NORTHWEST CROPS & SOILS PROGRAM

2021 Vermont Non-GMO Corn Silage Performance Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2021 VERMONT NON-GMO CORN SILAGE PERFORMANCE TRIAL

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In 2021, 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 in 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 2021, 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 four 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.

King's Agriseeds	Seedway, LLC
1828 Freedom Rd. Lancaster, PA 17601 (717) 687-6224	171 Ledgemere Point Bomoseen, VT 05732 (802)-338-6930

Table 2. 10 non-GMO silage corn varieties evaluated in the 2021 trial.

Company/Brand	Variety	Traits	RM
Seedway, LLC	SW 2360	none	84
King's Agriseeds	KF 34C30	none	84
King's Agriseeds	KF 40C30	none	90
King's Agriseeds	KF 43C40	none	93
Seedway, LLC	SW 3937BMR	BMR	98
King's Agriseeds	KF 48C90	none	98
King's Agriseeds	KF 51C50	none	101
Seedway, LLC	SW 5410	none	104
Seedway, LLC	SW 5440	none	106
Seedway, LLC	SW 7000	none	114

The soil type at the Alburgh location is a Benson rocky silt loam (Table 3). The seedbed was prepared with fall moldboard plow, spring disking, followed by a spike tooth harrow. The previous crop was perennial forage grasses and legumes. On 6-Apr, 19-19-19 was applied at a rate of 300 lb ac^{-1}. Plots were planted on 14-May with a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units

(Nevada, IA) at a rate of 34,000 seeds ac^{-1}. Plots were 20' long and consisted of four rows of corn 30" apart. On 17-Jun, plots were top-dressed with 400lbs ac^{-1} of 24-12-18. To control weeds, Sterling Blue® from WinField ® United was applied at a rate of 8 fl oz ac^{-1} on 23-Jun. The corn was harvested with a John Deere 2-row chopper and a wagon fitted with scales. Plots were harvested by relative maturity on 14-Sep, 21-Sep, and 28-Sep. 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 E. E. Cummings Crop Testing Laboratory at the University of Vermont (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 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, 2021.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam
Previous crop	Perennial grass and legume
Row width (in)	30
Plot size (ft)	10 x 20
Seeding rate (seeds ac^{-1})	34,000
Planting date	14-May
Tillage operations	Fall moldboard plow, spring disk, spike tooth harrow
Top-dress fertilizer (lbs. ac^{-1})	24-12-18 (400)
Herbicide (fl oz ac^{-1})	Sterling Blue® (8)
Harvest date	14-Sep, 21-Sep, and 28-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 during the growing season. By August, counties in northern Vermont were in moderate drought (D1) according to the U.S Drought Monitor. Precipitation was more than an inch below average from May through August. Average temperature varied from month to month. Temperatures in June and August were 2.81 and 3.25 degrees above average respectively, but July was over 4 degrees cooler than normal. However, this season's conditions did provide optimal Growing Degree Days (GDDs) through the season with a total of 2613 GDDs accumulated May-Sep, 64 above normal.

Table 4. Weather data for Alburgh, VT, 2021.

Alburgh, VT	May	June	July	August	Sept
Average temperature (°F)	58.4	70.3	68.1	74	62.8
Departure from normal	-0.03	2.81	-4.31	3.25	0.14
Precipitation (inches)	0.66	3.06	2.92	2.29	4.09
Departure from normal	-3.1	-1.2	-1.14	-1.25	0.42
Growing Degree Days (50-86°F)	334	597	561	727	394
Departure from normal	33	73	-134	85	7

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1991-2020) from Burlington, VT.

Corn silage varieties varied statistically in dry matter and yield (Table 5). Ideally, silage should be harvested between 30% to 35% dry matter depending largely on the type of storage. The trial had a wide range of relative corn maturities making harvest at the proper dry matter for each variety a challenge. Overall, corn yields were high this season, with the average being 23.8 tons ac^{-1}, but yields ranged from 18.1 ton ac^{-1} (KF 34C30) to 28.6 ton ac^{-1} (SW 5440). The hot growing season with ample GDDs allowed the long season varieties to reach maturity and had the highest yields in the trial. The high yields were likely a result of exceptional soil quality, low weed pressure, and optimal growing conditions.

