COVER CROPS FOLLOWING CORN SILAGE AND WINTER WHEAT

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Abstract

Cover crops are widely used in Wisconsin following corn silage or winter wheat harvest to control erosion, but effects on subsequent corn yields and their optimum N rates have not been documented. Two separate studies were conducted to: (1) determine the effect of rye as a cover or silage crop on corn yields at varying N rates and (2) determine the effect of radish on corn yields and optimum N rates. In two of three years, a reduction in corn silage yield was determined following rye silage compared to rye as a cover crop, but no differences in yield were determined between no cover crop and rye cover crop in any year. Rye as a cover crop did not appear to influence optimal N application rates. However, with the addition of rye silage, total biomass production (i.e. total silage) in the rye silage system was equivalent or greater than other treatments in two of three years. These results show no negative yield effects from a rye cover crop on corn silage yield and a potential benefit of an increase in total feed production when the rye is allowed to grow and harvested. Radish had no effect on corn yield or response to N fertilizer compared to no cover crop. No N credit from radish was determined.

Introduction

Across Wisconsin, growers are experimenting with different techniques to conserve soil and plant nutrients, specifically nutrients applied as manure. Utilization of cover crops to provide these soil and nutrient conservation benefits are a popular method due to increased promotion of cover crops by seed dealers, government agency/programs, and extension field days. A recent survey (CTIC, 2013) of growers across the US – the majority of whom were in the Midwest - found that the most popular benefits from cover crops that growers wanted to obtain were: (1) reduction in soil compaction (58%), (2) reduction in soil erosion (56%), and (3) nitrogen scavenging (41%). Not surprisingly, winter cereal grains were listed as the most widely used cover crop (72% of survey respondents) because of their ability to achieve all three of these benefits. In addition, the most common management practices associated with use of cover crops were continuous no-till (55%) and manure applications (28%). Unfortunately, there is a lack of information on cover crop performance and impacts on subsequent crop management for Wisconsin growers to base their production decisions on. There is clear evidence of soil conservation (e.g. Kaspar et al., 2001) and soil quality (e.g. Jokela et al., 2009) benefits to using cover crops. However, there is a lack of regionally specific information on cover crop performance and effects on subsequent corn crop yield. With the prevalence of corn silage produced in Wisconsin, which is harvested in late-summer or early autumn, there is a clear opportunity for cover crops to be planted. In addition, it is likely that manure will be applied after corn silage harvest allowing cover crops to provide both soil and nutrient conservation benefits. There are potential trade-offs with cover crop use such as competition for soil water and nutrients and yield loss. The potential for yield loss is a real concern of Wisconsin farmers and there are quantified examples of corn yield reductions following a rye cover crop (e.g. 13 bu ac^{-1}

decrease reported by Stute et al., 2009). Radish is also a popular cover crop growing in Wisconsin following winter wheat. Radish has been documented to be an excellent scavenger of N (Dean and Weil, 2009; O'Reilly et al., 2012), but there is little evidence that it can offer an N credit. To address these issues regarding cover crops in Wisconsin, studies were conducted to: (1) determine the effect of rye as a cover or silage crop on corn yields at varying N rates and (2) determine the effect of radish on corn yields and optimum N rates.

Materials and Methods

Rye study

The rye study was conducted between 2011 and 2014 at the University of Wisconsin Arlington Agricultural Research Station on a Plano silt loam (fine-silty, mixed, superactive, mesic Typic Argiudoll). The experimental design was a randomized complete block, split plot design, with cover crop as the main plot factor and N rate as the split plot factor. The system is a no-till, continuous corn silage rotation with a fall application of liquid dairy manure (LDM). The whole plot treatments were no cover crop, rye grown as a cover crop (terminated in early spring), and rye grown as a silage crop (harvested in late spring). The split-plot treatments were 60, 100, or 160 lb-N ac^{-1}. The 100 lb-N ac^{-1} treatment represents the recommended N rate (after our fall application of LDM). The 160 lb-N ac^{-1} treatment represents the recommend N rate if ignoring a manure N credit. The plots were established after a late-summer corn silage harvest in 2011 and plots were maintained across both years (i.e. effects are cumulative). Liquid dairy manure was applied at a rate of 9,700, 11,800, and 12,000 gal ac^{-1} on 23 Sept. 2011, 5 Oct. 2012, and 10 Oct. 2013, respectively. Rye was drill-planted (depth of 1 in) on 5 Oct. 2011, 11 Oct. 2012, and 18. Oct. 2013 at a rate of 100 to 140 lb-seed ac^{-1} (85-93% germination). Rye as a cover crop was chemically terminated on 11 April 2012, 1 May 2013, and 9 May 2014. Rye as a silage crop was harvested mechanically 10 May 2012, 21 May 2013, and 30 May 2013. Nitrogen fertilizer was applied 5 June 2012 and 28 June 2013 as ammonium nitrate. Pre-sidedress soil nitrate samples (0-1 ft) were collected in each year, both before N application of ammonium nitrate. Corn silage was harvested by hand from 10 ft of two rows on 11 Sept. 2012, 30 Sept. 2013, and 18 Sept. 2014.

