Northern NY Agricultural Development Program
2016-2017 Project Final Report

Evaluating Yield and Quality of Winter Rye and Triticale Harvested for Hay Crop Silage

Project Leader:

- Eric O. Young, Research Agronomist, W. H. Miner Agricultural Research Institute, Chazy, NY, 518-846-7121, young@whminer.com

Collaborator(s):

- Miner Institute: Keegan Griffith, Laura Klaiber, Catherine Ballard, Rick Grant and Jeff Darrah

Cooperating Producers:

- Miner Institute Dairy Farm, Chazy, NY

Background:

Growing winter forage crops (WFC) for spring hay harvest is becoming a more popular practice in NY. Triticale sales alone have increased from a few thousand acres to >30,000 acres planted for harvest in New York State (2014, Cornell). Challenging weather over the past several years has resulted in variable forage crop yields, and dairy producers are looking for ways to increase total forage production while minimizing nutrient losses. Research shows that WFC can reduce erosion, decrease nitrate leaching losses, and improve overall soil quality when established after corn silage. Successful establishment of WFC is also possible in the final year of alfalfa-grass stands using a no-till seeder.

Ketterings et al. (2015) evaluated yields of 44 triticale and 19 winter rye fields following corn silage from 2012-2014 in NY to determine costs of double cropping. Yield data were combined and expected changes in profit were used to estimate break-even yields. When 75 lb nitrogen per acre (N/ac) was applied to obtain a 2-ton dry matter/ac yield, production cost ranged from $111 to $145/ton (no-till was least costly). Without N addition, costs ranged from $83 to $118/ton. A break-even yield of 1 ton DM/ac was found if no yield penalty for corn was assumed. Estimates were based on an assumed forage value of $180/dry matter ton and did not include fiber digestibility measures.

In light of the lack of forage quality data on WFC in NY, the objective of our study was to characterize yield and forage quality to determine the potential benefits of WFC on dairy farms in Northern NY.

Methods:

- Winter triticale was planted on 9/15/16 with a no-till grain drill at 120 lb/ac in a 9-acre field at Miner Institute after termination (with glyphosate) of an alfalfa-grass stand.

- Winter rye was planted on 10/11/16 after corn silage harvest at 108 lb/ac in a 14-acre field using a grain drill after dairy manure was applied (4,000 gal/ac) and incorporated with a disk harrow. Rye received 70 lb N/ac as urea ammonium nitrate on 5/21/18.

- Rye and triticale samples were collected weekly from each field using a 40 by 8 inch (2.2 ft^2) sampling frame beginning on 5/11/17 and ending on 5/30/17. Six replicate frames were randomly taken from each field on each date. Dry matter yield was determined by weighing the amount of wet and dry forage for each sample. Samples were sent to Dairy One for NIR analysis.

- Samples of rye and triticale were analyzed for % dry matter (DM), yield, crude protein (CP), aNDF, ADF, 30-hr NDF digestibility (NDFD30), lignin, rate of NDF digestibility (kd), total dissolved nutrients (TDN), water-soluble carbohydrates (WSC), and minerals for each time. Analysis of variance was used to determine differences between rye and triticale yield/quality over the sampling period.

- At the final sampling date (5/30/17), ash-corrected NDF (aNDFom), 30-hr digestible NDF (NDFD30om), and undigested fiber at 30, 120, and 240-hr time points were also measured (abbreviated as uNDF30om, uNDF120om, and uNDF240om).

Results and Discussion:

Average dry matter yields for winter rye and triticale increased 10.28 and 2.95-fold, respectively from 5/11/17 to 5/30/17 (Figure 1, Table 1). Triticale dry yields were significantly higher than rye for the first three samples, but DM yield for rye was significantly higher than triticale on the final sampling date. This could be related to the fact the the rye received 70 lb N/acre (as UAN) on 5/12/17, whereas the triticale field did not.

Since the triticale was no-till planted into an alfalfa-grass field following glyphosate application, we anticipated significant N release the following spring and therefore did not apply UAN. Due to the wet spring in 2017, it is likely that substantial available N was leached from the triticale field and that the crop would have responded to additional N had it been applied.

