Sustainable Agriculture Research and Education

Interaction of winter cereal rye as cover crop and manure application on soil nitrate and corn yield.

Introduction

The use of cover crops across Wisconsin has recently gained interest with farmers and landowners. A few of the benefits of using cover crops include reductions of soil erosion, increasing water infiltration, reduce nutrient losses, and increasing soil organic matter. Input costs which include seed, time, and planting costs are associated with implementing a cover crop into a cropping system.

Chippewa County has a high percentage of private wells which test above 10ppm soil nitrate (NO_3^-). Farmers were interested of the effect of cover crops on soil nitrate. Questions were raised by Chippewa County farmers about the effect of cover crops and the interaction with manure on corn grain yield. To begin to investigate these questions, a Sustainable Agriculture Research and Education grant was secured to implement a research and education project on the effect of cover crops and manure on corn grain yield and soil nitrate.

Method

The two-year study design included three treatments which included winter cereal rye as the cover crop with no manure applied, winter cereal rye with manure applied, and no manure or winter cereal rye (untreated check). The treatments were replicated three times in a randomized complete block design.

Soil samples were taken from each plot prior to planting the cover crop and tested for soil nitrate levels at the 0 to 1 foot and 1 to 2 foot depths. Following soybean harvest, winter cereal rye was drilled at 2 bushels per acre in early November in 2017 and 2018 into recently harvested soybeans. Manure which consisted of dairy calf manure with sawdust bedding was applied to treatment plots at 10 ton per acre one month following winter cereal rye planting. The Carbon : Nitrogen ratio of the manure was 100:1.

Spring fertility applications included 120 pounds/acre diammonium phosphate (18-46-0) and 85 pounds/acre potash (0-0-60) prior to planting. Rye was terminated with glyphosate herbicide at 32.0 ounce/acre rate. Corn was planted no-till into soybean residue with thirty-inch spacing in spring 2018 and 2019. Corn planted May 15, 2018 and May 29, 2019. Corn planting population was 31,200 seeds per acre with a starter fertilizer application (2X2) and 45 pounds/acre ammonium sulfate (21-0-0).

Summer nitrogen application included sidedress nitrogen in late June using mix of ammonium sulfate and urea (46-0-0) to apply 98 pounds/acre actual nitrogen (70 pounds/acre Ammonium Sulfate + 180 pounds/acre urea.

Soil samples were taken and data gathered for soil nitrate (NO_3^-) levels during fall, spring and summer. Fall Nitrate was taken after corn harvest. Spring samples were taken in mid-May and summer samples in late-June. Routine soil samples were taken at the start of the project in mid-November 2017 to obtain a baseline for manure application rates.

Routine soil sample results:
Soil pH = 6.4; Organic matter = 2.3%; Phosphorus = 33 ppm; Potassium = 107 ppm

Corn harvest was completed in October in 2017 and November 2018. Corn yield and moisture measurements were recorded.

Results

Table 1. indicates rye plus manure yielded significantly more than the untreated check (P=0.05 and P=0.10) in 2018. Rye was not significantly different from the untreated check or the rye plus manure treatment (P=0.05 and P=0.10). Soil nitrate levels were higher in the check than in the rye or rye plus manure treatments.

In 2019, rye plus manure had significantly lower yield compared to rye or check (P=0.05 and P=0.10). Rye and Check were not different from one another (P=0.05 and P=0.10). Soil nitrate levels were higher in the check in spring and summer but lower in the fall than in the rye or rye plus manure treatments. Individual treatment and plot data are represented in Table 2 for 2018 and Table 3 for 2019.

Table 1. Soil nitrate levels and corn grain yield from rye and manure treatments.