Radish study

The radish study was conducted between 2012 and 2013 on a farmer field near West Bend in Washington County, WI. The soil type was a Theresa silt loam (fine-loamy, mixed, superactive, mesic, Typic Hapludalf). The system is a no-till corn-soybean-winter wheat rotation with a cover crop planted after winter wheat. The experimental design was a randomized complete block, split-plot. Cover crop was the whole plot factor and treatments were with or without radish. Nitrogen rate for corn was the split plot factor and treatments were rates of 0, 40, 80, 120, 160, and 200 lb-N ac^{-1}. Radish was planted following winter wheat harvest in August of 2012 at a rate of 8 lb-seed ac^{-1} and sampled prior to killing frost in November of each year. Nitrogen fertilizer was applied as a sidedress application (V4-5) as urea with Agrotain®. Presidedress nitrate soil samples were collected before N application each year. Corn grain was harvested mechanically.

Results and Discussion

Corn silage following rye

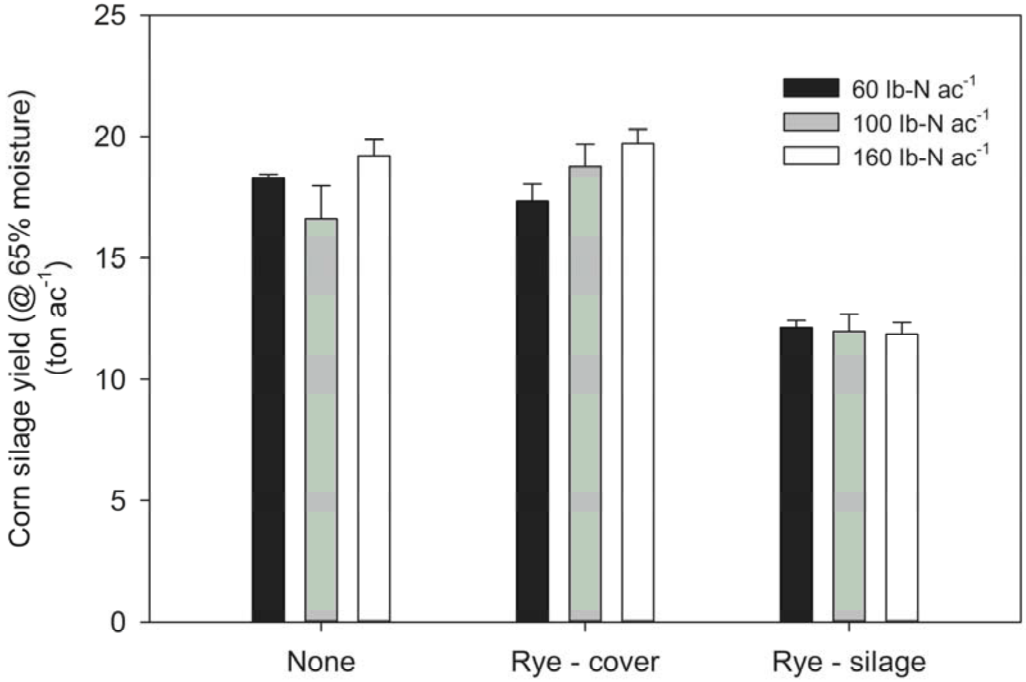

Figure 1. Corn silage yields at three nitrogen (N) rates following no cover crop, rye cover crop, or rye silage crop in 2012. Error bars are standard error.

