Northern NY Agricultural Development Program
2015-2017 Project Report

Agronomic and Forage Quality Characteristics of Brown Midrib (BMR) And Non-BMR Corn Silage Hybrids Grown in NNY: Year 3

Project Leaders:

- Eric O. Young, Michael Miller, Kurt Cotanch, Catherine S. Ballard, and Richard J. Grant
  William H. Miner Agricultural Research Institute, 1034 Miner Farm Rd/PO Box 90, Chazy, NY 12921; 518-846-7121 x113

Collaborators:

- Adirondack Farms, LLC, Peru, NY

Background:

Corn silage is a major source of energy in dairy cattle rations and an important source of dietary fiber and starch. Corn silage varies in yield and quality depending on growing environment, genetics, and harvest management (Cherney et al., 1991; Oba and Allen, 2000; Johnson et al., 2003; Ballard et al., 2001; Kung et al., 2008). For example, brown midrib (BMR) hybrids have higher fiber digestibility and can offer more milk production potential per ton compared to non-BMR hybrids (Cherney et al., 1991). The BMR trait in both corn and sorghum-sudan silage confers higher fiber digestibility and the potential for higher milk production potential compared with non-BMR genetics (Grant et al., 1991; Aydin et al. 1999).

In general, there is a tradeoff between yield and fiber digestibility with respect to corn hybrids. Fiber digestibility (measured as 30-hr neutral detergent fiber digestibility; NDFd) of BMR is typically 8 to 10 units higher than NDFd of non-BMR hybrids, with 20 to 30% lower lignin content. However, research has shown that the increase in NDFd observed with BMR hybrids can come at the expense of yield (Oba and Allen, 2000; Ballard et al., 2001; Kung et al., 2008). Farmers often report reduced yields for BMR compared to non-BMR corn hybrids.

Commercially-available BMR hybrids include bm3 (Dow AgroSciences/Mycogen Seeds) and bm1 (Dupont/Pioneer) genotypes. Relatively little research has evaluated performance among bm1, bm3, and non-BMR hybrids with respect to yield and forage quality.

Dairy farms in Northern New York (NNY) and other regions of the US are interested in potential yield and quality differences among bm1, bm3, and non-BMR hybrids in order to optimize economic and production efficiency of dairy rations.

Objectives:

1. Determine yield and forage quality differences among three BMR (bm1 and bm3) and two non-BMR corn hybrids grown at two locations in NNY.
2. Evaluate overall forage quality differences among hybrids, including indigestible or undigested fiber measures (uNDF).

Methods:

A 14-acre tile-drained research field at Miner Institute in Chazy, NY, was used for the trial. The soil type is mapped as Adjiduamo silty clay. A randomized complete block design was utilized and hybrids were randomly assigned to plots within each block. All hybrids at Miner Institute were at planted on 6/8/17 at a 30-inch row spacing. Replicated strips at Miner were 6-rows wide and approximately 500 feet long arranged in a randomized complete block design. Hybrids at Adirondack Farms were planted between 5/17/17 and 5/24/17 and each hybrid was planted to a single field without replication (Table 1).

Table 1. Hybrids and planting information for Miner Institute, Chazy, NY, and Adirondack Farms, Peru, NY. BMR/non-BMR comparison trial, NNYADP, 2017.

Hybrid and planting data	Hybrid 1	Hybrid 2	Hybrid 3	Hybrid 4	Hybrid 5
	----------Miner Institute----------				
Hybrid (company and number)	Mycogen F2F379 (bm3)	Mycogen F2F499 (bm3)	Pioneer P0238XR (bm1)	Pioneer PO533AM1 (non-BMR)	Mycogen TMF2Q419 (non-BMR)
Planting date	6/8/17	6/8/17	6/8/17	6/8/17	6/8/17
Population	34,000	34,000	34,000	34,000	34,000
Harvest date	10/12/17	10/12/17	10/12/17	10/12/17	10/12/17
	----------Adirondack Farms----------				
Hybrid	Mycogen-F2F379	Mycogen-F2F499	Pioneer-P0238XR	Pioneer PO533AM1	Mycogen TMF2Q419
Planting date	5/24/17	5/18/17	5/17/17	Not planted	Not planted
Population	33,763	33,663	36,028	-	-
Harvest date	10/3/17	10/2/17	9/27/17	-	-

At planting, 100 lb/ac of 23-12-18 fertilizer was applied and 100 lb/ac of N were side-dressed to strips in mid-July as liquid urea ammonium nitrate. Cornell University N fertility guidelines were used to estimate total N assuming a yield goal of 20 tons/ac.

