Vermont Non-GMO Corn Silage Performance Trial

NORTHWEST CROPS & SOILS PROGRAM

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2019 VERMONT NON-GMO CORN SILAGE PERFORMANCE TRIAL

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In 2019, the University of Vermont Extension Northwest Crops and Soils Program evaluated yield and quality of 10 non-GMO corn silage varieties at Borderview Research Farm, Alburgh, 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 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 2019, 10 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 10 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.

Albert Lea/Viking	Seedway, LLC
1414 West Main St, PO Box 127 Albert Lea, MN 56007 (800) 352-5247	171 Ledgemere Point Bomoseen, VT 05732 (802)-338-6930

Table 2. 10 non-GMO silage corn varieties evaluated in the 2019 trial.

Company/Brand	Variety	Traits	RM
Seedway, LLC	SW 2360		87
Albert Lea/Viking	O.71-90UPGS		90
Albert Lea/Viking	42-92GS		92
Seedway, LLC	SW 3750		93
Seedway, LLC	SW 3937BMR	BMR	94
Albert Lea/Viking	O.82-95		95
Seedway, LLC	SW 3980		98
Albert Lea/Viking	O.69-01		101
Seedway, LLC	SW 5410		103
Seedway, LLC	SW 5410		103

The soil type at the Alburgh location is a Benson rocky silt loam (Table 3). The seedbed was prepared with spring disking followed by a spike tooth harrow. The previous crop was corn grain.

Plots were planted on 29-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 20' long and consisted of four rows of corn 30" apart. Plots received liquid starter fertilizer (9-18-9) at a rate of 5 gal ac^{-1} at planting. On 24-Jun, plots were sprayed with 3pts Lumax EZ herbicide. On 29-Jun, corn was topdressed with 400 lb ac^{-1} of 28-0-23. On 27-Sep, the corn was harvested with a John Deere 2-row chopper and a wagon fitted with scales. An approximate 1 lb subsample was taken from each plot and dried to calculate dry matter content. The dried subsamples were 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 silage corn variety trial information, Alburgh, VT, 2019.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam
Previous crop	corn grain
Row width (in)	30
Plot size (ft)	10 x 20
Seeding rate (seeds ac^{-1})	40,000
Planting date	29-May
Tillage operations	Spring disk, spike tooth harrow
Starter fertilizer (gal ac^{-1})	5 (9-18-9)
Topdress fertilizer (lbs ac^{-1})	400 (28-0-23)
Harvest date	27-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. The undigested NDF (uNDF) is the residue after fermentation for a given amount of time, from 30 to 240 hours.

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 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). Overall the season began cooler and wetter than normal but became hot and dry in the middle of the summer. July brought above normal temperatures and little rainfall. The longest period without rainfall in July lasted 12 days. 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. This was evident in smaller than normal ears and poor tip fill experienced in corn fields around the region. However, these warm conditions did provide corn with well-needed Growing Degree Days (GDDs). Although the season was relatively cool a total of 2254 GDDs accumulated May-Sep, 42 above normal.

Table 4. Weather data for Alburgh, VT, 2019.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	53.3	64.3	73.5	68.3	60.0
Departure from normal	-3.11	-1.46	2.87	-0.51	-0.62
Precipitation (inches)	4.90	3.06	2.34	3.50	3.87
Departure from normal	1.45	-0.63	-1.81	-0.41	0.23
Growing Degree Days (50-86°F)	189	446	716	568	335
Departure from normal	-9	-29	76	-13	17

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 and yield (Table 5). The variety with the highest population was SW 2360 (36,881 plants ac^{-1}) and the lowest was O.71-90UPGS with 34,049 plants ac^{-1}. Due to adverse spring planting conditions, higher seeding rates were implemented to account for cold and wet soil conditions. At the time of harvest, plant populations were slightly higher than the recommended 34,000 plants ac^{-1}. Yields also varied statistically. The top yielding variety was 42-92GS with 28.1 tons ac^{-1}. This was statistically similar to just one other variety, SW 3980 (23.9 tons ac^{-1}). Yields ranged from 19.4 to 28.1 tons ac^{-1}.

