Wisconsin Cover Crop Research Summary

Fall cover cropping in corn silage-corn rotations with fall manure in Wisconsin: Effects on yield and residual soil nitrogen

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The objectives of this study are to determine the performance of cool-season grass cover crops in different regions of Wisconsin and to quantify effects on subsequent corn crop yield and management. With the prevalence of corn silage production in Wisconsin, which is harvested in late summer, 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. However, growers in Wisconsin climates may have concerns about trade-offs with management such as extra field work in the spring, competition for soil water and nutrients, and other associated costs that can only be addressed through coordinated research and extension efforts across the state. 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 decrease reported by Stute et al., 2009).
In this study, manure was applied at a target rate of 10,000 gallons/ac following corn silage harvest. First year availability of nitrogen (N) from manure was around 100 lb/ac at each site except Marshfield, where low percent solids in the liquid dairy manure resulted in a much lower nutrient contribution.

Following manure application, cover crop seed was drilled at target rates of 90 lb/ac pure live seed (PLS) for winter rye, 80- lb/ac PLS for spring barley, 13 lb/ac PLS for annual ryegrass, and 100 lb/ac PLS for winter triticale. At the time of winterkill/dormancy, aboveground biomass of cover crops was photographed and sampled, and soil was sampled (0-12" and 12-24") for NO_3^- and NH_4^+. Each site had whole plot treatments including: No manure with no cover crop; manure with no cover crop; manure with winter rye; manure with annual rye grass; manure with spring barley; manure with triticale for forage. Study sites included Arlington Agricultural Research Station in south-central WI; Hancock Agricultural Research Station in the central sands region of WI; Marshfield Agricultural Research Station in north-central WI; and Lancaster Agricultural Research Station in south-west WI.

In spring, surviving cover crops were sampled and terminated (except triticale), with soil sampling for NO_3^- and NH_4^+ (0-12" and 12-24"), and corn was drill seeded. Just prior to heading out, triticale biomass was sampled, and harvested for forage, with delayed corn planting in this treatment. Presidedress soil NO_3^- samples were collected, and N as urea was applied at varying rates from 0 to 250 lb N/ac, using a urease inhibitor at Arlington, Lancaster, and Marshfield, and untreated urea at split N rates at Hancock only up to 300 lb N/ac. Corn silage subsamples were collected in no cover crop, winter rye, and triticale treatments at 200N only (240N at Hancock). Corn grain was harvested mechanically, and soil was collected from selected treatments and analyzed for NO_3^- and NH_4^+. Soil and cover crop data is not presented here.

Yields trends across the 12 site-years in this study are not easily summarized. Establishing linear plateau models can help to identify changes in yield and optimum N rate. Comparison of manure and no manure treatments, both without cover crop, indicated a 100 lb N/ac credit in only one site-year, with other site years far from achieving the full estimated credit. When comparing cover crop use to no cover crop (all treatments receiving fall manure), we found that winter rye results in no or slight yield increase with concurrent N rate reduction only at Hancock. In three of the remaining site-years, winter rye was associated with decrease in yield of 15 bu/ac and increase in N rate of 20-40 lb/ac, and one site-year had a 44 bu/ac loss in yield, while also identifying a 69 lb/ac reduction in optimum N rate to achieve that lower yield. Annual ryegrass treatment resulted in neutral effect on yield and slight-to-moderate decrease in N rate (3-37 lb/ac reduction) in 6 of 8 site-years. Barley resulted in wide swings in N rate, from 50 lb/ac reduction to 30 lb/ac increase in optimum rate, with roughly neutral effects on yield (+1 to -12 bu/ac changes). Triticale, which was harvested as a forage and resulted in delayed corn planting, was associated with yield decreases ranging from 20 to 90 bu/ac, and varying changes to optimum N rate (24 lb/ac decrease to 94 lb/ac increase to achieve the max yield). Inclusion of triticale forage neutralizes this negative yield effect, or even increases total production in all site years, when considering triticale forage and corn silage yields together. This is the final year of the study.

