NORTHWEST CROPS & SOILS PROGRAM

2021 Vermont Organic Silage Corn Performance Trial

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2021 VERMONT ORGANIC SILAGE CORN PERFORMANCE TRIAL

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The University of Vermont Extension Northwest Crops and Soils Program conducted an organic silage corn variety trial in 2021 to provide unbiased performance comparisons of commercially available varieties. To determine varieties that are best suited to this production system and our region's climate, we evaluated 14 commercially available organic corn silage varieties. It is important to remember that the data presented are from a replicated research trial from only one location in Vermont and represent only one season. Crop performance data from additional tests in different locations and over several years should be compared before making varietal selections.

MATERIALS AND METHODS

In 2021, organic corn silage varieties were evaluated at Borderview Research Farm in Alburgh, Vermont. The plot design was a randomized complete block with four replications. Treatments were fourteen corn silage varieties submitted by two companies (Table 1). These varieties were evaluated for silage yield and quality. Relative maturity and varietal characteristics are provided in Table 2.

Table 1. Participating companies and contact information.

Albert Lea Seed	Blue River Hybrids
1414 West Main St, PO Box 127 Albert Lea, MN 56007 (800) 352-5247	2326 230th Street Ames, IA 50014 (800) 370-7979

Table 2. Organic corn varieties evaluated in Alburgh, VT, 2021.

Company	Variety	Traits	Relative maturity (RM)
Blue River Hybrids	14A91	None	82
Blue River Hybrids	21L90	None	85
Blue River Hybrids	23A71	None	86
Blue River Hybrids	22K32	None	89
Blue River Hybrids	30K84	None	90
Albert Lea/Viking	O.31-91P	None	91
Blue River Hybrids	34K79	None	93
Albert Lea/Viking	O.45-97UP	None	97
Blue River Hybrids	43L96	None	98
Blue River Hybrids	42C87	None	98
Albert Lea/Viking	O.69-01UP	None	101
Albert Lea/Viking	O.51-04	None	104
Blue River Hybrids	54PM37	PuraMaize™	105
Blue River Hybrids	54C27	None	105

The soil type at the Alburgh location is a Benson rocky silt loam (Table 3). The seedbed was prepared with fall moldboard plow followed by spring disk harrow and field cultivation. The previous crop was perennial forage including grass and some legumes.

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. Weed control was through mechanical cultivation including one pass with a tineweeder (16-May) followed by row-cultivation on 28-May and again on the 12-Jun. Plots were topdressed with 1000 lbs of ProBooster™ a 10-0-0 organic approved fertilizer from North Country Organics (Brandon, VT).

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 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 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 hr).

Table 3. Organic silage corn variety trial information, Alburgh, VT, 2021.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam
Previous crop	Perennial forage
Row width (in)	30
Plot size (ft)	10 x 20
Seeding rate (viable seeds ac^{-1})	34,000
Planting date	14-May
Tillage operations	Spring disk, spike tooth harrow
Top dress fertilizer (lb ac^{-1})	10-0-0 ProBooster (1000)
Weed control	Tineweed, Row cultivate
Harvest date	14-Sep, 21-Sep, 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) are 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.

Varieties varied significantly in dry matter (DM) content 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. Corn yields were high for organic corn in this region averaging 24.6 tons ac^{-1}. The highest yielding variety was 42C87 which produced 31.8 tons ac^{-1} and was statistically similar to O.51-04, 43L96, O.69-01UP, 54C27. 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 characteristics of 14 organic corn silage varieties, 2021.

Variety	**RM**	**Harvest DM**	**Yield, 35% DM**
		%	tons ac^{-1}
14A91	82	37.7	18.5
21L90	85	36.6	20.9
23A71	86	36.0	20.3
22K32	89	35.6	22.8
30K84	90	35.9	25.6
O.31-91P	91	35.5	21.5
34K79	93	35.3	20.8
O.45-97UP	97	35.3	24.8
43L96	98	33.8	27.0*
42C87	98	34.7	**31.8**
O.69-01UP	101	36.5	28.2*
O.51-04	104	34.6	29.0*
54PM37	105	32.3*	25.4
54C27	105	**31.5***	28.0*
‡LSD (p = 0.10)		1.59	5.92
Trial mean		35.1	24.6

†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

Corn silage varieties varied significantly in terms of quality (Table 6). The average protein concentration was 8.39%, and the highest content of 9.28% produced by variety 30K84. Overall, ADF and aNDFom values were indicative of adequate quality corn silage, averaging 24.5% and 42.0% respectively. There were no significant differences in either ADF or aNDFom between varieties. Variety 34K79 was the top performer in lignin (2.60%) and in starch (36.4%). The average TDN was 36.2% and the 240-hr uNDFom was 12.0%; there were no significant differences between varieties for either parameter. Varieties differed significantly in terms of NDF digestibility (30-hr NDFD). The highest digestibility was 61.5% for variety 30K84. This was statistically similar to five other varieties. The average NE_L was 0.648 Mcal lb^{-1} and was not statistically different between varieties. There were significant differences in the predicted milk yield (lbs.) per ton and milk yield (lbs.) per acre. The variety O.69-01UP had the highest predicted milk yield per ton, 3203 lbs. The variety 42C87 had the greatest predicted milk yield per acre, 33,136 lbs.

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Table 6. Quality characteristics of 14 organic corn silage 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}
14A91	82	8.30	27.8	47.0	3.38	26.0	62.0	12.2	61.1*	0.619	2936	18910
21L90	85	8.38	28.3	47.8	3.28	23.6	61.8	14.1	57.0	0.608	2768	20230
23A71	86	8.73*†	26.8	44.4	3.35	27.0	62.0	13.3	57.1	0.627	2937	20950
22K32	89	8.73*	24.5	42.4	3.00*	32.1*	62.8	11.6	58.0	0.645	3020*	23808
30K84	90	**9.28**	26.1	44.4	3.00*	27.3	62.3	11.4	**61.5**	0.631	3157*	28036*
O.31-91P	91	7.88	25.2	42.8	2.80*	31.2*	62.8	12.5	57.1	0.640	2830	21201
34K79	93	8.58	21.7	38.2	**2.60**	**36.4**	65.0	10.0	59.2*	0.685	3142*	22767
O.45-97UP	97	8.03	22.7	40.4	2.68*	34.6*	63.5	11.7	59.0*	0.658	2806	24548
43L96	98	8.03	23.1	39.9	2.90*	33.0*	63.8	13.2	54.5	0.663	2798	26384*
42C87	98	8.80*	22.9	41.1	2.75*	32.0*	64.3	11.8	60.7*	0.665	3031*	**33,136**
O.69-01UP	101	8.45	23.0	37.7	2.80*	34.5*	63.5	11.0	56.9	0.660	**3203**	31781*
O.51-04	104	8.25	23.5	40.0	3.08	33.6*	63.3	10.8	58.5*	0.659	3095*	31442*
54PM37	105	8.20	22.8	39.2	2.70*	34.1*	64.5	11.4	55.8	0.668	2971	26517*
54C27	105	7.90	25.3	42.9	3.03*	31.6*	63.0	12.6	57.3	0.644	2937	28774*
‡LSD (p = 0.10)		0.612	¥NS	NS	0.455	6.57	NS	NS	3.09	NS	227	6643
Trial mean		8.39	24.5	42.0	2.95	31.2	63.2	12.0	58.1	0.648	2974	25606

†Values in **bold** indicate the top performer for the production metric and varieties with an asterisk* performed statistically similarly to the top performer.
‡LSD (0.10); least significant difference at the p=0.10.
¥NS-There was no statistical difference between treatments in a particular column.