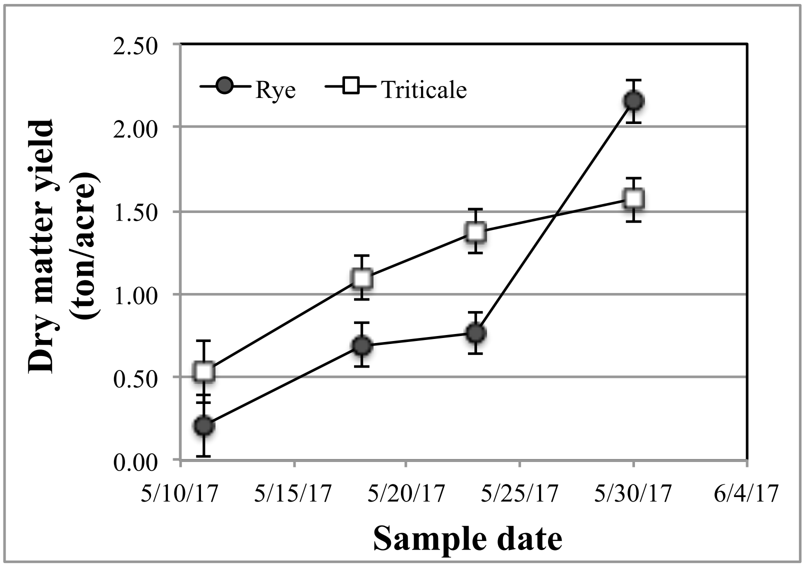

Figure 1. Winter rye and triticale dry matter yield over time.

Table 1. Yield and forage quality measures for rye and triticale over time.

Variable	**Harvest date**	**Rye**	**Triticale**	**SEM¶**	***P* Forage**	***P* Time**	***P* Forage x Time**
DM yield (ton/ac)	5/11/17	0.21a§	0.53a	0.2	0.23	<0.01	<0.01
	5/18/17	0.69a	1.09b	0.1			
	5/23/17	0.77a	1.37b	0.1			
	5/30/17	2.16a	1.57b	0.1			
Crude protein (%)	5/11/17	25.0a	16.6b	1.0	<0.01	<0.01	0.14
	5/18/17	20.4a	15.5b	0.7			
	5/23/17	20.5a	14.1b	0.7			
	5/30/17	18.6a	11.0b	0.7			
NDFD30 (% of NDF)	5/11/17	71.0a	61.0b	1.2	<0.01	<0.01	<0.01
	5/18/17	63.3a	63.5a	0.8			
	5/23/17	63.8a	59.7b	0.8			
	5/30/17	55.8a	52.7b	0.8			
aNDF (% DM)	5/11/17	32.7a	36.7b	1.0	0.01	<0.01	0.01
	5/18/17	44.6a	47.2b	0.7			
	5/23/17	49.8a	49.5a	0.7			
	5/30/17	58.5a	57.7a	0.7			
ADF (% DM)	5/11/17	19.3a	22.8b	0.6	<0.01	<0.01	<0.01
	5/18/17	27.1a	28.7b	0.5			
	5/23/17	29.1a	30.5a	0.5			
	5/30/17	35.6a	34.7a	0.5			

§ Means with different letters are significantly differ at $P \leq 0.05$

¶ SEM = standard error of the mean

Not surprisingly, yield and quality measures all varied significantly over time (Table 1). Crude protein (CP) was significantly higher at each sampling date for rye (Table 1). The higher mean CP for rye was also likely related to the UAN application since N application is known to increase CP content of grass.

Mean NDFD30 did not differ on the 5/23 sampling date but was significantly higher for rye for the other dates. For the final sampling on 5/30, NDFD30 was approximately 3 percentage-units greater for rye indicating higher milk production potential in a dairy ration. Both rye and triticale were at or just past the boot growth stage (i.e., seed head not emerged) on the 5/30 date.

