2020

Vermont Organic Silage Corn Performance Trial

Heather Darby

Ivy Krezinski

Rory Malone

Sara Ziegler

2020 Vermont Organic Silage Corn Performance Trial

Dr. Heather Darby, UVM Extension Agronomist
Ivy Luke, Rory Malone, and Sara Ziegler
UVM Extension Crop and Soil Technicians
802-524-6501

Visit us on the web at http://www.uvm.edu/nwcrops

THE UNIVERSITY OF VERMONT EXTENSION

2020 VERMONT ORGANIC SILAGE CORN PERFORMANCE TRIAL

Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

The University of Vermont Extension Northwest Crops and Soils Program conducted an organic silage corn variety trial in 2020 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 9 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 2020, 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 nine 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, 2020.

Company	Variety	Traits	Relative Maturity (RM)
Blue River Hybrids	08B55	None	78
Blue River Hybrids	14A91	None	82
Blue River Hybrids	26B78	None	88
Albert Lea/Viking	O.31-91P	None	91
Blue River Hybrids	33A16	None	92
Blue River Hybrids	38G54	None	96
Blue River Hybrids	42C87	None	98
Albert Lea/Viking	O.69-01UP	None	101
Albert Lea/Viking	O.55.02UP	None	102

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 silage with a winter rye cover crop.

On 29-Apr, manure was applied at a rate of 10 tons ac^{-1}. Plots were planted on 20-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 were thinned to a target population of 34,000 seeds ac^{-1} on 25-Jun.

Weeds were controlled by early season tine weeding on 29-May and 9-Jun, and mechanical row cultivation 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 10-Sep, 16-Sep, and 23-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. Organic silage corn variety trial information, Alburgh, VT, 2020.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam
Previous crop	Corn silage with winter rye
Row width (in)	30
Plot size (ft)	10 x 20
Seeding rate (viable seeds ac^{-1})	40,000 thinned to 34,000
Planting date	20-May
Tillage operations	Spring disk, spike tooth harrow
Harvest date	10-Sep, 16-Sep, 23-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 throughout much of the main growing 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.

Varieties varied significantly in population, yield, and dry matter (DM) content at harvest (Table 5). The average population at harvest was 32,876 plants ac^{-1} and ranged from 29,621 plants ac^{-1} (0.55.02UP) to 34,521 plants ac^{-1} (38G54). The average dry matter content at harvest was 38.3% and ranged from 33.7% to 41.7%. Ideally, silage should be harvested around 35% dry matter. At the time of harvest, most varieties had a dry matter slightly over 35%, which is the ideal dry matter percentage 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. In years with droughty conditions, the moisture content of the whole corn plant can be misleading and may reach optimal levels earlier than expected. Therefore, monitoring maturity and moisture content early and constantly is crucial. Corn yields were still relatively high for organic corn in this region averaging 22.2 tons ac^{-1}. The highest yielding variety was 38G54 which produced 24.6 tons ac^{-1} but was not statistically different from five other high yielding varieties.

Table 5. Harvest characteristics of 9 organic corn silage varieties, 2020.

Variety	RM	Plant Population plants ac^{-1}	Harvest DM %	Yield, 35% DM tons ac^{-1}
08B55	78	32234^{a}†	37.5^{c}	19.3^{b}
14A91	82	34195^{a}	38.1^{bc}	19.4^{b}
26B78	88	34304^{a}	33.7^{d}	21.8^{ab}
0.31-91	91	32017^{ab}	39.0^{abc}	20.6^{b}
33A16	92	32888^{a}	37.3^{c}	22.1^{ab}
38G54	96	34521^{a}	39.1^{abc}	24.6^{a}
42C87	98	33759^{a}	38.2^{bc}	24.3^{a}
0.69.01P	101	32343^{a}	40.3^{ab}	23.9^{a}
0.55.02UP	102	29621^{b}	41.7^{a}	24.0^{a}
‡LSD (p = 0.10)		2576	2.70	3.00
Trial mean	92	32876	38.3	22.2

