NORTHWEST CROPS & SOILS PROGRAM

2020 Vermont Non-GMO Corn Silage Performance Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2020 VERMONT NON-GMO CORN SILAGE PERFORMANCE TRIAL

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In 2020, the University of Vermont Extension Northwest Crops and Soils Program evaluated yield and quality of six non-GMO corn silage varieties at Borderview Research Farm in Alburgh, VT. To successfully transition 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 2020, 6 non-GMO corn silage varieties from two seed companies (Table 1) were evaluated at Borderview Research Farm in Alburgh, VT. The trial design was a randomized complete block with three replications. Plots were 10' x 20'. Treatments were 6 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.

Dyna-Gro (Crop Protection Services)	Seedway, LLC
Tom Barber	171 Ledgemere Point
East Aurora, NY	Bomoseen, VT 05732
(716) 912-5494	(802) 338-6930

Table 2. 6 non-GMO silage corn varieties evaluated in the 2020 trial.

Company/Brand	Variety	Traits	RM
Seedway, LLC	SW 2360	none	84
Seedway, LLC	SW 3750	none	93
Dyna-Gro	D39CC43	none	95
Seedway, LLC	SW 3980	none	99
Dyna-Gro	D47CC29	none	103
Seedway, LLC	SW 5410	none	104

The soil type at the Alburgh location is a Benson rocky silt loam (Table 3). The seedbed was prepared with two passes with the Pottinger TerraDisc (Valparaiso, IN). The previous crop was corn silage with a winter rye cover crop. On 29-Apr, solid manure was applied at a rate of 10 tons ac^{-1}. Plots were planted on 13-May with a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units (Nevada, IA) at a rate of 40,000 seeds ac^{-1}. Plots were thinned to a population of 34,000 seeds ac^{-1} on 20-Jun. Plots received liquid starter fertilizer (9-18-9) at a rate of 5 gal ac^{-1} at planting. On 19-May, plots were sprayed with Acuron™ from Syngenta at a rate of 3 quarts ac^{-1}. On 23-Jun, corn was top-dressed with 200 lbs. ac^{-1} of urea (46-0-0). The corn was harvested with a John Deere 2-row chopper and a wagon fitted with scales. Short season varieties were harvested on 10-Sep and later season varieties were harvested on 18-

Sep. An approximate 1 lb subsample was taken from each plot and dried to calculate dry matter content. The dried subsamples were first ground with a Wiley sample mill to a 2mm particle size followed by a cyclone sample mill to 1mm particle size (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. The NIR procedures and corn silage calibration from Dairy One Forage Laboratories (Geneva, NY) were used to determine crude protein (CP), starch, lignin, ash, total fatty acids (TFA), ash corrected neutral detergent fiber (aNDFom), and neutral detergent fiber digestibility (NDFD; 30, 240 h).

Table 3. Non-GMO silage corn variety trial information, Alburgh, VT, 2020.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam
Previous crop	corn silage
Row width (in)	30
Plot size (ft)	10 x 30
Seeding rate (seeds ac^{-1})	40,000 thinned to 34,000
Planting date	13-May
Tillage operations	Pottinger TerraDisc
Starter fertilizer (gal ac^{-1})	5 (9-18-9)
Top-dress fertilizer (lbs. ac^{-1})	200 (46-0-0)
Harvest date	10-Sep & 18-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 like 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. Total digestible nutrients (TDN) is a measure of the energy value in a feedstuff. Neutral detergent fiber expressed on an organic matter basis (aNDFom) is used when high ash content leads to ash remaining in the fiber residue. 240-hr uNDFom is the undigestible NDF on an organic matter basis after 240 hours in rumen fluid. This can cause an overvaluation of the NDF and can cause nutritionists to underfeed fiber. Net energy lactation (NE_L) is estimated energy value of feed used for maintenance plus milk production during dairy cow lactation or last two months of gestation for dry, pregnant cows.