RYE AS A COVER CROP OR SILAGE CROP FOLLOWING CORN SILAGE

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Winter rye (*Secale cereale*) is commonly used in the upper Midwest as a cover crop to prevent soil erosion, immobilize soil nitrate susceptible to leaching, and suppress weed growth. It can be planted in the fall after early harvested crops including maize (*Zea mays* L.) harvested for silage. Winter rye is also a high quality forage crop that can be harvested in the spring, thus diversifying forage. Cover cropping can reduce nitrate leaching, particularly when combined with fall manure application, with potential trade off in plant-available nitrogen (N) immobilization. This five-year study quantifies N uptake and N removal from rye-cover or rye-silage and evaluates how use of cover or silage crops alters optimal N fertilizer rate for the subsequent corn silage crop. The study was conducted in Arlington, WI. Whole plot treatments included winter rye as a forage (123 kg seed ha^{-1}), winter rye as a cover crop (123 kg seed ha^{-1}), and no rye. All plots received liquid dairy manure prior to rye planting in September of all four study years. Split plot treatments were N rates of 67, 112, and 179 kg N ha^{-1} applied as ammonium nitrate at sidedress. Soil nitrate concentrations at preplant and presidedress were lower with rye cover or rye silage compared to the no rye control. However, optimum N rate did not differ between the control and rye cover. In 2012, corn silage yield following rye silage was significantly lower than other treatments, but in 2013 the corn silage yields were not as suppressed by the rye silage. These results indicate that a rye silage-corn silage system in Wisconsin could result in greater forage production while simultaneously protecting groundwater quality and reducing soil erosion.

DETERMINING THE NITROGEN CREDIT FROM ANNUAL LEGUME COVER CROPS

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In this 3-year study, Dr. Ruark's lab collaborated with County Extension and NRCS to evaluate benefits of annual clovers to corn. Berseem and Crimson clover were seeded mid-August at approximately 15 lb seed/ac, following winter wheat harvest. The clovers winterkilled in both seasons, and corn was seeded the following year. Soil nitrogen (N) was evaluated at the time of winterkill, preplant, and presidedress to determine effects that clovers have on soil N dynamics due to clover covers. Clover biomass was also sampled at winterkill to quantify aboveground biomass and accumulation of N. Nitrogen was applied to corn at rates varying from 0 to 280 lb N/ac in the form of urea with Agrotain.

In 2015, crimson clover produced 1.1 ton/ac dry matter, containing 47 lb N/ac. Berseem produced 1.2 ton/ac dry matter, containing 75 lb N/ac. Soil at winterkill demonstrated reduced soil nitrate in berseem clover relative to no clover, though similar soil nitrate in crimson clover. At preplant, all treatments had similar soil nitrate levels, and at sidedress, nitrate in crimson clover treatment had decreased relative to no clover or berseem.

In 2016, crimson clover produced 1.1 ton/ac dry matter, containing 70 lb N/ac. Berseem produced 1.2 ton/ac dry matter, containing 81 lb N/ac. Soil tested at winterkill showed a 25% increase in total plant-available N (Nitrate and ammonium) under clover, which evened out by preplant and sidedress.
Yield in 2015 demonstrated potential for 10 bu/ac increase in yield using either clover, with yield maxing out around 205 bu/ac at high N rates (240 lb N/ac). There was a lot of variation in actual yield values, precluding more sophisticated analysis of this year alone.

Yield in 2016 demonstrated a clear benefit with the clovers. Using quadratic plateau models (not used in 2015 because models failed), it was determined that the crimson clover resulted in a 46 lb/ac nitrogen credit, with no change to corn yield. Berseem clover resulted in a 15 lb/ac N credit and a 13.5 bu/ac increase in corn yield. Max yields (and optimum N rates) as determined by the quadratic plateau model are as follows: 208 bu/ac (140 lb N/ac) using crimson clover, 223 bu/ac (171 lb N/ac) using berseem clover, and 210 bu/ac (186 lb N/ac) using no clover cover crop. This study is continuing in the 2017 season. Overall, we are seeing a clear benefit in yield and/or reduction in N need by a corn crop following berseem or crimson clover cover crop. Further, this system is easy to manage because the clover establishes well when planted in August in Wisconsin, and reliably winterkills, thus minimizing management.

Cover Crop Interseeding in Wisconsin using a modified grain drill

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The objective of this study was to evaluate interseeding cover crops into V5 corn using a modified grain drill and to access cover crop biomass and corn grain yield. The study was done in 2014, 2015, and 2016. All cover crops were successfully established in all years. In 2014 and 2015 within four weeks of seeding radish, red clover, and winter rye had germinated, had consistent growth during the growing season, and had good vigor up until two weeks of grain harvest. In 2015, the oat/pea did not have good vigor and had very poor biomass accumulation. In both years the corn never showed any visible symptoms of stress and the cover crops did not significantly reduce corn yields (<0.0001). Radish and oat/pea winterkilled and rye and red clover needed terminated in spring. Both years all cover crops were completely buried by the corn residue after harvest and resulted in variable biomass data. In 2016, all cover crop germinated, however only radish and red clover survived until grain harvest.