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

Corn silage varieties varied significantly in terms of quality (Table 6). The average protein concentration was 8.80%, and the highest content of 9.77% produced by variety 08B55, which was statistically higher than all but one variety. Overall ADF and NDF values were indicative of adequate quality corn silage, averaging 22.5% and 41.5% respectively. Variety 33A16 was the top performer in both ADF and NDF but was statistically similar to three other varieties in both quality measures. Variety 14A91 was the top performer in lignin (2.38) and in starch (38.5%). Variety 14A91 had a lignin content that was statistically similar to three other varieties but was only statistically similar to one other variety (variety 33A16) in terms of starch. Variety 08B55 was statistically higher in total fatty acids (TFA) than all other varieties with 3.93% TFA. TDN ranged from 62.8% to 66.5%, aNDFom ranged from 34.6% to 43.7%, and 240-hr uNDFom ranged from 9.4% to 12.2%; The variety 14A91 was the top performer in all three categories. Varieties also differed significantly in terms of NDF digestibility (30-hr NDFD). The highest digestibility was 58.9% for variety O.31-91. This was statistically similar to two other varieties. NE_L was highest in variety 14A91 (0.708 Mcal lb^{-1}) but was statistically similar to three other varieties. The predicted milk yield (lbs.) per ton ranged from 2801 to 3376 lbs. ton^{-1} and was highest for variety 33A16 which was statistically similar to four other varieties. Variety 38G54 had the highest milk yield (lbs.) per acre with 27,467 lbs. ac^{-1}, and five varieties were statistically similar.

Table 6. Quality characteristics of 9 organic corn silage 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}
08B55	78	9.77^{a}†	27.7^{e}	48.9^{d}	3.17^{d}	23.0^{e}	3.93^{a}	64.3^{bcd}	43.7^{d}	12.2^{d}	56.5^{bc}	0.648^{cd}	3030^{cd}	20611^{d}
14A91	82	8.72^{bcd}	19.1^{a}	36.4^{a}	2.38^{a}	38.5^{a}	3.33^{b}	66.5^{a}	34.6^{a}	9.40a	56.8^{bc}	0.708^{a}	3306^{ab}	22465^{cd}
26B78	88	9.31^{ab}	22.5^{bcd}	41.4^{bc}	3.17^{d}	31.7^{cd}	3.03^{b}	63.8^{cd}	39.7^{bcd}	10.1^{ab}	56.6^{bc}	0.667^{bcd}	3327^{ab}	25416^{abc}
0.31-91	91	8.10^{d}	21.7^{abc}	40.4^{ab}	2.68^{ab}	32.6^{bc}	2.92^{bc}	64.5^{abcd}	39.1^{bc}	10.3^{ab}	58.9a	0.674^{abcd}	3155^{bc}	22808^{bcd}
33A16	92	8.60^{bcd}	18.9^{a}	36.3^{a}	2.49^{a}	36.3^{ab}	3.22^{b}	66.0^{ab}	35.0^{a}	9.60^{ab}	57.8^{ab}	0.701^{ab}	3376^{a}	26154^{ab}
38G54	96	8.63^{bcd}	20.7^{ab}	39.3^{ab}	2.72^{abc}	33.1^{bc}	3.14^{b}	65.0^{abc}	37.9^{ab}	9.80^{ab}	58.2^{ab}	0.683^{abc}	3188^{abc}	27467^{a}
42C87	98	8.96^{bc}	23.3^{bcd}	42.2^{bc}	2.92^{bcd}	31.2^{cd}	2.39^{d}	63.5^{cd}	40.6^{bcd}	10.50^{bc}	56.6^{bc}	0.657^{cd}	3045^{cd}	25713^{abc}
0.69.01P	101	8.70^{bcd}	24.9^{de}	45.0^{cd}	3.25^{d}	28.3^{d}	2.46^{cd}	62.8^{d}	43.6^{d}	11.50^{cd}	55.3^{cd}	0.642^{d}	2872de	24045^{abcd}
0.55.02UP	102	8.39^{cd}	23.7^{cd}	43.3^{bc}	3.11^{cd}	30.7^{cd}	2.35^{d}	63.0^{cd}	42.2^{cd}	11.50^{cd}	54.2^{d}	0.648^{cd}	2801^{e}	23448^{bcd}
‡LSD (p = 0.10)		0.780	2.90	4.16	0.402	4.21	0.480	2.06	4.03	1.09	2.07	0.0365	188.0	3612
Trial mean	92	8.80	22.5	41.5	2.88	31.7	2.97	64.4	39.6	10.5	56.8	0.669	3122	24236

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

DISCUSSION

Figure 1 below displays the projected milk production, in lbs. ton^{-1} and lbs. ac^{-1} of the nine 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 three varieties that produced both above average yield and quality: 38G54, 26B78, and 33A16. These varieties had relative maturities of 96, 88, and 92 respectively. The varieties that performed below average for yield and quality were 08B55 (RM 78), O.69.01P (RM 101), and O.55.02UP (RM 102). Overall, the mid-season varieties had higher yields and better quality than the shortest & longest maturing varieties unlike in the 2019 trial, in which both short and long season varieties produced high yields and quality corn silage under organic management. This highlights the importance of choosing a corn silage variety that will grow well even in years with unfavorable weather. In years when weather is less favorable, such as this growing season, choosing a short or long season variety may become risky. 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.

