop performance. Once the crop is a bit taller, fertilizer can be side-dressed to provide any additional N that may be needed. One method of measuring the nitrogen needed post-planting is by the late-spring soil nitrate test (LSNT), which reflects plant-available nitrogen in the soil (Kuo and Jellum, 2002).

Planting a cover crop protects the soil and prevents nutrients from leaching or running off; winter rye cover crop planted in fall was found to increase corn yield the following year in Wisconsin (Andraski and Bundy, 2005). While some trials have found no yield benefits the first year following an intercrop or cover crop, over several years the cover crop treatments yielded more corn than did unfertilized treatments in a study conducted in western New York State (Scott et al., 1987). In some studies conducted in Iowa, corn yield can be negatively impacted following a winter rye or other winter small grain cover crop (Carlson, 2012).

When a cover crop is used the level of management needed increases to ensure N availability to the cash crop. Side dressing fertilizer can be used to mitigate the risk of not having enough N available. Presence of a cover crop affects nitrogen forms in the soil and can greatly affect its productivity. During decomposition of a cover crop, nitrogen in the organic matter can be mineralized by microbes into ammonium and nitrate, which are plant-available forms on nitrogen. However, if the added organic matter has a high carbon-nitrogen ratio, as is the case with winter rye, net N immobilization can occur, thus reducing plant-available N in the soil.

This study compared the effects of high and low N rates on corn yields following a winter rye cover crop. Trials were conducted in 2010, 2012, and 2013 on three Practical Farmers of Iowa Cooperator farms: Rob Stout (West Chester), Tim Smith (Eagle Grove), and Jeremy Gustafson (Boone).

Methods

Cover crop and nitrogen rate treatments implemented on the three cooperator farms are listed in **Table 1**. Only at West Chester was a "no cover" treatment included in the trial.

Cover crop seeding dates, termination dates, termination methods, tillage operations, and corn planting dates are listed in **Table 2**.

All cover crops were established in fall following a soybean crop and sampled for biomass the following spring just prior to termination. At West Chester, liquid swine manure was injected in fall following soybean harvest both years. Additionally, 30 lb N/a as UAN (28% N) was applied with corn at planting. At Eagle Grove a dry fertilizer (18-60-90 with 25 lb S/a) was deep banded with the strip till pass following cover crop planting. At Boone 30 lb N/a as AMS was applied pre-plant in the spring.

Soil samples were collected in spring after corn emergence both years at West Chester and in 2012 at Eagle Grove. No samples were conducted at Boone in 2013. The late spring nitrate test was conducted at the Iowa State University Soil and Plant Analysis Lab. At Eagle Grove, corn leaf tissue samples were collected from each treatment on July 9, 2012 as well. Tissue N was measured by Ag Source Laboratories in Lincoln, Neb.

Data were analyzed using JMP Pro 10 (SAS Institute Inc., Cary, NC) and yield comparisons employ least squares means for accuracy. Statistical significance is determined at $P \leq 0.05$ level and means separations are reported using Tukey's Least Significant Difference (LSD).

Table 1

Replications, cover treatments, and side-dressed nitrogen rates and forms implemented on cooperator farms.

Location	Year	Reps	Cover treatment	Side-dressed N rates (lb N/a)	Side-dressed N form
West Chester (SE Iowa)	2010	3	With and without winter rye	0 and 50	UAN (28% N)
West Chester (SE Iowa)	2012	3	With and without winter rye	0 and 50	Urea (with Agrotain)
Eagle Grove (North central Iowa)	2012	4	With winter rye	100 and 140	UAN (32% N)
Boone (Central Iowa)	2013	5	With winter rye	110 and 150	UAN (32% N)

Table 2

Cover crop seeding dates, termination dates, termination methods, tillage operations, and corn planting dates, and side-dressing dates on cooperator farms.

Location	Cover crop seeding date	Cover crop termination date	Termination method	Tillage	Corn planting date	Side-dress date
West Chester (SE Iowa)	Sept. 16, 2009	April 12, 2010	Roundup Weathermax (32 oz./a)	No-till	April 17, 2010	June 7, 2010
West Chester (SE Iowa)	Sept. 13, 2011	April 26, 2012	Roundup Weathermax (40 oz./a)	No-till	May 21, 2012	June 25, 2012
Eagle Grove (North central Iowa)	Fall 2011	April 2, 2012	glyphosate (30 oz./a)	Strip-till	April 26, 2012	May 31, 2012
Boone (Central Iowa)	Sept. 1, 2012	April 20, 2013	glyphosate (32 oz./a) + 2,4-D (16 oz./a)	Strip-till	May 10, 2013	June 25, 2013

Results and Discussion

Total annual rainfall at West Chester in 2010 was 50 in. and in 2012 was 23 in. Normal rainfall at the farm is 33 in. Total annual precipitation at Eagle Grove in 2012 was 15 in., while the location average is 32 in. Total annual precipitation at Boone in 2013 was 29 in., just below the annual average of 35 in.