Table 5. Harvest data for 10 non-GMO corn varieties, 2019.

Variety	RM	Plant populations	Harvest DM	Yield, 35% DM
		plants ac^{-1}	%	tons ac^{-1}
SW 2360	87	**36881**	38.1	22.6
O.71-90UPGS	90	34049	33.8	21.5
42-92GS	92	36518*	35.7	**28.1**
SW 3750	93	35864*	36.1	20.4
SW 3937BMR	94	35138	32.3	19.4
O.82-95	95	36155*	34.5	22.9
SW 3980	98	36227*	33.2	23.9*
O.69-01	101	35356	32.0	22.4
SW 5410	103	35647*	32.2	21.0
O.51-04PGS	104	35284	33.7	21.3
LSD (p = 0.10)	N/A	1276	NS	4.73
Trial mean	96	35712	33.5	22.4

Data marked with and asterisk * are statistically similar to top performer in **bold**.
N/A - statistical analysis not performed for this parameter.
NS - not significant at the p=0.10 level.

The silage quality characteristics also varied statistically across varieties (Table 6). Crude protein (CP) averaged 7.93% across the trial with the top variety, SW 3937BMR, having 9.00% protein. This was statistically similar to one other variety, O.69-01. The NDF, lignin, and TDN content did not vary statistically among varieties. Varieties differed in ADF, ranging from 21.4 to 28.4%. The top performing variety, O.51-04PGS, was statistically similar to three other varieties. The variety SW 2360 had the highest starch content of 37.5%, and this was statistically similar to three other varieties. The variety FW 3937BMR was the top performer in 30 hr NDFD (71.5%) and 240 hr uNDF (6.56%). Milk yield per ton of dry matter (DM) was also not significantly different, with the highest milk yield being 3667 lbs ton^{-1} by O.51-04PGS. When differences in yield are considered, varieties differed statistically in milk yield per acre. The top milk yield per acre was produced by variety 42-92GS with 33,211 lbs ac^{-1}. This was statistically similar to three other varieties.

Table 6. Corn silage quality characteristics of 10 non-GMO corn varieties, 2019.

Variety	RM	CP	ADF	NDF	Lignin	Starch	TDN	240 hr uNDF	30 hr NDFD	Milk	
		----------% DM ----------						% DM	% NDF	lbs ton^{-1}	lbs ac^{-1}
SW 2360	87	8.10	22.1*	39.1	**2.6**	**37.5**	**64.0**	8.50	61.9	3549	27987
O.71-90UPGS	90	7.43	26.1	43.5	2.9	31.1	63.3	9.60	60.7	3595	27104
42-92GS	92	7.63	25.0	43.9	2.9	31.0	62.3	9.20	62.9	3428	**33211**
SW 3750	93	7.57	23.4*	39.9	2.9	34.0*	6.03	9.00	60.8	3574	25551
SW 3937BMR	94	**9.00**	28.4	46.0	3.0	27.1	62.3	**6.50**	**71.5**	3552	24224
O.82-95	95	7.57	26.3	44.7	3.1	30.9	62.3	10.0	62.2	3547	28395*
SW 3980	98	7.50	23.1*	39.5	**2.6**	35.7*	63.3	8.90	62.2	3651	30575*
O.69-01	101	8.63*	25.1	41.9	3.0	29.5	62.3	9.60	64.7	3639	28527*
SW5410	103	7.93	25.0	41.8	3.1	30.4	62.7	10.2	60.6	3589	26383
O.51-04PGS	104	7.97	**21.4**	**38**	3.2	35.8*	63.3	8.00	64.4	**3667**	27388
LSD (p = 0.10)	NA	0.646	3.39	NS	NS	4.83	NS	1.34	3.1	NS	4994
Trial mean	96	7.93	24.6	41.8	2.9	32.3	62.9	8.95	63.2	3579	27934

*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 at the end of this document 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 state that these differences are statistically significant (Tables 5 and 6).

