2018

Non-GMO Corn Silage Variety Trial

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NORTHWEST CROPS & SOILS PROGRAM

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THE UNIVERSITY OF VERMONT
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2018 NON-GMO CORN SILAGE VARIETY TRIAL
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In 2018, the University of Vermont Extension Northwest Crops and Soils Program evaluated yield and quality of 12 non-GMO corn silage varieties at Bridgeman View Farm in Franklin, VT. A non-GMO milk market has prompted some dairy farmers to start growing corn silage that has not been genetically modified. Conventional farmers have countless corn silage varieties available supported by performance data and trait information. To successfully convert to growing non-GMO corn, farmers are looking for more information on non-GMO varieties that are available and perform well in our region. While the information presented can begin to describe the yield and quality performance of these non-GMO corn silage varieties in this region, it is important to note that the data represent results from only one season and one location.

MATERIALS AND METHODS

In 2018, 12 non-GMO corn silage varieties from four seed companies (Table 1) were evaluated at Bridgeman View Farm in Franklin, VT. The trial design was a randomized complete block with two replications. Plots were 7.5' x approximately 650'. The length of each plot was measured at harvest. Treatments were 12 non-GMO corn silage varieties. These varieties were evaluated for silage yield and quality. Relative maturity (RM) and varietal characteristics are provided in Table 2.

Table 1. Participating companies contact information.

King's Agriseed	Master's Choice	Mycogen Seeds	Seedway, LLC
1828 Freedom Rd.	305 West Vienna St.	6383 Ethan Allen Hwy.	171 Ledgemere Point
Lancaster, PA 17601	Anna, IL 62906	St. Albans, VT 05478	Bomoseen, VT 05732
717-687-6224	866-444-1044	802-363-2803	802-338-6930

Table 2. 12 non-GMO silage corn varieties evaluated, 2018.

Variety	Company/Brand	RM
KF 34C30	King's Agriseed	84
KF 43C40	King's Agriseed	94
MC 3320	Master's Choice	82
MC 4570	Master's Choice	95
2G161	Mycogen	84
MY87B10	Mycogen	87
SW 2790	Seedway, LLC	87
SW 3750	Seedway, LLC	93
SW 3937BMR	Seedway, LLC	94
SW 3980	Seedway, LLC	99
SW 5410	Seedway, LLC	104
TMF96Q40	Mycogen	96

The trial was no-till planted into herbicide terminated winter rye on 18-May (Table 3). The UVM staff assisted with organization, planting, scouting, and harvesting of the trial. All other crop management was performed by the farmer and farm staff. Plots were scouted for disease and populations measured on 7-Sep by randomly selecting two 13’ sections of each plot. In each section, the number of plants were counted and each plant was inspected for presence of foliar diseases. Harvested silage was captured in a wagon and weighed with a set of portable truck scales. An approximate 1 lb subsample was taken from each plot and dried to calculate dry matter content. The dried subsamples were then ground on a Wiley sample mill to a 2mm particle size and to 1mm particle size on a cyclone sample mill from the UDY Corporation. The samples were then analyzed for quality at the University of Vermont Cereal Testing Lab (Burlington, VT) with a FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer.

Table 3. Non-GMO corn variety trial details, Franklin, VT, 2018.

Location	Bridgeman View Farm Franklin, VT
Soil type	Peru stony fine sandy loam
Previous crop	Corn silage w/winter rye cover crop
Tillage operations	No-till
Seeding rate (viable seeds ac^{-1})	33,000
Planting equipment	John Deere 7000 no-till corn planter
Treatments (varieties)	12
Replications	2
Row width (in.)	30
Plot size (ft)	7.5 x 610
Planting date	18-May
Weed control	2.7 qt. ac^{-1} Acuron applied 20-May
Starter fertilizer (at planting)	10 gal. ac^{-1} 19.6-8.4-2.8
Additional fertilizer (topdress)	125 lbs ac^{-1} 39-0-0 applied 22-Jun
Harvest date	24-Sep

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the crude protein (CP) content of forages. The CP content 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). This analysis can be conducted over a wide range of incubation periods from 30 to 240 hours. 30 hr NDFD is typically used when evaluating forage for ruminants as it is most similar to the actual passage time through the rumen. 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.

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 due to 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. Hybrids that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk.