All plots at Miner Institute were harvested on 10/6/17 by chopping individual strips into dump trucks and weighing on truck scales. A composite sample was taken from each load and two vacuum-sealed bags (FoodSaver; Jarden Corp., Rye, NY) were filled and stored at room temperature for 0, 30, 60, 90, and 120 days. Samples from Adirondack and Miner Institute were analyzed for the following:

- pH (Miner)
- Percentage dry matter (DM)
- Starch, 7-hr starch digestibility (StarchD), crude protein (CP), soluble protein (SP), total digestible nutrients (TDN), acid detergent fiber (ADF), lignin, non-structural carbohydrates (NSC), and ash content (CVAS).
- NIR analyses (CVAS): Amylase NDF (aNDFNIR), 30-hr fiber digestibility (aNDFd30), and undigested NDF at 30-, 120- and 240-hr calibrated for ash-corrected basis (uNDF30NIR, uNDF120NIR, and uNDF240NIR)
- *In vitro* analyses (CVAS): Ash-corrected amylase NDF (aNDFom), 30-hr ash-corrected amylase NDF digestibility (aNDFd30om), and undigested NDF for fresh chop and at 120 days of ensiling for

30-, 120- and 240-hr time points (uNDF30om, uNDF120om, uNDF240om) using the Tilley-Terry rumen fermentation system.
- Fiber yields: Potentially digestible NDF (pdNDF) is calculated by subtracting uNDF240om from aNDFom. To calculate fiber yields, aNDFom, uNDF30om, uNDF120om, uNDF240om, and pdNDF were multiplied by yield and presented on 35% DM basis.
- Kernel processing score (CSPS) for fresh chop samples (CVAS)
- Lactic acid, acetic acid, ammonia-N, and percentage dry matter recovery were also measured for 30, 60, 90, and 120-day fermentation samples.

Statistical computations were performed using the Statistical Analysis System (version 9.4; SAS Institute Inc., Cary, NC). Data was subjected to analysis of covariance using the MIXED procedure of SAS (Littell et al., 1996). The model included hybrid as a fixed effect and block was a random effect in the model. Least squares means were separated using the Tukey's procedure when a significant *F*-test ($P \leq 0.10$) was detected. Linear regression was used to compare uNDF measures between NIR- and Tilley-Terry based methods. Significance was declared at $P \leq 0.05$ and tendency at $0.10 \geq P > 0.05$. Hybrids grown at Adirondack Farms were planted to individual fields without replication and therefore only means and standard errors were calculated.

Results and Discussion:

Fresh Chop Samples

- DM at harvest ranged from 27.5 to 35.3% at Miner and from 33.1 to 35.1% at Adirondack (Tables 2, A1).

- Dry matter content of Hybrid 2 was lower (mean %DM = 27.5%) than optimum moisture content for silage (32 to 35%DM).

- Yields ranged from 11.6 to 16.9 tons/acre (35% DM basis) for the Miner trial, with hybrid 5 having a larger ($P < 0.05$) yield than hybrid 2 (Tables 2).

- Starch content ranged from 28.4 to 31.3% at Miner and from 30.1 to 33.7% at Adirondack.

- StarchD for hybrids 1, 2, and 5 (61.2, 61.2, and 62.5%) was significantly greater ($P < 0.05$) than hybrids 3 and 4, whereas differences in starchD for hybrids at Adirondack were minimal (range = 60.3 to 61.3%).

- There were relatively minor differences in CP, SP, TDN, and ADF for hybrids grown at Miner and Adirondack.

- Hybrids 1 and 2 (bm3) hybrids had significantly greater ($P < 0.05$) aNDFd30 than hybrid 3 (bm1) and non-BMR at Miner and Adirondack.