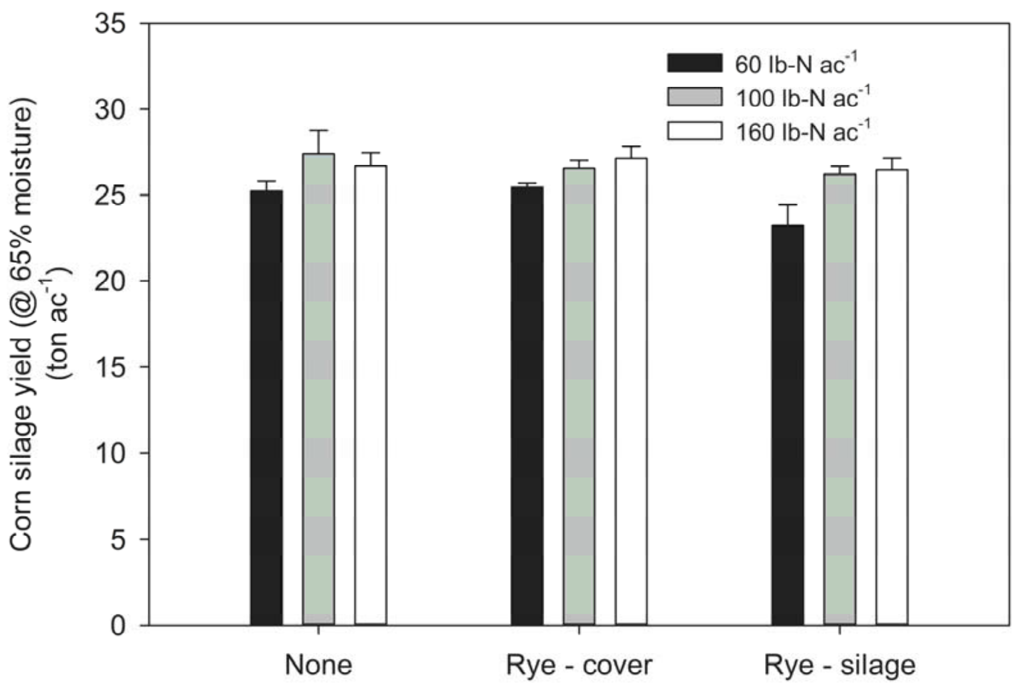

Figure 2. Corn silage yields at three nitrogen (N) rates following no cover crop, rye cover crop, or rye silage crop in 2013. Error bars are standard error.

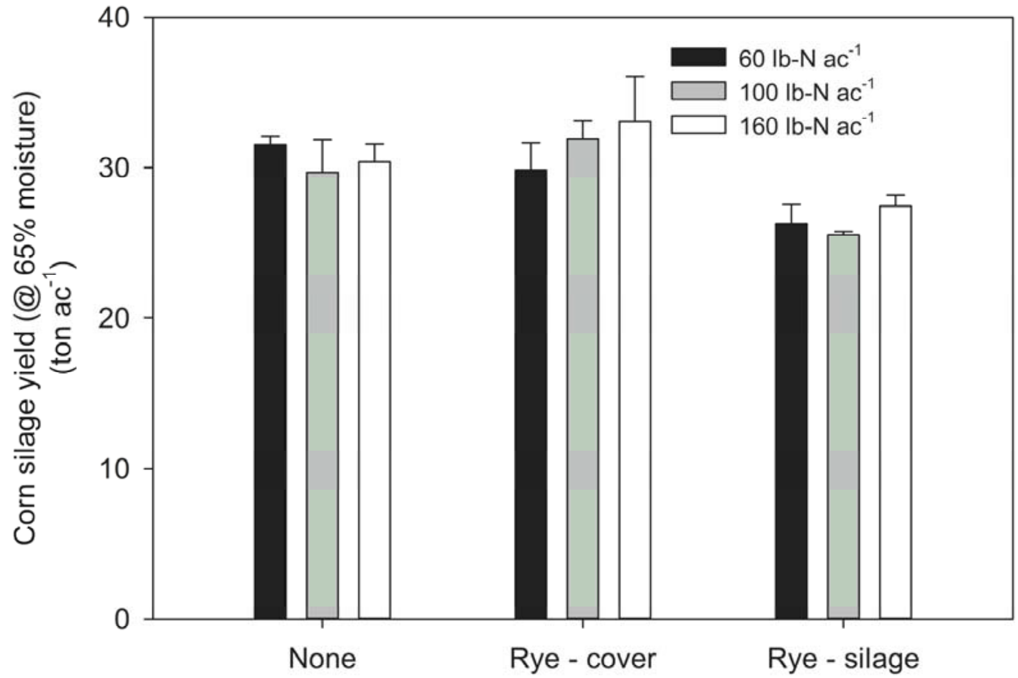

Figure 3. Corn silage yields at three nitrogen (N) rates following no cover crop, rye cover crop, or rye silage crop in 2014. Error bars are standard error.