In this example, 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	2.0

RESULTS

Weather data for the location nearest the trial site, West Berkshire, VT, was collected from an Ambient Weather WS-1001-WIFI wireless remote monitoring weather station accessed through Weather Underground (http://www.wunderground.com) (Table 4). In general, temperatures were slightly above normal through the summer and fall with the exception of June while accumulated precipitation followed the opposite trend. Below average rainfall was accumulated across the entire growing season as much of the state experience drought conditions. There were several extended periods of dry conditions including one at the beginning of August in which very little to no rainfall was accumulated for over two weeks. This dry period, which occurred around the time corn plants were developing tassels and silks for pollination, may have negatively impacted corn plant growth and productivity. However, these warm conditions did provide optimal Growing Degree Days (GDDs) through the season with a total of 2522 GDDs accumulated, 311 above normal. Because of the warm and dry conditions, all varieties reached maturity by mid- to late September.

Table 4. Weather data for West Berkshire, VT, 2018.

West Berkshire, VT	May	June	July	August	Sept
Average temperature (°F)	59.6	63.1	72.1	71.2	62.9
Departure from normal	3.17	-2.74	1.49	2.43	2.31
Precipitation (inches)	2.49	3.59	2.53	2.37	2.83
Departure from normal	-0.96	-0.10	-1.62	-1.54	-0.81
Growing Degree Days (50-86°F)	356	417	674	655	420
Departure from normal	158	-57	34	74	102

Based on weather data collected from http://www.wunderground.com via a weather station in West Berkshire, VT .
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Corn silage varieties varied statistically in harvest characteristics (Table 5). Plant populations were relatively low overall, likely due to the dry weather experienced throughout the season and did not differ. The average dry matter content at harvest was 52.0%. Ideally silage should be harvested around 35% dry matter. If the plants were harvested slightly earlier, the moisture content would have been more ideal for the ensiling process. Harvesting silage too dry can pose issues for fermentation, cause inadequate packing leading to mold growth, or complicate balancing rations and maintaining palatability. Yields also varied statistically. The top yielding variety was KF 34C30 with 21.8 tons ac^{-1}. This was statistically similar to all but five of the varieties. Yields ranged from 10.8 to 21.8 tons ac^{-1} (Figure 1).

Table 5. Harvest data for 12 non-GMO corn varieties, 2018.

Variety	**RM**	**Plant Populations**	**Harvest DM**	**Yield, 35% DM**
		plants ac^{-1}	%	tons ac^{-1}
KF 34C30	84	24126	49.4	**21.8**
KF 43C40	94	31162	47.4	19.8*
MC 3320	82	27141	59.6	20.2*
MC 4570	95	31162	46.1	21.2*
2G161	84	32167	56.4	15.4
MY87B10	87	**32502**	55.2	17.5
SW 2790	87	27811	61.8	16.4
SW 3750	93	28146	51.3	13.6
SW 3937BMR	94	29487	54.3	10.8
SW 3980	99	29822	48.1	21.0*
SW 5410	104	31497	**42.1**	20.4*
TMF96Q40	96	32502	52.6	21.0*
LSD (p = 0.10)	N/A	NS	3.2	4.15
Trial mean	92	29794	52.0	18.3

*Varieties with an asterisk are not significantly different than the top performer in **bold**.
N/A statistical analysis not completed for this parameter.
NS not statistically significant.

The silage quality characteristics also varied statistically across varieties (Table 6). Crude protein averaged 7.42% across the trial with the top variety, KF 43C40, having 8.90% protein. This was statistically similar to one other variety, MC 4570. No other variety reached above 7.75%. The lowest protein content was quite low at 6.39%. The ADF, NDF, and starch content did not vary statistically among varieties. Varieties differed in TDN, ranging from 62.5 to 69.2%. The top performing variety, KF 43C40, was statistically similar to all other varieties except for three which had TDN content below 64%. Net energy calculations use TDN to estimate the digestible energy content of feeds utilized for maintenance, lactation, or gain accounting for differences in efficiency of use of the energy for the different goals. Net energy for lactation (NE_L) averaged 0.645 for the trial with the highest level of 0.676 Mcal lb^{-1} produced by variety KF 43C40, which was similar to all varieties except for three. The same trend was also observed in milk yield per ton of dry matter with the highest milk yield being 3134 lbs ton^{-1}. When differences in yield are considered, varieties also differed statistically in milk yield per acre. The top milk yield per acre was produced by variety KF 34C30 with 23,623 lbs ac^{-1}. This was statistically similar to six other varieties.

Table 6. Corn silage quality characteristics of 12 non-GMO corn varieties, Franklin, VT, 2018.