While there were significant differences between aNDF and ADF, there were no differences at the final sampling. Mean aNDF on 5/30 for rye and triticale was just above optimum with respect to grasses (~55% NDF), indicating harvest timing was close to optimum.

Lignin content increased significantly as dry matter yield increased (Table 2). Interestingly, rye had higher lignin content at harvest but also had significantly higher fiber digestibility as measured by NDFD30 (Table 1). Rye also had a faster digestibility rate constant (kd) at harvest and higher total dissolved nutrient content (Table 2).

Compared to grasses, lignin content of rye and triticale at harvest was lower than average values based on the Dairy One database.

Water soluble carbohydrates (WSC) were significantly higher for triticale at each sampling date. Phosphorus content was significantly higher for rye at each date while potassium content (K) was significantly higher for rye on all sampling dates except for the first date.

The last harvest date was close to the recommended harvest timing for dairy forage (i.e., boot stage). On the last sampling date, ash-corrected fiber content (aNDFom), NDFD30om, and undigested fiber (uNDF) at 30-, 120- and 240-hr time points were also measured. Rye had significantly higher aNDFom and higher NDFD30om, though not statistically significant (Table 3).

Interestingly, uNDF contents were highly similar between rye and triticale for each time point, indicating little difference in fiber quality based on these measures. Plotting uNDF at the three time points and fitting with power curves also showed highly similar prediction equations for rye and triticale (Figure 2).

It is important to note that uNDF was estimated by NIR and not wet chemistry, which may have affected results. For example, we have found large discrepancies between uNDF measured by the Tilley Terry method and NIR predictions for corn silage. It is possible that larger uNDF differences between rye and triticale would have been found if the Tilley Terry method was used. The Tilley Terry method is considered the gold standard for uNDF measurements because it mimics the rumen. uNDF240om is considered an estimate of indigestible NDF (iNDF). Rye and triticale had identical mean uNDF240om (9.2 % of DM) indicating similar iNDF and quality.

Table 2. Yield and forage quality measures for rye and triticale over the sampling period.

Variable	Harvest date	Rye	Triticale	SEM	*P* Forage	*P* Time	*P* Forage x Time
Lignin (% DM)	5/11/17	1.2a	1.5a	0.3	0.14	<0.01	<0.01
	5/18/17	1.3a	2.3b	0.2			
	5/23/17	1.7a	2.4b	0.2			
	5/30/17	3.6a	2.9b	0.2			
kd (%/hr)	5/11/17	5.1a	3.9b	0.2	<0.01	<0.01	<0.01
	5/18/17	4.0a	4.4a	0.2			
	5/23/17	4.1a	3.9a	0.2			
	5/30/17	3.7a	3.2b	0.2			
TDN (% DM)	5/11/17	79.3a	76.3b	0.8	<0.01	<0.01	0.92
	5/18/17	73.8a	71.5b	0.5			
	5/23/17	72.0a	69.7b	0.5			
	5/30/17	66.3a	63.5b	0.5			
WSC (% DM)	5/11/17	22.2a	26.3b	1.2	<0.01	<0.01	0.14
	5/18/17	13.1a	19.5b	0.8			
	5/23/17	9.7a	17.8b	0.8			
	5/30/17	5.7a	14.1b	0.8			
P (% DM)	5/11/17	0.54a	0.44b	0.01	<0.01	<0.01	0.04
	5/18/17	0.49a	0.41b	0.01			
	5/23/17	0.42a	0.38b	0.01			
	5/30/17	0.40a	0.31b	0.01			
K (% DM)	5/11/17	2.7a	2.7a	0.13	<0.01	<0.01	0.08
	5/18/17	3.5a	3.0b	0.09			
	5/23/17	3.5a	2.9b	0.09			
	5/30/17	3.0a	2.5b	0.09			

Table 3. Mean ash-corrected NDF (aNDF30om), NDFD30om, and undigested fiber contents at three time points for rye and triticale at the final harvest date (5/30/17).