- Hybrids 1 and 2 had significantly lower ($P < 0.05$) uNDF30om than hybrids 3, 4 and 5; hybrid 3 was significantly lower ($P < 0.05$) than hybrids 4 and 5 at Miner. The uNDF30om was lower for bm3 hybrids than bm1 hybrid at Adirondack.

- The uNDF120om and uNDF240om were significantly lower ($P < 0.05$) for hybrids 1 and 2 compared to hybrids 3, 4, and 5 grown at Miner. The uNDF120om and uNDF240om was lower for hybrids 1 and 2 (bm3) than hybrid 3 (bm1) at Adirondack.

- Lignin content was significantly lower ($P < 0.05$) for hybrids 1, 2, and 3 compared to hybrids 4 and 5 at Miner. Lignin content for hybrids at Adirondack ranged from (2.19 to 2.48%).

- The CSPS for hybrid 1 was lower ($P < 0.05$) than all other hybrids at Miner (37.8 vs 57.1, 49.9, 54.8, and 52.5, %). The CSPS for hybrids at Adirondack ranged from 49.5 to 64.9%.

- Hybrid 5 had a larger ($P < 0.05$) potentially digestible (pdNDF) yield than hybrid 2, but hybrid 2 was harvested before it reached maturity (Table 3).

- Hybrid 1 and 2 (bm3) have lower ($P < 0.05$) uNDF240 yield than hybrids 4 and 5 (non-BMR) (Table 3).

The 2017 growing season was challenging due to an excessively wet spring, which delayed planting and a mild summer. Therefore, yield was lower ($P < 0.05$) for hybrid 2 (F2F499) compared to hybrid 5 (TMF2Q419) with no differences between other hybrids. Hybrid 2 (F2F499) was harvested before it reached optimum harvest dry matter and may have contributed to its lower yield. The previous two years (2015 and 2016) showed no significant difference in yield between BMR and non-BMR hybrids grown at Miner. ***Brown midrib hybrids are often characterized by the industry as having lower yield potential compared to non-BMR; however, our data suggest that BMR can have similar yield potential under the same field conditions.***

Starch content was not different among hybrids grown at Miner. However, fiber digestibility as measured by aNDFd30om was substantially greater, equating to approximately 5 lb of milk/cow/day more than non-BMR hybrids (i.e., assuming 0.5 lb milk/cow/day for every one percentage-unit increase in aNDFd30; Oba and Allen, 2000).

Another important result is higher aNDFd30 of the hybrids 1 and 2 (bm3) compared to hybrid 3 (bm1). The hybrids 1 and 2 (bm3) also had significantly lower uNDF240om and higher pdNDF than the other hybrids. Differences between bm1 and bm3 were also apparent at Adirondack.

Differences in fiber digestibility and yields have important implications for dairy ration formulation and farm economics. Our results show clear differences in fiber quality related to hybrid genetics.

Forage Quality at Different Fermentation Time Points

With the exception of digestible starch (starchD), soluble protein (SP), and pH, there were relatively minor differences in forage quality with increasing fermentation time (Appendix Tables A1-A6).

Fiber digestibility, lignin, and undigested fiber trends among hybrids were similar to fresh chop results (Tables A1-A6).

StarchD increased with time of fermentation and peaked at 90 to 120 days of fermentation. At 120 days of fermentation, hybrid 2 and 5 had significantly higher starchD (74.7 and 72.6%) than hybrids 1 and 4 (Table A6). For Adirondack samples, starchD for hybrid 3 (bm1) at 120 days of fermentation was 5%-units lower than hybrid 1 and 2 (bm3).

Differences in starchD trends between sites suggest that growing environment influenced starch degradability. Soluble protein also peaked at 120 days of fermentation. A decrease in pH occurs with fermentation as organic acids are produced, increasing soluble protein degradability and consequently starch digestibility. In contrast, trends among hybrids were similar for fresh chop and later fermentation time points with respect to fiber quality. Ordinarily, you would expect no influence of silage fermentation on fiber digestibility measures.