There was a significant effect of the cover/silage treatment on corn silage yield in 2012 and 2014 and a significant effect of N rate in 2013; the interaction effect was not significant in any year. Rye silage yield was 2.48 ton-dry matter (DM) ac^{-1} in 2012, 1.02 ton-DM ac^{-1} in 2013, and 1.32 ton-DM ac^{-1} in 2014. Based on corn silage yield gaps between rye silage and other systems, the rye silage production at least equaled those gaps in 2012 and 2013. Presidedress soil nitrate concentrations were significantly lower in rye silage plots compared to other plots in two of three years (2013 and 2014). Based on average PSNT values (Table 1), there is no N credit in the rye silage plots, while there would be an N credit of at least 10 lb-N ac^{-1} in the no cover and rye cover plots.

Table 1. Presidedress soil nitrate concentrations (letters indicate differences by column).

System	2012 PSNT	2013 PSNT	2014 PSNT
	---------------	mg kg^{-1}	---------------
None	13.6	10.4 a	12.4 a
Rye – cover	10.0	11.3 a	11.6 a
Rye – silage	9.1	7.1 b	6.1 b

Corn grain following radish

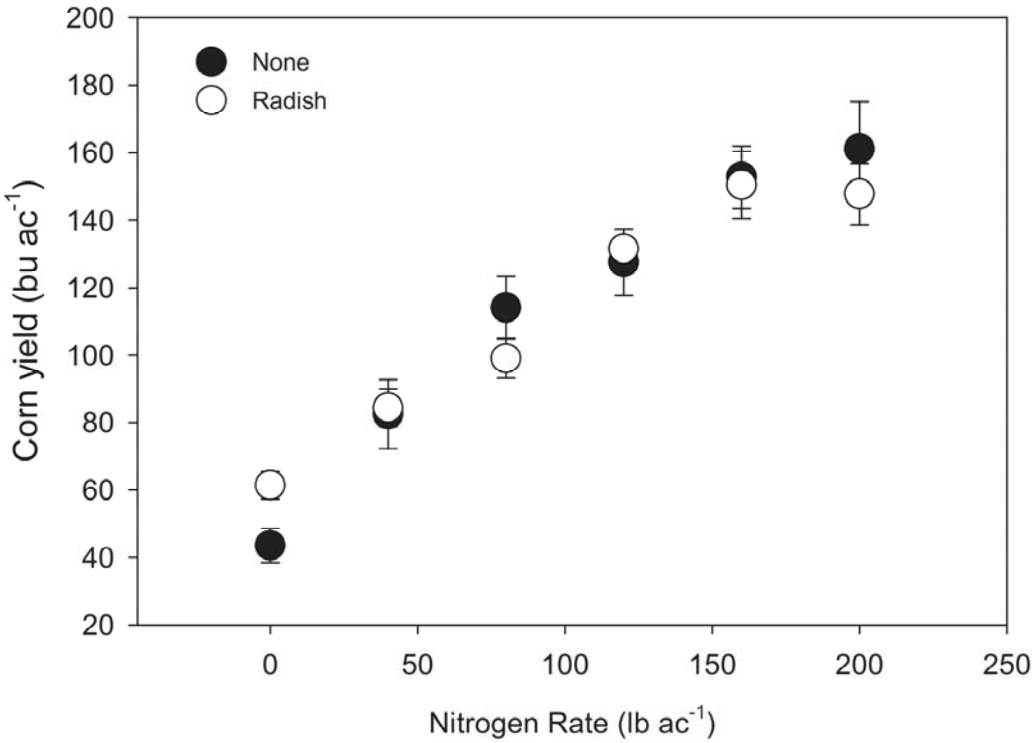

Figure 4. Corn yields following no cover crop or radish as a cover crop in 2013. Error bars are standard error.

There was no effect of the radish cover crop on corn yield or response to N fertilizer. The N uptake in the radish above ground biomass and below ground biomass was 27.4 and 20.7 lb ac^{-1}, respectively. The C:N ratio for the above ground and below ground biomass was 13:1 and 25:1. While these C:N ratios may be favorable for N release, there was no difference in the PSNT concentrations between treatments (4.0 mg kg^{-1} for no radish, 6.4 mg kg^{-1} for radish). Both of these concentrations are below a threshold of 10 mg kg^{-1} to indicate an N credit.

Conclusions

Rye, when grown as a cover crop in corn silage cropping systems did not appear to have any negative effects on yield, even when terminated as late as the second week of May. Allowing rye to grow longer into May and harvesting the rye biomass did result in lower subsequent corn silage yields; it is not clear if the amount of rye silage produced will consistently overcome the yield loss in corn silage. Rye as a cover crop did not alter the optimum N rate. Radish following winter wheat did not result in an N credit, determined through response to N and using the PSNT.

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