At West Chester, an average of 2074 lb/a and 3592 lb/a cover crop dry matter was measured in spring 2010 and 2012, respectively. At Eagle Grove, an average of 806 lb/a cover crop dry matter was collected in spring 2012. At Boone, an average of 910 lb/a of cover crop dry matter was observed in spring 2013.

Recommended side-dress N rates at West Chester and Eagle Grove, as calculated by the late spring nitrate test, are provided in **Table 3**.

At West Chester, corn yields were greater in 2012 than in 2010 (**Figure 1**). Bars with different letters above them are different (LSD = 29). In both years, neither cover crop nor N rate had any effect on corn yield. Corn yields were statistically similar regardless of presence or absence of cover crop or side-dressed nitrogen rate. Mean yield was 137.8 bu/a in 2010 and was 170.6 bu/a in 2012. Average corn yields in Washington County, Iowa were 132.5 bu/a and 132.1 bu/a in 2010 and 2012, respectively (National Agricultural Statistics Service, 2013). The LSNT recommended that both strips with cover and without cover receive 40-50 lb N/a in 2010 and recommended that strips with cover receive 40 lb N/a in 2012 (**Table 3**). Our results suggest the LSNT was overestimating the amount of side-dressed N necessary.

Table 3

	Side-dress nitrogen rate recommendations from late spring nitrate test.		
Location	**Year**	**Cover Crop Treatment**	**LSNT recommendation (lb N/a)**
West Chester (SE Iowa)	2010	With cover crop	40-50
West Chester (SE Iowa)	2010	Without cover crop	40-50
West Chester (SE Iowa)	2012	With cover crop	40
West Chester (SE Iowa)	2012	Without cover crop	0
Eagle Grove (North central Iowa)	2012	With cover crop	140

At Eagle Grove in 2012, corn following a winter rye cover crop yielded similarly between the high (140 lb N/a) and low (100 lb N/a) side-dress treatments (LSD = 8.3, lower-case letters; Figure 2). Mean corn yield between the two treatments was 169.2 bu/a. Average corn yield for Wright County, Iowa in 2012 was 153.7 bu/a (National Agricultural Statistics Service, 2013). The LSNT recommended a side-dress application of 140 lb N/a (**Table 3**), and the corn tissue test a month after side-dress N was applied showed that strips receiving the high and low rates were both deficient for nitrogen. Given that no yield difference was observed between the two side-dress N rates, our results again suggest that the LSNT was underestimating the amount of plant-available nitrogen and overestimating the amount of side-dressed N necessary as with the case at West Chester.

At Boone in 2013, corn yield following a winter rye cover crop was greater at the high (150 lb N/a) than at the low (110 lb N/a) side-dress rate (LSD = 5.4, upper-case letters; **Figure 2**). Corn yields were 149.7 bu/a and 143.5 bu/a at the high and low rates, respectively. At printing time, average corn yields for Boone County, Iowa were not available. As with at Eagle Grove, it is unknown what corn yield results would have been with high and low N rates following a "no cover crop" treatment. With the price of nitrogen ranging around $0.50/lb and corn prices this fall near $5/bu, the additional 40 lb N/a side-dressed in the high rate treatment did result in an increase in return of approximately $12.50/a compared to the low rate. The late spring soil nitrate test was not measured at this location.

Conclusion

Although the late spring nitrate test encouraged side-dressed N application to corn in 2010 and following a cover crop in 2012 at West Chester, no difference was observed between field strips that received 50 lb N/a and did not receive side-dress nitrogen. Similarly, while 140 lb N/a was recommended by the LSNT at Eagle Grove, no difference in corn yield was observed between strips receiving side-dress applications of 140 lb N/a and 100 lb N/a. From the trials at West Chester and Eagle Grove, our results suggest that the LSNT was underestimating the amount of plant-available nitrogen and overestimating the amount of side-dressed N necessary.

At Boone in 2013, the 150 lb N/a side-dress application following a cover crop resulted in a 6.2 bu/a increase in yield compared to the 110 lb N/a side-dress application.

Understanding nitrogen dynamics in wet and dry years is critical when cover crops are added to the farming system. Drought conditions in 2012 may have affected crop responses to nitrogen from the cover crop and side-dressed nitrogen. At Eagle Grove, the low side-dress rate yielded the same but cost $26.40/a less than the high rate, which nearly offset the generally accepted cost of successfully establishing cover crops (approximately $35/a). But in 2013, an extremely wet and then dry year, an extra $20/a worth of nitrogen added to corn following a winter rye cover crop resulted in an increase of 6.2 bu/a of corn. This netted the farm $12.50/a, which offset roughly a third of the cost of the additional expenses of the cover crop.

