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 8 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. With one more year of data collection coming in 2017, we expect to hone in in yield effects attributed to fall grass cover cropping.

Examining the effect of cover crop treatments on potentially mineralizable nitrogen

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In Wisconsin dairy production, farms cows are fed conserved forages, grain, protein, and mineral supplements, and manure is collected, stored, and applied to cropland to recycle nutrients back through feed production. Around 65% of the manure produced on average is applied onto the field in Wisconsin (Powell et al., 2005). Silage production involves the intensive removal of biomass and nutrients that are never cycled back into the system. This continual removal of both the grain and stover for silage can cause a long term deficit of N in the soil. One proposed conservation practice to combat the overall N removal from these systems has been the use of a cover crop to increase soil N supply, measured here as potentially mineralizable nitrogen (PMN). Cover crops are valuable in corn silage-based rotations to provide ground cover after harvest and to reduce N leaching after fall manure application. However, previous research (Sharifi 2013) has shown that PMN exhibits seasonal variation; as both the soil and manure will change in-terms of potential N supply.

The objectives of our study were to determine the effect of cover cropping on potentially mineralized nitrogen using a 7 day anaerobic method (7day-AN PMN) (2015 and 2016 season) and a long term aerobic incubation (40wk-AE PMN) (2015 season). In our current study, we are examining the effect rye as a cover (chemically terminated) or a forage (harvested) crop will have on the system by measuring the PMN from soils collected throughout the growing season. The potentially mineralizable nitrogen was then compared to the plant N uptake and yield to evaluate seasonal soil N supply. The study site was a continuous corn silage system with fall manure application and no further N added. The experimental design was a randomized complete block treatment with a split plot design where the whole plot treatments were no cover, rye as a cover (chemically terminated) or as a forage (harvested) crop and the split plot treatment was depth (0-15cm; 15-30cm.

N mineralization (derived from 40wk-AE PMN) fit a linear model, not a first-order exponential model, after 40 weeks. Kinetic models, widely used to determined N mineralization potential, appear to underestimate N mineralization on these manured soils. There were no significant differences in treatment or time but significant differences in depth.

There were no statistical differences in PMN among cover crop treatments at any time point in the 2015 season. However, the PMN for both the no cover crop and rye forage treatments decreased over the growing season, while the PMN for rye cover did not. The 7day-AN incubation showed a significant three way interaction between treatment, time, and depth in 2016. PMN exhibited different patterns across the growing season but only significantly differed between cover crop treatments in May.

There were also significant difference of N uptake in the corn and corn yield between treatments in both years. In 2015, there was a 36 kg ha^{-1} reduction in plant N uptake from no cover to rye as cover treatment and another 33 kg ha^{-1} reduction from rye as cover to rye as forage treatment and in 2016 the corn in the NC treatment showed over the twice the uptake than corn in the RF treatment in 2016. Thus rye as a cover or forage crop decreased N uptake and corn yield.

Together, this suggests that the soil may not be supplying different amounts of N, but the plantsare taking up different amounts of N. This further indicates that there is some factor other than N availability that is causing differences in plant N uptake. This research underscores the importance of using both soil and agronomic measures to evaluate N availability.

DETERMINING THE NITROGEN CREDIT FROM ANNUAL LEGUME COVER CROPS

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In this 2-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.