Variable	Rye	Triticale	SEM	*P* Forage
aNDFom (%DM)	55.4a	53.1b	0.4	<0.01
NDFD30om (%NDFom)	71.1a	69.3a	0.7	0.08
uNDF30om (%DM)	16.0a	16.3a	0.5	0.62
uNDF120om (%DM)	10.4a	10.0a	0.3	0.29
uNDF240om (%DM)	9.2a	9.2a	0.3	0.86

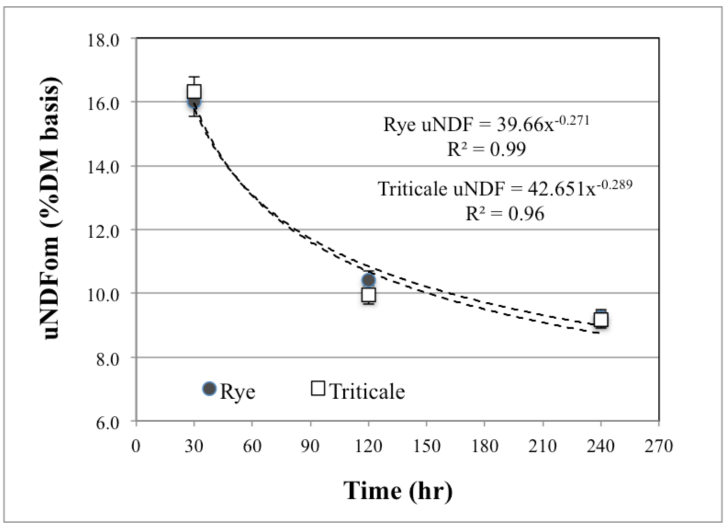

Figure 2. Mean uNDF at 30-, 120-, and 240-hr for rye and triticale forage.

Conclusions/Outcomes/Impacts:

Our results showed winter forage crops after corn silage harvest can be established successfully in Northern NY with economical yields and high quality for harvest as hay crop silage.

For triticale, average yields at harvest were close to economic yields as estimated by Ketterings et al. (2015) and above economic yield thresholds for rye. The application of 70 lb N/ac as UAN helped to achieve a higher dry matter yield for the rye.

We also demonstrated that triticale can be successfully established using no-till methods after termination of an alfalfa-grass field. While significant N was likely released from the terminated alfalfa-grass crop in the spring, given the wet spring, additional N application would have likely increased dry matter yields and crude protein content.

Our project further demonstrated that double cropping with winter forages and corn silage is possible in Northern NY and may be an important crop production risk management strategy. In addition, cover crops take up residual N, reduce erosion, increase soil organic matter, and ultimately improve soil health over the long-term. Thus, double cropping with winter forages can afford both crop production and environmental benefits for farms in Northern NY.

Based on our results, both rye and triticale are viable winter forage crops to harvest as dairy forage with minimal forage quality differences. Differences in yield and protein was mainly driven by the N application to the rye in the spring. We would anticipate a similar response by triticale with additional N application.

Further research is warranted to determine the best methods of forage crop establishment across varying soil conditions and potential impacts on subsequent corn silage yields and farm economics.

Outreach:

We will work with NNYADP publicist Kara Dunn to disseminate our findings to appropriate outlets. A summary of our findings will be published in the Miner Farm Report.

Acknowledgments:

We would like to thank the Miner Institute Dairy Farm personnel for their help in carrying out this project. Thanks also to the Clinton County Soil and Water Conservation District for allowing us to use their no-till grain drill.

Reports and/or articles in which results of this project have been published:

Results from this project have not been previously published.

For More Information:

Eric O. Young, Research Agronomist, W. H. Miner Agricultural Research Institute, Chazy, NY, 518-846-7121, young@whminer.com

References:

Ketterings, Q., Ort, S., Swink, S., Godwin, G., Kilcer, T., Miller, J., & Verbeten, W. (2015). Winter Cereals as Double Crops in Corn Rotations on New York Dairy Farms. Journal of Agricultural Science JAS, 7(2), 18-25. http://dx.doi.org/10.5539/jas.v7n2p18