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 varieties were treated as fixed. Variety 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 varieties 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 varieties 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 varieties. Varieties that were not significantly lower in performance than the highest variety in a column are indicated with the same letter. In this example, variety C is significantly different from variety A but not from variety 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 varieties 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 varieties were significantly different from one another. The top yielding variety C is indicated in bold.

Hybrid	Yield
A	6.0[b]
B	7.5[ab]
C	**9.0[a]**
LSD	2.0

RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 4). The region experienced drought and warmer than average temperatures this season. While May was cooler than average, from June to August temperatures were higher than normal. In July, the average temperature in Alburgh, VT was 4.17° F higher than normal. Above average temperatures coincided with little rainfall from May to July. In both May and June, there were periods without rain that lasted nearly two weeks. July was particularly hot and dry. But in August there were a couple large rain events and the average monthly precipitation was 2.86 in. above normal. However, this season's warm conditions did provide optimal Growing Degree Days (GDDs) through the season with a total of 2484 GDDs accumulated May-Sep, 139 above normal.

Table 4. Weather data for Alburgh, VT, 2020.

Alburgh, VT	May	June	July	August	Sept
Average temperature (°F)	56.1	66.9	74.8	68.8	59.2
Departure from normal	-0.44	1.08	4.17	0.01	-1.33
Precipitation (inches)	2.35	1.86	3.94	6.77	2.75
Departure from normal	-1.04	-1.77	-0.28	2.86	-0.91
Growing Degree Days (50-86°F)	298	516	751	584	336
Departure from normal	6	35	121	2	-24

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Corn silage varieties varied statistically in population, dry matter, and yield (Table 5). The variety with the highest population was D47CC29 (34,412 plants ac^{-1}) and the lowest was SW 5410 with 28,967 plants ac^{-1}. At the time of harvest, plant populations in most varieties were around the recommended 34,000 plants ac^{-1}. Harvest dry matter ranged from 37.6% (SW 5410) to 40.8% (D39CC43). Yields also varied statistically. The top yielding variety was D47CC29 with 27.8 tons ac^{-1}. Variety yields ranged from 19.1 to 27.8 tons ac^{-1}.

Table 5. Harvest data for 6 non-GMO corn varieties, 2020.

Variety	RM	Plant populations	Harvest DM	Yield, 35% DM
		plants ac^{-1}	%	tons ac^{-1}
SW 2360	84	34267[a]†	40.4[a]	19.1[c]
SW 3750	93	31654[b]	38.6[ab]	20.5[bc]
D39CC43	95	33323[ab]	40.8[a]	25.2[ab]
SW 3980	99	33541[a]	40.6[a]	23.7[abc]
D47CC29	103	34412[a]	37.8[b]	27.8[a]
SW 5410	104	28967[c]	37.6[b]	23.2[abc]
‡LSD (*p* = 0.10)		1678	2.39	5.20
Trial mean	96	32694	40.5	23.2

†Within a column, treatments marked with the same letter were statistically similar (p=0.10).
‡LSD –Least significant difference at p=0.10.

The silage quality characteristics, except for crude protein (CP), also varied statistically across varieties (Table 6). Crude protein averaged 8.35% across the trial. The ADF concentrations ranged from 18.3% to 22.2%; the variety SW 3980 was the top performer and was statistically similar to three other varieties. The NDF concentrations ranged from 35.6% to 40.6%; the top performer, SW 3980, was statistically similar to all but two varieties. The variety SW3980 was the top performer for lignin (2.46%), starch (38.8%), and total fatty acids (3.57%). The variety SW 3980 was the top performer in aNDFom and 240-hr uNDFom with 33.7% and 9.53% respectively. SW 3980 was statistically similar to three other varieties in both aNDFom and 240-hr uNDFom. The variety DC39CC43 was the top performer in 30-hr NDFD (56.9%) and the trial average was 55.2%. The trial average for NE_L 0.691Mcal $lb.^{-1}$ and SW 3980 was the top performer (0.706 Mcal lb^{-1}). SW 3750 had the highest predicted milk yield per ton of dry matter (DM), 3179 lbs. ton^{-1}; the trial average was 3094 lbs. ton^{-1}. When differences in yield are considered, varieties differed statistically in milk yield per acre. The top milk yield per acre was produced by variety D47CC29 with 30,336 lbs. ac^{-1}; the trial average was 25,160 lbs. ac^{-1}.