ACKNOWLEDGEMENTS

UVM Extension Northwest Crops and Soils Program would like to thank Roger Rainville and the staff at Borderview Research Farm for their generous help with this research trial as well as Henry Blair, John Bruce, Catherine Davidson, Hillary Emick, and Lindsey Ruhl for their assistance with data collection and entry. We would also like to thank the seed companies for their seed and cooperation in this study. 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. Any reference to commercial products, trade names, or brand names is for information only, and no endorsement or approval is intended.

UVM Extension helps individuals and communities put research-based knowledge to work

THE UNIVERSITY OF VERMONT EXTENSION

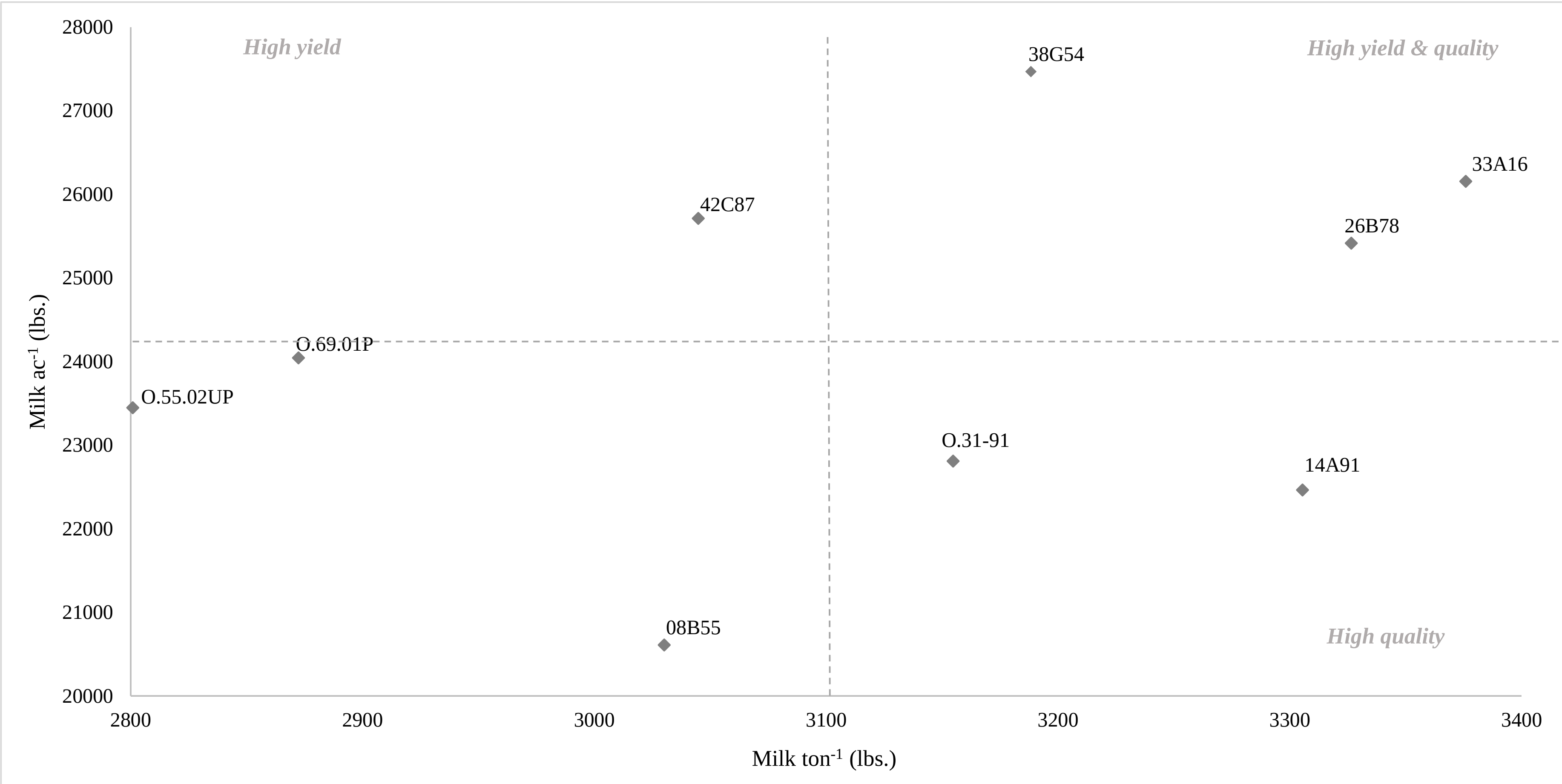

Figure 1. Milk production of 9 organic corn varieties, Alburgh, VT, 2020.
Shows relationship between milk per ton and milk per acre. Dotted lines represent the mean milk per ton and milk per acre for the trial.