Variety	CP	ADF	NDF	Starch	TDN	30 hr NDFD	NE_L	Milk	
			% DM			% NDF	Mcal lb^{-1}	lbs ton^{-1}	lbs ac^{-1}
KF 34C30	7.53	**23.0**	**38.3**	41.9	68.6*	46.5*	0.670*	3089*	**23623**
KF 43C40	**8.90**	23.5	38.9	37.8	**69.2**	**47.0**	**0.676**	**3134**	21654*
MC 3320	7.21	23.6	39.5	41.9	66.8*	45.3	0.651*	2958*	20948*
MC 4570	8.20*	23.3	39.4	38.1	68.2*	46.2*	0.666*	3059*	22744*
2G161	7.03	25.9	43.7	38.3	66.2*	46.0*	0.641*	2899*	15821
MY87B10	7.72	24.6	42.9	35.5	66.4*	45.8*	0.644*	2915*	17877
SW 2790	6.39	28.3	49.3	32.0	62.5	43.8	0.603	2635	15145
SW 3750	6.72	26.5	47.6	33.7	63.9	44.3	0.619	2739	13031
SW 3937BMR	7.25	26.0	47.2	32.5	63.0	44.2	0.607	2665	10027
SW 3980	7.08	25.8	42.9	35.9	66.7*	45.5*	0.649*	2947*	21667*
SW 5410	7.70	24.4	43.0	35.4	67.3*	44.0	0.661*	3009*	21487*
TMF96Q40	7.29	23.7	39.7	**42.4**	67.6*	46.1*	0.659*	3012*	22123*
LSD (p = 0.10)	0.779	NS	NS	NS	3.43	1.59	0.038	255	4962
Trial mean	7.42	24.9	42.7	37.1	66.4	45.4	0.645	2922	18846

*Varieties with an asterisk are not significantly different than the top performer in **bold**.
N/A statistical analysis not completed for this parameter.
NS not statistically significant.

Figure 1 below displays the projected milk production, in lbs ton^{-1} and lbs ac^{-1} of the trialed corn silage varieties. The dotted lines indicate the trial averages for these parameters. This figure provides a visualization of yield and quality but does not, however, state that these differences are statistically significant (Tables 5 and 6).

