2014

Brown Mid-Rib Corn Variety Trial

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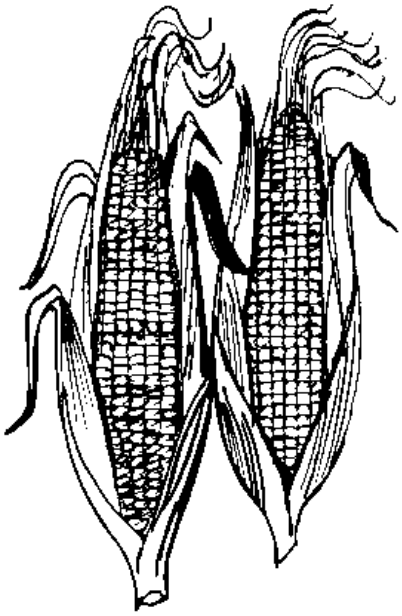

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

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Brown mid-rib (BMR) corn has a lower lignin content than other silage corn varieties, which makes it more digestible to dairy cows, potentially increasing milk production. Growers interested in BMR corn look for high-yielding varieties with favorable quality. Since 2010, the University of Vermont Extension Northwest Crops & Soils program has conducted research trials to evaluate BMR corn silage varieties. In 2014, the trial included 10 varieties from three different seed companies. While the information presented can begin to describe the yield and quality performance of these BMR corn varieties in this region, it is important to note that the data represent results from only one season and one location. Compare other hybrid performance data before making varietal selections.

MATERIALS AND METHODS

A trial was conducted at Borderview Research Farm in Alburgh, Vermont in 2014 to evaluate ten BMR corn varieties. The experimental design was a randomized block of 5'x 30' plots (two 30" rows of corn) with three replications (Table 1). The soil was a Benson rocky silt loam, and the area was previously planted with corn. The seedbed was prepared with spring disking and finished with a spike tooth harrow. The corn was planted on 15-May at a rate of 34,000 seeds per acre with a John Deere 1750 four-row corn planter.

At planting, 250 lbs per acre of 10-20-20 starter fertilizer was applied through the planter. On 5-Jun, Syngenta's selective herbicide Lumax® (Mesotrione, S-Metolachlor, and triazine) was applied at a rate of 3 quarts per acre with Dupont Accent® (Nicosulfuron) at a rate of 0.33 ounces per acre. An additional topdress fertilizer (urea (46-0-0)) was applied on 2-Jul at a rate of 200 lbs per acre. Plots were harvested on 22-Sep and 3-Oct with a John Deere two-row chopper, and whole-plant silage was collected and weighed in a forage wagon.

Table 1. Agronomic information for the 2014 BMR corn variety trial at Borderview Research Farm.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn
Tillage operations	Fall chisel plow, spring disk, spike tooth harrow
Plot size (ft.)	5 x 30
Replicates	3
Seeding rate	34,000 seeds ac^{-1}
Row width (in.)	30
Planting date	15-May
Starter fertilizer	250 lbs ac^{-1} of 10-20-20
Additional fertilizer (topdress)	200 lbs ac^{-1} urea (46-0-0), 2-Jul
Herbicide	3 qt ac^{-1} Lumax®, 0.33 oz ac^{-1} Accent®, 5-Jun
Harvest date	22-Sep, 3-Oct

Treatments were 10 publicly-available corn varieties (Table 2). The seed for this trial was donated by three participating seed companies, Mycogen, Pioneer, and Seedway, LLC, whose contact information is listed below. Varieties ranged from 88-110 days in relative maturity. Relative Maturity (RM) and seed trait information was provided by the seed companies.

Mycogen	Pioneer	Seedway
Claude Fortin Highgate, Vermont (802) 363-2803	Bourdeau Bros. Sheldon, VT (802) 933-2277	Ed Schillawski Shoreham, Vermont (802) 897-2281

Table 2. Relative maturities and listed traits of ten evaluated BMR varieties.

