Northern NY Agricultural Development Program
2015-2016 Project Report

Double Cropping with Cereal Rye and Corn Silage: Impacts on Nutrient Efficiency and Forage Production in NNY

Project Leader:

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Cooperators:

- New York State Department of Environmental Conservation (NYSDEC) Lake Alice Wildlife Management Area, Town of Chazy, Clinton County
- Miner Institute Dairy Farm, Chazy, NY

Background:

Establishing a winter forage crop such as rye or triticale after corn silage harvest can reduce erosion and nutrient losses and potentially supply a hay forage crop for harvest the following spring if managed properly.

Concerns over phosphorus (P) and nitrogen (N) loss and their role in water quality deterioration are a major concern in the Lake Champlain Basin and elsewhere in the US.

Growing forages such as winter rye have the potential to reduce environmental impacts of corn production, increase soil health over the long-term, and provide farms with needed forage. This is particularly important in the face of increasing weather extremes that increase production and environmental risks.

The objective of this project was to determine the agronomic and potential environmental benefits of establishing a winter rye cover crop following corn silage harvest. Specific objectives were to:

- Determine yield and basic forage quality of winter rye planted in the fall after corn and harvested at the boot stage in the spring, and

- Quantify N, P, and sediment loading differences in surface runoff and subsurface tile drainage from corn plots with and without a winter rye cover crop.

Methods:

With previous funding provided by Miner Institute and the farmer-driven Northern New York Agricultural Development Program (NNYADP), four paired plots (~150 ft. x 75 ft.) designed for capturing surface and subsurface runoff were established and instrumented with runoff monitoring instrumentation at the NYSDEC Lake Alice Wildlife Area in Chazy, NY. Briefly, tile drainage was installed at an average depth of approximately 3.5 ft. below the soil surface in each plot (25 ft. lateral spacing). Three tiles are centered in each plot running up and down the slope (~5%) and drain to a main line that outlets to individual concrete manholes where flows are sampled and gauged using 5-gallon buckets modified with v-notch weirs equipped with data loggers. Flow curves were generated in the field by relating water level to measured flow values.

Runoff instrumentation was designed and tested in the field at this site with previous NNYADP funding (2012-2014) and proved to be very effective.

In September 2015, the previous corn silage crop was harvested, followed by an application of composted semi-solid dairy manure at a rate of approximately 5 tons/acre. Plots were then disk harrowed and winter rye was planted with a grain drill on October 7 at 100 lbs/ac.

The following spring, rye biomass was measured approximately weekly using a frame sampling and rye biomass was hand-harvested from six points within each plot until rye reached the boot stage. The last samples were taken on 5/22/16 when rye was approximately at boot stage.

Corn was no-till planted into standing rye at 34,000 seeds/acre on 5/23/16. Glyphosate was applied to rye the following day. All plots were sidedressed with 80 lb N/ac in early July.

In the fall, six subplots plots of corn from each main plot were harvested (on 9/9) with a pull-type harvester equipped with load cells and a sampling unit to enable yield and basic forage quality comparison between treatments. Samples were sent to Dairy One Laboratories for basic forage quality assessment (NDF, ADF, and crude protein content).

Due to tree roots penetrating the main tile outlet for the system, flows were impeded throughout much of the winter months. This problem was resolved in late March 2016 when the soil thawed and flow monitoring commenced on March 28, 2016. Runoff samples were collected for nutrient analysis when rainfall events were sufficient to produce runoff. Due to the relatively dry season, many of the rain events in 2016 did not result in runoff events. For all but one large runoff event in October 2016, grab samples were used to estimate nutrient loadings. For the October event, autosamplers were deployed for each surface and subsurface bucket and used to calculate loadings. Loadings

were estimated by multiplying nutrient concentration by the volume of runoff for a given event. It should be noted some rainfall events did not produce runoff from all plots.

Runoff water samples were analyzed for soluble reactive phosphorus (SRP), total phosphorus (TP), nitrate-N, total N (TN) and total suspended solids (TSS; a measure of sediment loss) at the Miner Institute laboratory.

Results and Discussion:

Winter Rye and Corn Silage Yields

Dry matter yield at harvest averaged just over 1 ton/acre for the last samples taken at the boot stage (Appendix: Figure 1). The relatively low yield can be partially attributed to: 1) heavy deer browsing during early spring 2) no application of fertilizer nitrogen (N) applied at greenup, 3) low manure application rate history on the field and 4) a low soil test phosphorus (P) level of ~2 lb/acre.