Table 5. Harvest data for 10 non-GMO corn varieties, 2021.

Variety	RM	Harvest DM	Yield, 35% DM
		%	tons ac^{-1}
SW 2360	84	37.9	22.8
KF 34C30	84	37.5	18.1
KF 40C30	90	35.4	21.6
KF 43C40	93	34.0	25.4*
SW 3937BMR	98	36.8	18.9
KF 48C90	98	37.4	27.9*
KF 51C50	101	35.8	25.8*
SW 5410	104	33.8	27.9*
SW 5440	106	33.2*	**28.6**
SW 7000	114	**31.3**	20.5
‡LSD (p = 0.10)	§N/A	2.18	5.53
Trial mean		35.3	23.8

†Values in **bold** indicate the top performer for the production metric and varieties with an asterisk* performed statistically similarly to the top performer.
‡LSD –Least significant difference at p=0.10.
§N/A - statistical analysis not performed for this parameter.

There were few statistically significant differences in silage quality characteristics between varieties. (Table 6). SW 3937BMR had the highest crude protein content, 9.23% and the trial average was 8.04%. The trial average for ADF, aNDFom, lignin, starch, and TDN were 25.1%, 42.8%, 2.91%, 31.6%, and 63.3% respectively. SW 3937BMR was the top performer in both 240-hr uNDFom and 30-hr NDFD, with 10.1% and 62.0% respectively. The trial average was 12.6% for 240-hr uNDFom and 56.2% for 30-hr NDFD. The trial average for NE_L was 0.643 Mcal $lb.^{-1}$. SW 3937BMR had the highest predicted milk yield per ton of dry matter (DM), 3118 lbs. ton^{-1}; the trial average was 2869 lbs. ton^{-1}. When differences in yield are considered, varieties did not differ statistically in milk yield per acre, and the trial average was 23,672 lbs. ac^{-1}.

Table 6. Corn silage quality characteristics of 10 non-GMO corn varieties, 2021.

Variety	RM	CP	ADF	aNDFom	Lignin	Starch	TDN	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	8.03	27.5	45.4	3.30	30.0	61.8	13.0	55.5	0.622	2773	22022
KF 34C30	84	8.80*	25.1	43.3	3.03	28.4	63.5	13.2	56.9	0.647	2978*	18925
KF 40C30	90	8.10	26.5	44.9	3.00	29.8	63.0	12.0	58.1	0.639	2862	21627
KF 43C40	93	8.23	22.1	37.7	2.68	36.2	65.0	12.7	51.9	0.653	2857	25348
SW 3937BMR	98	**9.23**	22.8	39.5	2.53	33.8	64.5	**10.1**	**62.0**	0.666	**3118**	20453
KF 48C90	98	7.68	22.5	39.2	2.70	36.9	64.5	10.8*	56.7	0.672	2826	27686
KF 51C50	101	7.85	23.2	40.7	2.60	33.4	63.8	12.5	56.1	0.655	2814	25369
SW 5410	104	6.90	29.9	49.4	3.30	26.6	62.0	15.1	53.6	0.610	2624	25571
SW 5440	106	7.83	24.5	41.9	2.93	32.8	63.0	12.6	55.1	0.650	2725	27367
SW 7000	114	7.80	26.8	46.5	3.05	28.3	61.5	14.3	56.2	0.614	3109*	22352
‡LSD (p = 0.10)	§N/A	0.731	¥ NS	NS	NS	NS	NS	1.67	3.27	NS	209	NS
Trial mean		8.04	25.1	42.8	2.91	31.6	63.3	12.6	56.2	0.643	2869	23672

†Values in **bold** indicate the top performer for the production metric and varieties with an asterisk* performed statistically similarly to the top performer.

‡LSD –Least significant difference at p=0.10.

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

§N/A - statistical analysis was not performed for the measure.

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