Variety	Company	Relative maturity	Traits
14RST	Seedway	98	BMR
F2F298	Mycogen	88-93	BMR, HXI, LL, RR2
F2F346	Mycogen	92-95	BMR, HXT, LL, RR2
F2F498	Mycogen	97-101	BMR, SSX, LL, RR2
F2F569	Mycogen	103-107	BMR, HXT, LL, RR2
F2F627	Mycogen	107-110	BMR, SSX, LL, RR2
F2F665	Mycogen	107-110	BMR, HXT, LL, RR2
P0238XR	Pioneer	102	BMR, HXX, LL, RR2
P0783XR	Pioneer	107	BMR, HXX, LL, RR2
SW3937	Seedway	94-96	BMR

BMR = Brown mid-rib, a naturally-occurring gene
HXI = Herculex® I Insect Protection, glyphosate (Roundup®, Touchdown®) and glufosinate (Ignite®) herbicide tolerance
HXT = Herculex Xtra®, provides season-long control of a variety of pests, including European corn borer, western bean cutworm, corn rootworm
HXX = Herculex XTRA® (HXX) combines Herculex I and Herculex RW traits to provide consistent, season-long control of corn rootworms, allows protection in-plant and above-and below-ground
LL = Glufosinate-ammonium (LibertyLink®) herbicide tolerance
RR2 = Roundup Ready corn, glyphosate (Roundup®, Touchdown®) herbicide tolerance
SSX = Genuity® SmartStax™, provides control of a variety of pests, including European corn borer, western bean cutworm, corn rootworm, provides herbicide flexibility and makes possible a 5% refuge requirement

Chopped silage was dried and ground with a Wiley laboratory mill. A subsample was retained for analysis. The subsamples of the harvested material were collected, dried, ground, and then analyzed at the University of Vermont's Testing Laboratory, Burlington, VT, for quality analysis. Dry matter yields were calculated and then adjusted to 35% dry matter.

Silage quality was analyzed using the FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer. Dried and coarsely-ground plot samples were brought to the lab where they were reground using a cyclone sample mill (1mm screen) from the UDY Corporation. The samples were then analyzed using the FOSS NIRS DS2500 for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), 30-hour and 48-hour digestible NDF (NDFD), starch, non-fiber components (NFC), nonstructural components (NSC), and total digestible nutrients (TDN).

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the CP content of forages. The CP content of forages is determined by measuring the amount of nitrogen and multiplying by

6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. Recently, forage testing laboratories have begun to evaluate forages for NDF digestibility (NDFD). Evaluation of forages and other feedstuffs for NDFD is being conducted to aid prediction of feed energy content and animal performance. Research has demonstrated that lactating dairy cows will eat more dry matter and produce more milk when fed forages with optimum NDFD. Forages with increased NDFD will result in higher energy values and, perhaps more importantly, increased forage intakes. Forage NDFD can range from 20 – 80% NDF.

Net energy for lactation (NE_L) is calculated based on concentrations of NDF and ADF. NE_L can be used as a tool to determine the quality of a ration, but should not be considered the sole indicator of the quality of a feed, as NE_L is affected by the quantity of a cow's dry matter intake, the speed at which her ration is consumed, the contents of the ration, feeding practices, the level of her production, and many other factors. Most labs calculate NE_L at an intake of three times maintenance. Starch can also have an effect on NE_L, where the greater the starch content, the higher the NE_L (measured in Mcal per pound of silage), up to a certain point. High grain corn silage can have average starch values exceeding 40%, although levels greater than 30% are not considered to affect energy content, and might in fact have a negative impact on digestion. Starch levels vary from field to field, depending on growing conditions and variety.

The silage performance indices of milk per acre and milk per ton were calculated using a model derived from the spreadsheet entitled "MILK2006," developed by researchers at the University of Wisconsin. Milk per ton measures the pounds of milk that could be produced from a ton of silage. This value is generated by approximating a balanced ration meeting animal energy, protein, and fiber needs based on silage quality. The value is based on a standard cow weight and level of milk production. Milk per acre is calculated by multiplying the milk per ton value by silage dry matter yield. Therefore, milk per ton is an overall indicator of forage quality and milk per acre an indicator of forage yield and quality. Milk per ton and milk per acre calculations provide relative rankings of forage samples, but should not be considered as predictive of actual milk responses in specific situations for the following reasons:

1) Equations and calculations are simplified to reduce inputs for ease of use,
2) Farm to farm differences exist,
3) Genetic, dietary, and environmental differences affecting feed utilization are not considered.