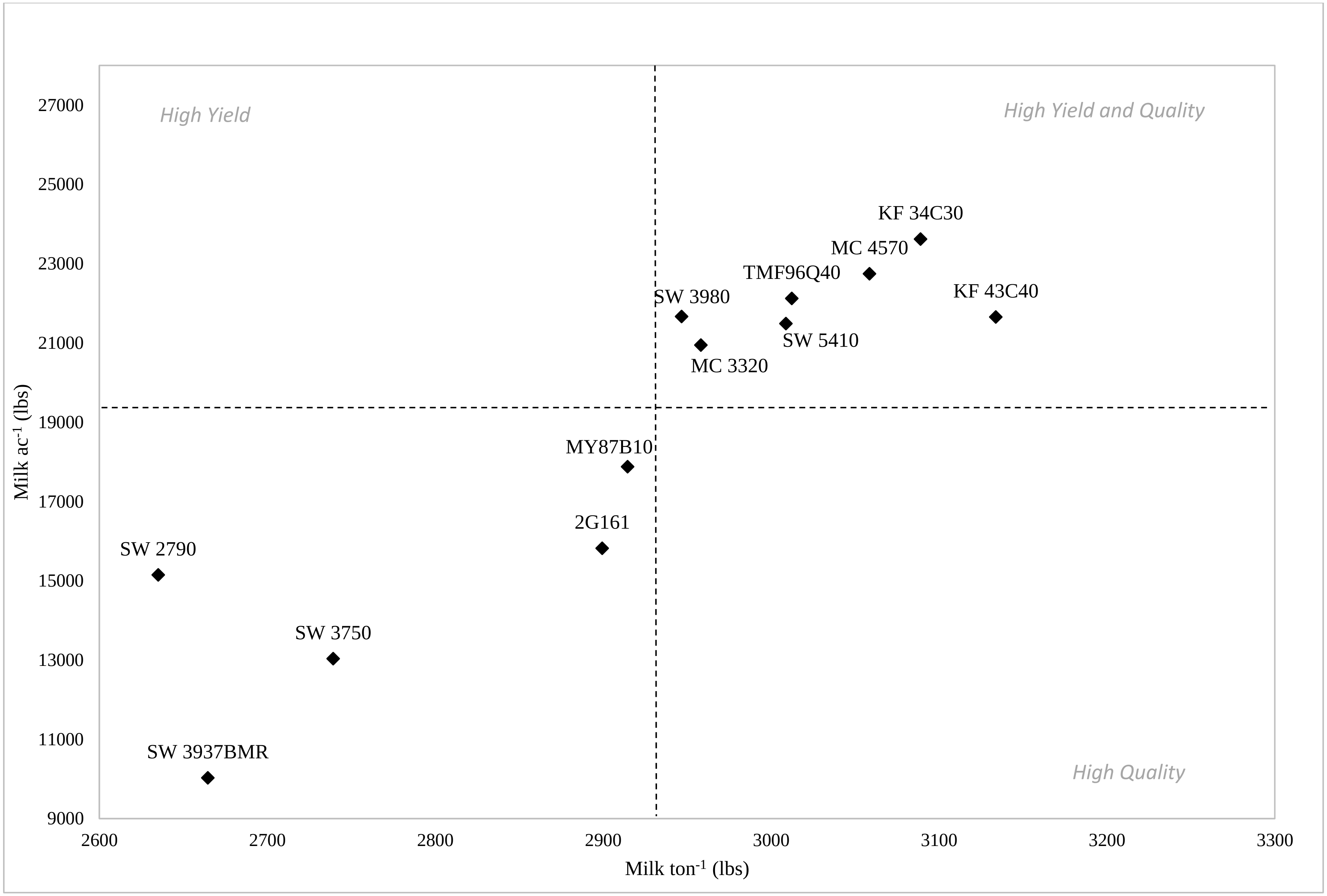

Figure 1. Milk production of 12 non-GMO corn varieties, Franklin, VT, 2018.
Shows relationship between milk per ton and milk per acre. Dotted lines represent the mean milk per ton and milk per acre for the trial.

The trial was scouted for foliar diseases on 7-Sep. Table 7 below summarizes the diseases that were present in the field at the time of scouting and the calculated percentage of the total corn population for that variety that was infected with each variety. With the dry conditions, much less disease pressure was observed in the trial compared to 2017. The most common diseases seen throughout the trial were Frogeye leaf spot and Common rust (Figures 2 and 3). The average incidence of frogeye leaf spot was 3.75% while common rust was 7.75%. The highest incidences were seen in SW 2790 with 19.8% for frogeye leaf spot, and in SW 3937BMR with 15.1% for common rust. Disease incidence does not capture potential differences in severity of the infections. More information is needed to determine the potential differences in disease susceptibility and the impacts of on corn silage yield and quality.

Table 7. Corn foliar disease incidence, 2018.

Variety	Frogeye leaf spot	Common rust
	% of plants infected	
KF 34C30	**0.00**	11.2
KF 43C40	0.00	4.31
MC 3320	4.76	3.57
MC 4570	0.00	12.0
2G161	0.00	**2.88**
MY87B10	0.00	7.57
SW 2790	19.8	5.40
SW 3750	1.56	5.68
SW 3937BMR	5.13	15.1
SW 3980	0.00	5.49
SW 5410	13.8	11.8
TMF96Q40	0.00	7.96
LSD (*p* = 0.10)	NS	NS
Trial mean	3.75	7.75

NS not statistically significant.

Figure 2. Frogeye leaf spot

Figure 3. Common rust

DISCUSSION

Corn silage yield and quality varied across the 12 non-GMO corn varieties evaluated in this trial. Performing this trial on-farm presented limitations for the number of replications possible which consequently limits the ability for robust statistical analyses. However, these data demonstrate the variability that can be observed across varieties and thus the importance of careful varietal selection based on information generated from our region. Both short and long season varieties produced high yields in this trial. For example, the highest yielding variety, KF 34C30, has a relative maturity of 84 days which is one of the shortest season varieties in the trial which performed statistically similar to variety SW 5410 with 20.4 tons ac^{-1} which was the longest season variety in the trial with a relative maturity of 104 days. These data highlight the importance of varietal selection but also only represent one year of data. More data and other factors should be considered when making management decisions. As more non-GMO varieties become available, further and more replicated investigation is warranted to understand the yield and quality potential of these varieties in our region.

ACKNOWLEDGEMENTS

UVM Extension would like to thank Tim Magnant and his staff at Bridgeman View Farm in Franklin for their generous help with the trials. We thank Ben & Jerry's Caring Dairy Program and seed companies for their generous support and participation in the trial. The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned or criticism of unnamed products is implied.

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