Table 6. Corn silage quality characteristics of 6 non-GMO corn varieties, 2020.

Variety	RM	CP	ADF	NDF	Lignin	Starch	Total fatty acids	TDN	aNDFom	240-hr uNDFom	30-hr NDFD	NE_L	Milk	
		---% of DM---									% of NDF	Mcal lb^{-1}	lbs. ton^{-1}	lbs. ac^{-1}
SW 2360	84	8.72	21.3^{bc}	40.3^{b}	2.52^{a}	34.2^{bc}	3.12^{bc}	65.7^{a}	38.5^{bc}	10.5^{b}	55.8^{ab}	0.686^{ab}	2990^{b}	19941^{c}
SW 3750	93	8.63	20.7^{bc}	38.9^{ab}	2.56^{a}	34.7^{ab}	3.26^{abc}	66.0^{a}	37.9^{bc}	10.6^{b}	54.6^{b}	0.696^{a}	3179^{a}	22677^{bc}
D39CC43	95	8.22	19.9^{ab}	38.2^{ab}	2.65^{a}	35.4^{ab}	2.94^{c}	65.7^{a}	36.7^{ab}	9.68^{a}	56.9^{a}	0.691^{a}	3118^{ab}	27512^{ab}
SW 3980	99	8.12	18.3^{a}†	35.6^{a}	2.46^{a}	38.8^{a}	3.57^{a}	66.0^{a}	33.7^{a}	9.53^{a}	56.6^{a}	0.706^{a}	3069^{ab}	25428^{ab}
D47CC29	103	8.39	18.5^{a}	35.9^{a}	2.60^{a}	37.6^{ab}	3.41^{ab}	65.7^{a}	33.8^{a}	9.98^{ab}	55.1^{ab}	0.702^{a}	3125^{ab}	30336^{a}
SW 5410	104	8.02	22.2^{c}	40.6^{b}	3.27^{b}	30.3^{c}	3.18^{abc}	63.7^{b}	40.3^{c}	12.2^{c}	52.0^{c}	0.665^{b}	3082^{ab}	25069^{bc}
‡LSD (p = 0.10)		¥ NS	2.07	3.48	0.404	4.14	0.439	1.24	3.45	0.858	1.81	0.0256	180	5136
Trial mean	96	8.35	20.2	38.2	2.68	35.2	3.25	65.4	36.8	10.4	55.2	0.691	3094	25160

†Within a column, treatments marked with the same letter were statistically similar (p=0.10).

‡LSD –Least significant difference at p=0.10.

¥ NS – There was no statistical difference between treatments in a particular column (p=0.10).

DISCUSSION

Figure 1 below displays the projected milk production, in lbs. ton^{-1} and lbs. ac^{-1} of the 6 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). There were two varieties that produced both above average yield and quality: D39CC43 and D47CC29. These varieties had relative maturities of 95 and 103 respectively. D47CC29 had the highest yield at 35% dry matter. The varieties SW 3980 (99 day) and D39CC43 (95 day) had yields that were statistically similar. The average trial yield (23.2 tons ac^{-1}) this year was higher than in the previous three years of this variety trial. The growing season overall was hot and dry, but all varieties produced high yields. 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.