Results from these trials show that adding a winter rye cover crop to a corn production system may be an economical way to more efficiently use nitrogen fertilizer. The other realized benefits from a winter cover crop, like reductions in soil and phosphorus loss, make this practice a must for farmers looking to reduce negative externalities of crop production.

Figure 1

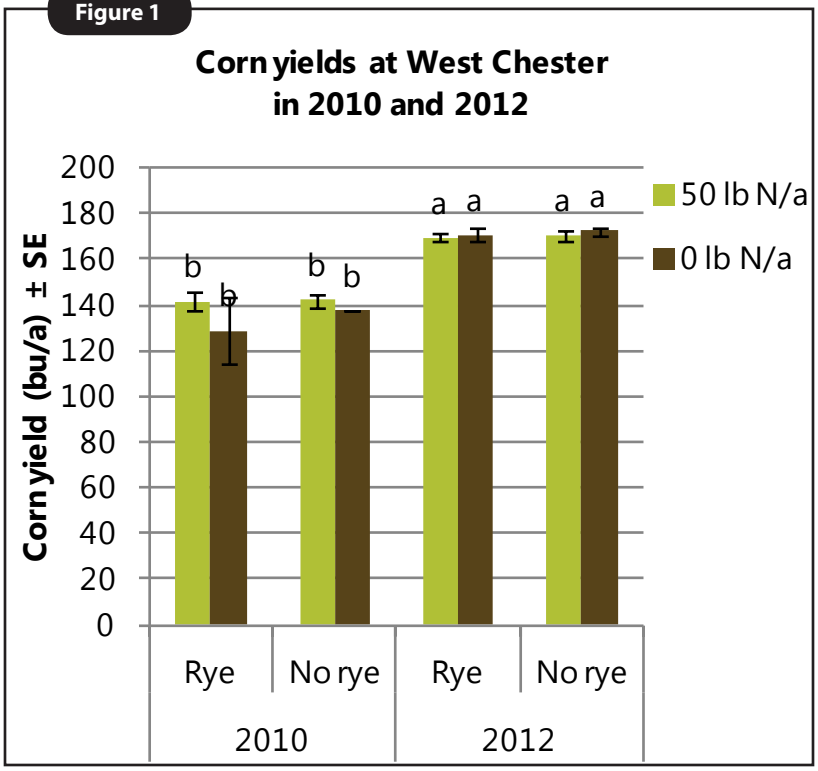
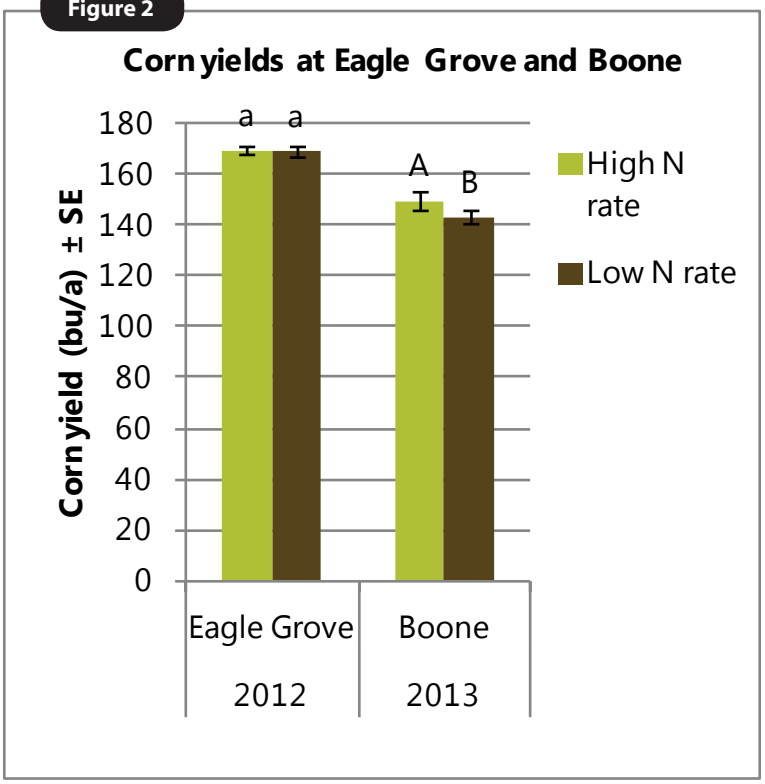


Figure 2



Winter rye shortly after germination.

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