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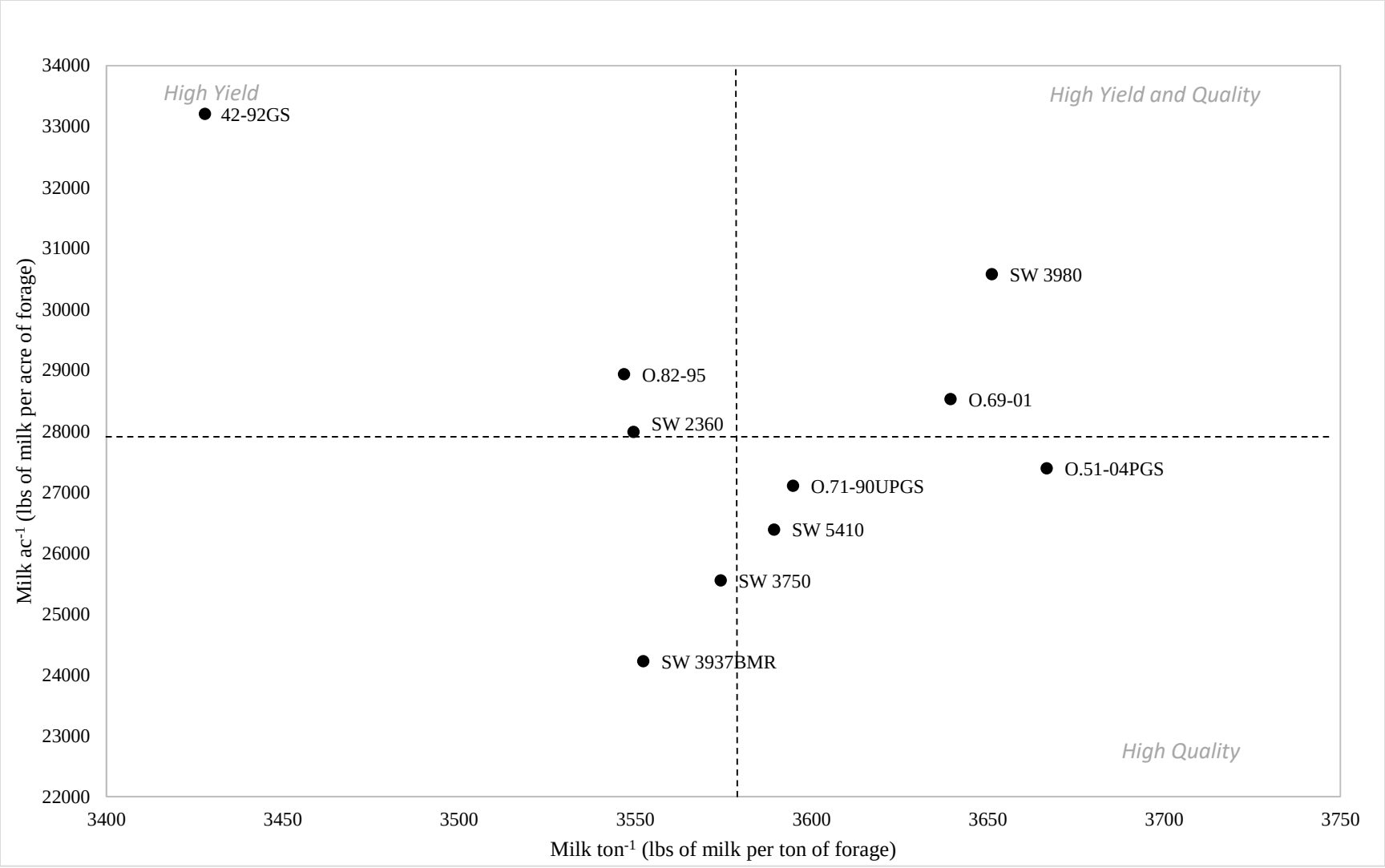

Figure 1. Milk production of 10 non-GMO corn varieties, 2019.
Shows relationship between milk per ton and milk per acre. Dotted lines represent the mean milk per ton and milk per acre for the trial.