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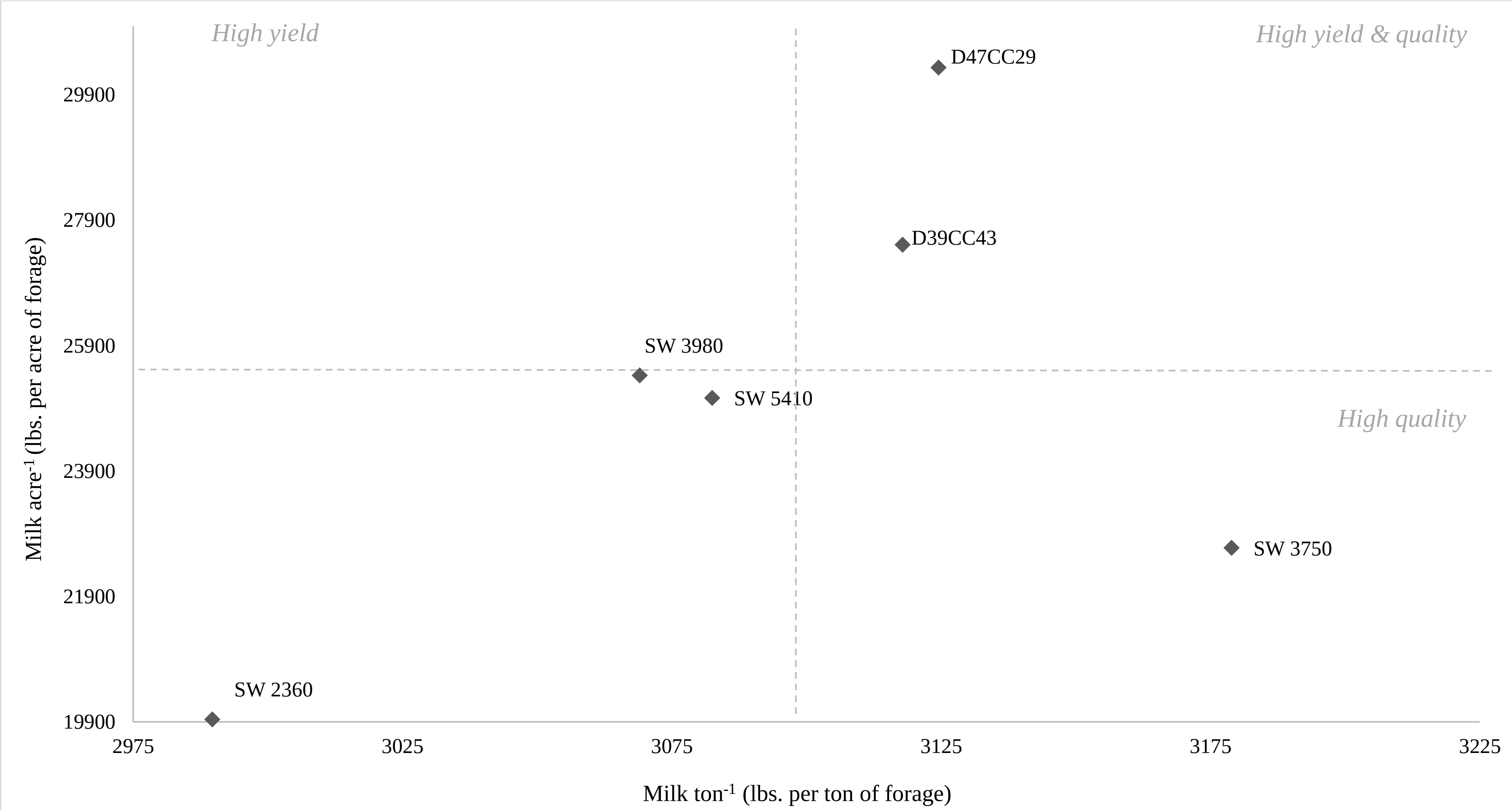

Figure 1. Milk production of 6 non-GMO corn varieties, 2020.
Shows relationship between milk per ton and milk per acre. Dotted lines represent the mean milk per ton and milk per acre for the trial.