2018

Vermont Organic Silage Corn Performance Trial

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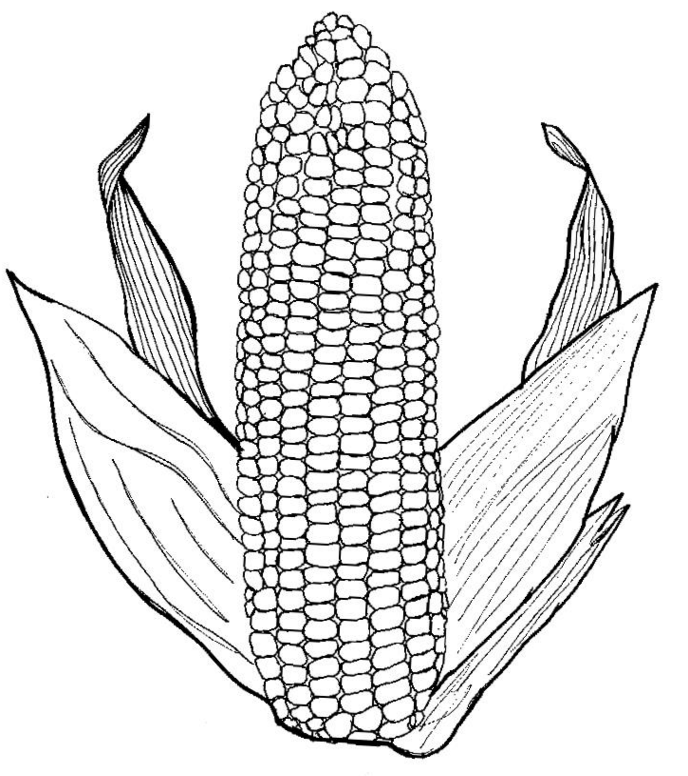

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THE UNIVERSITY OF VERMONT EXTENSION

2018 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 2018 to provide unbiased performance comparisons of commercially available varieties. With the expansion of the organic dairy industry in our region there is increased interest in organic corn silage production. To determine varieties that are best suited to this production system and our region's climate, we evaluated 11 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 2018, organic corn silage varieties were evaluated from three seed companies (Table 1) at Borderview Research Farm in Alburgh, Vermont. The plot design was a randomized complete block with three replications. Treatments were 11 corn silage varieties. 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	King's Agriseed
1414 West Main St, PO Box 127 Albert Lea, MN 56007 (800) 352-5247	2326 230th Street Ames, IA 50014 (800) 370-7979	1828 Freedom Rd. Lancaster, PA 17601 (717) 687-6224

Table 2. Organic corn varieties evaluated in Alburgh, VT, 2018.

Company	Variety	Traits	Relative Maturity (RM)
Blue River Hybrids	14A91	None	82
Blue River Hybrids	23A71	None	86
Blue River Hybrids	33A16	None	92
Blue River Hybrids	33L90	Leafy Floury	93
Blue River Hybrids	43L96	Leafy Floury	98
King's Agriseed	KF 42C20	None	92
King's Agriseed	KF 52C60	None	102
Albert Lea/Viking	O.51-04GS	None	104
Albert Lea/Viking	O.71-90GS	None	90
Albert Lea/Viking	O.79-00	None	100
Albert Lea/Viking	O.82-95	None	95

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 summer annual forages.

Plots were fertilized with 3 tons per acre of poultry manure prior to planting. Plots were planted on 21-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 two rows of corn 30" apart.

Weeds were controlled early season with tine weeding, hand hoeing on 12-Jun, and periodic row cultivation. In late June, corn was side-dressed with 30 lbs of additional N per acre in the form of sodium nitrate. On 12-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 then 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. Organic silage corn variety trial information, Alburgh, VT, 2018.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam
Previous crop	Summer annual forages
Row width (in)	30
Plot size (ft)	5 x 20
Seeding rate (viable seeds $acre^{-1}$)	34,000
Planting date	21-May
Tillage operations	Spring disk, spike tooth harrow
Harvest date	12-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.

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 yield 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 was hotter and dryer than normal as temperatures were slightly above normal with a few periods of very hot weather in the middle of the summer and only about 60% of the normal precipitation accumulation. There were only four rain events during this trial's growing season that produced >0.75" of accumulation. These four events constituted approximately 33% of the total rainfall. Therefore, there were extended periods with very little to no rainfall, the longest of which was approximately 25 days with no rainfall >0.25". 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. However, these warm conditions did provide optimal Growing Degree Days (GDDs) through the season with a total of 2650 GDDs accumulated May-Sep, 439 above normal.

Table 4. Weather data for Alburgh, VT, 2018.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	59.5	64.4	74.1	72.8	63.4
Departure from normal	3.10	-1.38	3.51	3.96	2.76
Precipitation (inches)	1.94	3.74	2.43	2.96	3.48
Departure from normal	-1.51	0.05	-1.72	-0.95	-0.16
Growing Degree Days (50-86°F)	352	447	728	696	427
Departure from normal	154	-27	88	115	109

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 did not vary statistically in yield or dry matter (DM) content at harvest (Table 5). The average dry matter content at harvest was 40.0% which indicates that all the varieties reached maturity by mid-September. However, dry matter content ranged from 36.9% to 50.3%. Ideally, silage should be harvested around 35% dry matter. If the plants were harvested slightly earlier, the moisture content would have been more ideal 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.