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and hybrids were treated as fixed. Hybrid mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among hybrids is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two hybrids within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids. In the example below, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Hybrid	Yield
A	6.0
B	7.5*
C	**9.0***
LSD (0.10)	2.0

RESULTS

Using data from a Davis Instruments Vantage Pro2 weather station at Borderview Research Farm in Alburgh, VT, weather data was summarized for the 2014 growing season (Table 3). The table shows weather information through the last corn harvest, 14-Oct. The spring was slightly wetter than usual, with higher precipitation in April through July than normal (based on 1981-2010 data). September and October were slightly drier than usual. Temperatures during the growing season were higher than the historical average in April, May and June, lower than the average in July and August, followed by a very warm fall. Temperatures in the first half of October were 69 degree days above the 30 year average. There were an accumulated 2,310 Growing Degree Days (GDDs) at a base temperature of 50°F from May to 14-Oct. This was 98 more than the historical 30-year average for May-October.

Table 3. Summarized weather data for 2014 – Alburgh, VT.

Alburgh, VT	April	May	June	July	August	September	October
Average temperature (°F)	43.0	57.4	66.9	69.7	67.6	60.6	55.0
Departure from normal	-1.8	1.0	1.1	-0.9	-1.2	0.0	6.8
Precipitation (inches)	4.34	4.90	6.09	5.15	3.98	1.33	2.00
Departure from normal	1.52	1.45	2.40	1.00	0.07	-2.31	-1.60
Growing Degree Days (base 50°F)	16	238	501	613	550	339	69
Departure from normal	16	40	27	-27	-31	21	69

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
October data represents weather recorded through the last corn harvest, 14-Oct 2014.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Dry matter content of the corn silage at harvest ranged from 33% (F2F498 and F2F569) to 46.5% (P0238XR). A range in dry matters is to be expected as the varieties differed in RM. Additionally, the

two-week difference in harvest dates could have affected dry matters. The variety with the highest yield after being adjusted to 35% dry matter was 'F2F627' (Table 4). The mean yield for the BMR variety trial was 18.3 tons per acre.

Table 4. Yield and dry matter content of ten BMR varieties, Alburgh, VT, 2014.

Variety	Relative Maturity	Yield at 35% DM tons ac^{-1}	Harvest DM %
14RST	98	14.5	33.8
F2F298	88-93	14.5	44.6*
F2F346	92-95	20.0*	38.9
F2F498	97-101	16.6	33.0
F2F569	103-107	18.7*	33.0
F2F627	107-110	**22.0***	44.8*
F2F665	107-110	21.4*	41.8
P0238XR	102	20.9*	**46.5***
P0783XR	107	19.1*	46.3*
SW3937	94-96	15.1	42.6
LSD (0.10)		4.1	2.5
Trial mean		18.3	40.5

Treatments indicated in **bold** had the top observed performance.
LSD – Least significant difference
* Treatments indicated with an asterisk did not perform significantly worse than the top-performing treatment in a particular column.

Figure 1 shows the difference in yield between varieties. Varieties that share a letter did not yield significantly different from each other.