Research by Dr. Quirine Ketterings indicates that fertilizer N is required to maximize rye yield where fields have a limited manure application history. Her research also indicates that low soil test P is also correlated with reduced winter forage crop yields.

The combination of the above factors contributed to the relatively low rye forage yields.

Corn silage yields were approximately 4 tons/acre lower in the winter rye plots. The much lower corn yield in the rye plots was likely a result of not killing the rye sooner with glyphosate. Ideally, rye should be sprayed approximately two weeks prior to planting corn. Since one of the objectives was to harvest rye as a forage, it was allowed to reach boot stage before it was sprayed.

It is also possible the allelopathic effects from the rye contributed to reduced corn growth. There were no significant differences in crude protein, ADF, or NDF content (Appendix: Table 1).

In 2017, glyphosate will be applied sooner to the rye and all plots will be disk harrowed prior to planting instead of no-till planting. No-till planting likely exacerbated corn yield differences because rye was difficult to plant into and created uneven seed depth placement in addition to shading emerging corn.

Runoff Water Quality from Rye and Control Plots: Tile Drainage

A total of seven runoff events were monitored during 2016. In general, rye plots had lower nitrate-N and total N export in tile flow compared to corn plots without rye (Appendix: Table 2).

While N loading tended to be lower from rye plots, it was not generally significant due to high variability among plots and the fact that there are only two replications per treatment at the site. Notwithstanding, several events showed substantially lower N loading (i.e., 2.9-fold greater nitrate-N loading from control plots on 4/7) from rye plots.

Other research in the Midwest has indicated that rye has the ability to scavenge excess nitrate and reduce N leaching loss to tile drains. Rye was actively growing in early spring as evidenced by the green growth in the plots (photos in Appendix).

The difference in P export between treatments was more variable. Plots with rye were treated as undrained plots in a previous experiment funded by NNYADP. We speculate that some sediment entered tiles while they were plugged to simulate the undrained conditions during this experiment, which could partially explain the higher TSS and P loading in rye plots for the 3/28 and 10/20 events (Appendix: Table 2). Rye plots had much larger nutrient loads for the 10/20 event and was likely driven by the much greater volume of water exported from rye plots (nearly 3-fold greater), though there was no significant difference in the volume of water exported for any event.

With respect to concentrations, Total Nitrogen (TN) for rye plots tended to be lower in the spring and growing season (Appendix: Table 3). Nitrate-N was similar between treatments but was higher in rye plots for the 10/20 event. Total and Soluble Reactive Phosphorus (SRP) concentrations were generally similar between treatments and Total Suspended Solids (TSS) concentrations were similar or higher in rye plots. Averaged over all grab sample events (not including the 10/20 event), TN and nitrate-N loading from rye plots was roughly half of the control plots (data not shown).

The high nitrate-N and TN concentrations observed for the 10/20 event may be related to the lack of rainfall during the season followed by a relatively large runoff event that mobilized residual N not taken up by the corn or rye crop.

Runoff Water Quality from Rye and Control Plots: Surface Runoff

In general, surface runoff volume was similar or lower for rye plots. Rye plots had 4.4-fold lower runoff volume for the 10/20 runoff event (Appendix: Table 4). The lower runoff volume for this event led to substantially lower nutrient loadings from rye plots for each of the constituents measured (Appendix: Table 4). Since rye was planted on 10/11, it is unlikely that this lower volume was due to the fall planted crop (planted 10/11), however, rye plots still had visible dead biomass from the previous fall planting that was incorporated into the soil after manure application and disk harrowing in fall 2016.

Although not statistically significant, TN loads were 1.9 to 16.5-fold lower for rye plots on 4/7, 6/4, 7/9, and 10/20. Mean TSS loads were 3.7- to 16.9-fold lower for rye plots on 4/7, 6/4, and 10/20. On the same dates, TP was 1.1- to 27-fold lower and SRP was 3.5- to 30.3-fold lower for rye plots, indicating the importance of erosion and TSS mobilization on P losses in surface runoff.

Our results suggest that the presence of a cover crop may have impeded the movement of sediments and P in surface runoff due to greater surface residue coverage and possibly more water infiltration, particularly for the higher flow events.

With the exception of the 10/20 event, nitrate-N loads and concentrations were minimal in surface runoff as expected, since most nitrate-N is found in leachate due to its high solubility (Appendix: Tables 4, 5). The higher nitrate-N load and concentrations for the 10/20 event was probably due to the recently applied manure before planting rye on 10/11.