Treatment	Fall 2017 NO_3^- ppm 0-1 ft	Spring 2018 NO_3^- ppm 0-1 ft	Summer 2018 NO_3^- ppm 0-1 ft	Fall 2018 Corn Yield bu/acre	Fall 2018 NO_3^- ppm 1-2 ft	Spring 2019 NO_3^- ppm 1-2 ft	Fall 2019 NO_3^- ppm 1-2 ft	Fall 2019 Corn Yield bu/acre
Check	6.9	4.3	9.3	119.4^{bc}	4.5	4.3	2.3	162.1^{a}
Rye	6.6	3.0	6.5	126.7^{ab}	4.5	2.7	2.7	157.9^{ab}
Rye + Manure	5.8	3.3	5.8	132.5^{a}	4.4	3.5	2.7	147.8^{bc}

Means followed by same letter do not significantly differ.

	2018 LSD	LSD
Check v Rye	9.39	9.82
Check v Rye+Manure	9.39	9.82
Rye v Rye+Manure	9.39	9.82

	2019 LSD	LSD
Check v Rye	6.00	6.62
Check v Rye+Manure	6.00	6.62
Rye v Rye+Manure	6.00	6.62

Table 2. Corn grain yield from Individual treated plots in 2018.

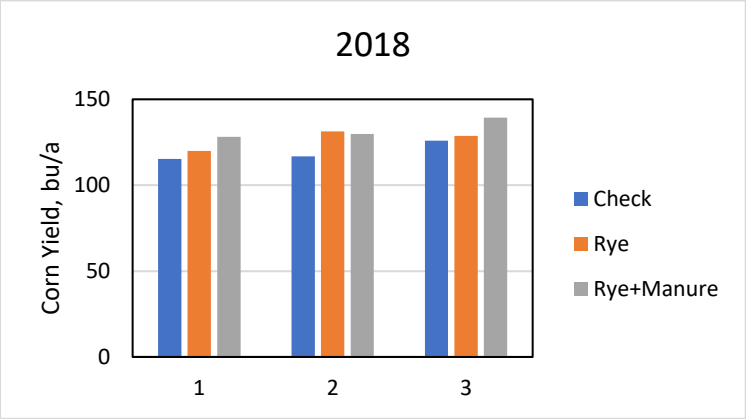
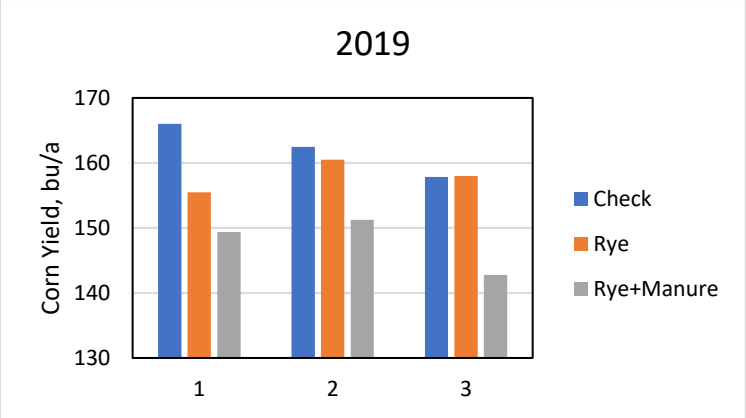


Table 3. Corn grain yield from Individual treated plots in 2019.



Conclusion

Higher soil nitrate levels observed in 2018 and in the spring and summer in 2019 in the untreated check compared to the rye plus manure treatment may have resulted from an interaction with the high-carbon manure application. The introduction of rye by itself or with manure reduced nitrate levels in five of the six timings indicating rye is assisting in removal of nitrate nitrogen. Higher corn yields observed in the rye and rye plus manure treatments in 2018 indicate the potential for more nitrate to be available for the growing crop. Lower overall nitrate in 2019 is reflective of excessive rainfall in 2019 and later planting date. Lower corn grain yields in the rye plus manure treatment in 2019 and lower nitrate levels in fall 2019 indicate a potential loss of nitrate available to the crop.

Inconsistencies with the rye plus manure treatment over the two years indicates a potential interaction between a high-carbon manure source and corn grain yield. Having winter cereal rye in the crop system appears to lower soil nitrate levels while not lowering grain yields. More research is needed on the interaction of winter cereal rye and high-carbon manure applications over a longer study period.

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