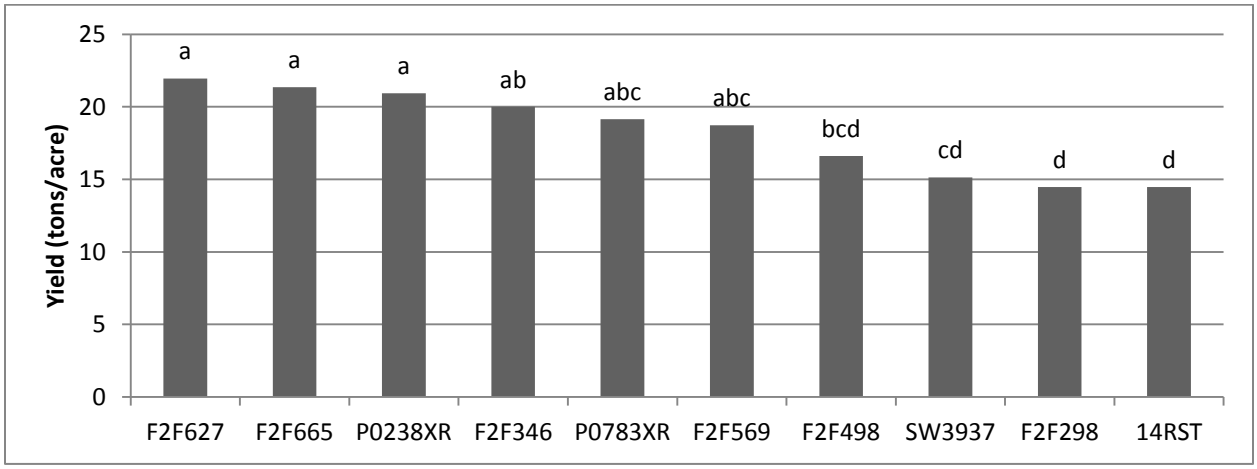

Figure 1: Yield at 35% dry matter of ten BMR corn silage varieties, Alburgh, VT, 2014

The BMR corn varieties differed significantly in all quality parameters except for NDFD, NSC, TDN, starch and milk per ton (Table 5). The variety P0238XR had the highest concentration of CP, NSC, TDN, starch, and NE_L. This variety also ranked highest in milk per acre. Varieties that performed statistically similar to P0238XR are denoted by an asterisk in Table 5.

Table 5. Forage quality of ten evaluated BMR corn varieties, Alburgh, VT, 2014.

Variety	Forage quality characteristics									Milk
	CP	ADF	NDF	NDFD	NSC	TDN	Starch	NE_L	ton^{-1}	ac^{-1}
	% of DM	% of DM	% of DM	% of DM	% of DM	% of DM	% of DM	Mcal lb^{-1}	lbs	lbs
14RST	8.8	24.9	46.7*	59.0*****	38.0*	68.0*	35.1*	0.66	3036*	15410
F2F298	7.6	22.5	43.7	59.3*	40.8*	69.7*	38.6*	0.68	3169*	16086
F2F346	8.0	22.6	40.2	56.3*	40.5*	70.7*	38.1*	0.70*	3276*	23010*
F2F498	8.4	21.7	40.3	61.0*	43.0*	71.2*	40.6*	0.70*	3271*	19018
F2F569	8.2	23.9	44.4*	60.3*	40.0*	70.6*	37.0*	0.69*	3222*	21148*
F2F627	7.1	**27.9***	**47.5***	56.0*	37.8*	69.0*	36.0*	0.68	3144*	24175*
F2F665	8.2	26.7*	46.9*	54.7*	39.4*	68.8*	36.9*	0.68	3145*	23525*
P0238XR	**9.7***	23.1	42.3	54.3*	**43.2***	71.2*	**40.7***	**0.71***	3330*	**24342***
P0783XR	9.0*	24.3	41.9	57.3*	41.0*	**71.6***	38.8*	0.71*	**3344***	22417*
SW3937	8.7	23.8	46.5*	**63.0***	37.9*	69.6*	35.5*	0.67	3111*	16436
LSD (0.10)	0.85	1.9	3.4	NS	NS	NS	NS	0.02	NS	4851
Trial mean	8.4	24.1	44.0	58.1	40.2	69.4	37.7	0.69	3205	20557

Treatments indicated in **bold** had the top observed performance.

* Treatments indicated with an asterisk did not perform significantly worse than the top-performing treatment in a particular column.

NS – No significant difference was determined between treatments.

DISCUSSION

The average yield for this BMR corn trial was 18.3 tons per acre at 35% dry matter content. This is lower than the trial averages in the previous three years. However, this year's quality values are the second highest out of the same years (Table 6). P0238XR, P0783XR, F2F346 and F2F569 each were above average in both milk per acre and milk per ton.

Table 6: Milk per ton and yield 2011-2014

Year	Milk per ton (lbs)	Yield at 35% DM
2011	3543	18.6
2012	3132	19.8
2013	2869	23.5
2014	3205	18.3

While BMR corn can have a yield drag when compared to conventional silage corn varieties in a given year, its higher NDF digestibility (NDFD) often makes it a viable choice for growers looking to maximize milk production. This year, the average NDFD was 58.1 in the BMR trial compared to 43.9 for the 2014 long season corn and 43.5 for the 2014 short season corn.

ACKNOWLEDGEMENTS

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