Total N, TP, and SRP concentrations were low and generally similar between treatments. **Surface runoff loads and concentrations trends indicate that runoff flow volume was a main driver of nutrient losses among plots.**

Conclusions/Outcomes/Impacts:

Results from this study showed that planting corn for silage following a winter rye crop can decrease yields significantly. The fact that rye was actively growing when corn was planted and corn was no-till planted likely exacerbated the yield penalty associated with the rye plots. For improved results, rye should be terminated two weeks prior to planting corn in combination with some level of tillage to increase rye biomass decomposition and allow for easier planting and more consistent planting depth for corn.

Since our plots have not had an extensive manure history and did not receive N in the spring, rye at harvest had low crude protein content (12%). If rye is to be harvested as a forage, applying N at greenup would increase yield and crude protein content and substantially improve quality and yield.

The impact of rye on runoff water quality was variable, but did appear to reduce sediment and P loss in surface runoff for some of the events. Rye plots had consistently lower nitrate-N and total N loading for events during the early spring and growing season, suggesting rye plots sequestered more N, either through greater total N uptake or N immobilization in biomass or the microbial pool. The relatively dry year likely contributed to the high variability among plots.

Outreach: Project results will be shared as a poster presentation at a University of Vermont (UVM) extension meeting focused on no-till, soil heath and cover crops in 2017, and articles published in Miner Institute's Farm Report. UVM graduate student Keegan Griffith is using data from this project for his MS thesis research.

Next Steps: The study will be repeated during the 2017 growing season.

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For More Information:

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Northern NY Agricultural Development Program
2015-2016 Project Report: APPENDIX

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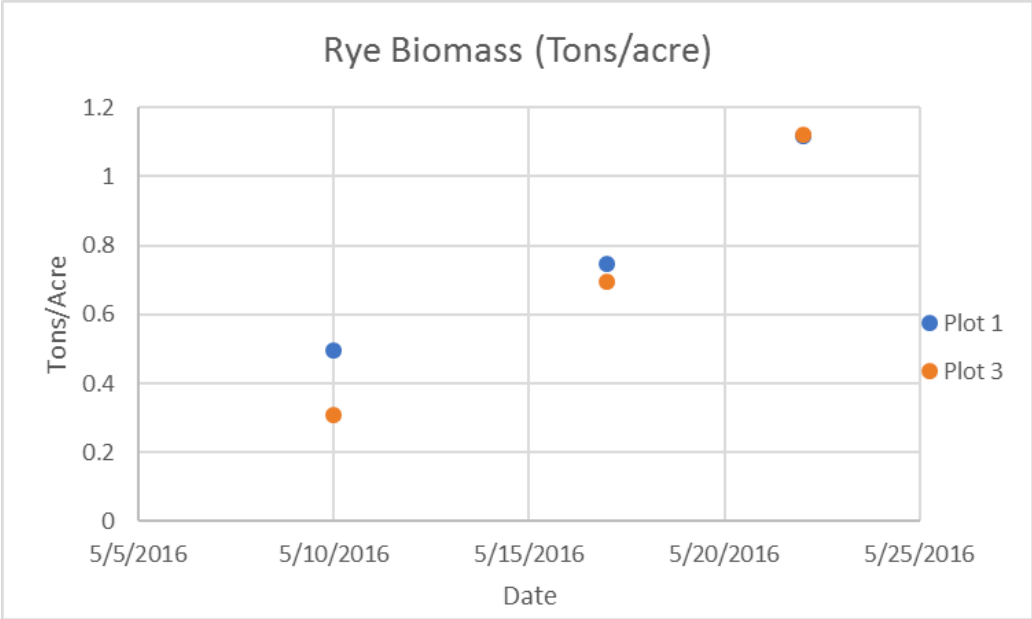

Figure 1. Winter rye yield (tons of dry matter/acre) during May 2016 up until glyophosate application and corn planting, Double Cropping Cereal Rye and Corn Silage Project, Northern NY, 2015-2016.

Table 1. Corn silage yield, crude protein, ADF, and NDF content for corn plots with and without a rye cover crop, Double Cropping Cereal Rye and Corn Silage Project, Northern NY, 2015-2016.

Corn Silage	Tons/Acre at 35%DM	% Crude Protein	%ADF	%aNDF
Cover	**14.7**[A]	**9.6**	**23.1**	**41.2**
Control	18.8[B]	9.2	20.8	36.3