Table 5. Harvest characteristics of 11 organic corn silage varieties, 2018.

Variety	RM	Harvest DM	Yield, 35% DM
		%	tons ac^{-1}
14A91	82	39.8	16.9
23A71	86	38.1	19.8
33A16	92	40.7	19.9
33L90	93	39.9	20.3
43L96	98	37.9	16.1
KF42C20	92	**50.3**	**21.0**
KF52C60	102	38.4	20.4
O.51-04	104	37.6	19.7
O.71-90	90	40.7	18.3
O.79-00	100	36.9	19.1
O.82-95	95	39.9	19.6
LSD (p = 0.10)	N/A	NS	NS
Trial mean	94	40.0	19.2

The top performer for a category is highlighted in **bold**.
N/A statistical analysis was not performed for the measure.
NS not statistically significant.

Corn yields were still relatively high for organic corn in this region averaging 19.2 tons ac^{-1}. The highest yielding variety was KF42C20 which produced 21.0 tons ac^{-1} but was not statistically different from any of the other varieties. This was likely due to high variation within treatments across the trial.

Corn silage varieties varied significantly in terms of crude protein, total digestible nutrients (TDN), 30-hr NDFD, net energy for lactation (NE_L), and milk yield lbs ton^{-1} (Table 6). Protein content averaged 7.94% with the highest content of 8.68% produced by variety O.51-04. This was statistically similar to two other varieties, 23A71 and 14A91 with 8.34 and 8.32% respectively. The low protein contents of many of the other varieties in the trial were likely due to limited ear and kernel formation from the drought conditions experienced during tasseling, pollination, and ear formation. Overall, ADF and NDF values were indicative of adequate quality corn silage, averaging 24.4 and 39.7% respectively and did not vary statistically among varieties. Similarly, ash and starch contents averaged 2.66 and 37.8%. Varieties did differ in TDN. The highest TDN content was 74.7% produced by variety O.79-00. This was statistically similar to three other varieties. Varieties also differed significantly in terms of NDF digestibility (30-hr NDFD). The highest digestibility was 48.1% for variety KF52C60. This was statistically similar to three other varieties. Net energy calculations estimate the digestible energy content of feeds utilized for maintenance, lactation, or gain accounting for differences in efficiency of use of the energy for the different goals. Net energy for lactation (NE_L) averaged 0.719 for the trial with the highest level of 0.747 Mcal lb^{-1} produced by variety O.79-00. This was statistically similar to two other varieties. Finally, due to these differences in quality, varieties differed statistically in milk yield per ton of feed but not by acre. This is due to statistical differences in quality but not yield. The highest milk yield per ton of dry matter was 3583 lbs ton^{-1} from variety O.79-00. This was similar to three other varieties, O.51-04, 23A71, and KF52C60.

Table 6. Quality characteristics of 11 organic corn silage varieties, 2018.

Variety	CP	ADF	NDF	Ash	Starch	TDN	30-hr NDFD	NE_L	Milk	
	% of DM						% of NDF	Mcal lb^{-1}	lbs ton^{-1}	lbs ac^{-1}
14A91	8.32*	23.9	39.5	2.91	37.1	71.9	46.9	0.712	3358	19909
23A71	8.34*	24.4	39.2	2.89	36.8	73.5*	47.7*	0.731*	3481*	24287
33A16	7.52	24.9	40.5	2.78	37.2	70.6	46.6	0.697	3255	22589
33L90	7.92	24.9	40.9	2.52	37.4	71.4	46.8	0.707	3319	23630
43L96	7.66	25.4	42.0	2.53	35.3	72.1	46.5	0.717	3382	18930
KF42C20	7.75	24.6	40.8	2.85	37.1	70.7	46.6	0.698	3266	23553
KF52C60	8.00	25.0	40.3	2.44	37.3	73.3*	**48.1**	0.727	3462*	**24735**
O.51-04	**8.68**	23.2	**37.4**	3.10	39.5	74.3*	47.8*	0.741*	3548*	24428
O.71-90	7.41	24.4	39.2	**2.38**	39.1	71.9	47.1	0.712	3355	21454
O.79-00	7.67	**23.1**	37.7	2.47	**40.5**	**74.7**	46.9	**0.747**	**3583**	23858
O.82-95	8.09*	24.4	39.3	2.43	38.6	72.4	47.7*	0.717	3395	23228
LSD (p = 0.10)	0.618	NS	NS	NS	NS	1.65	0.976	0.0195	129	NS
Trial mean	7.94	24.4	39.7	2.66	37.8	72.4	47.1	0.719	3401	22782

*Varieties with an asterisk are not significantly different than the top performer in **bold**.
NS not statistically significant.

DISCUSSION

Figure 1 below 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, however, state that these differences are statistically significant (Tables 5 and 6). There were four varieties that produced both above average yield and quality: O.79-00, O.51-04, 23A71, and KF52C60. Interestingly, three of these four top performing varieties were the three latest maturing varieties with relative maturities over 100 days. The other variety, 23A71, has a relative maturity of 86 days, one of the shortest in the trial. As conditions through the season and into the fall remained hot and dry, long season varieties were able to reach maturity well. However, in some years when weather is less favorable, this may become risky. Therefore, it is interesting to note that both short and long season varieties, can produce high yields and quality corn silage under organic management in this region. 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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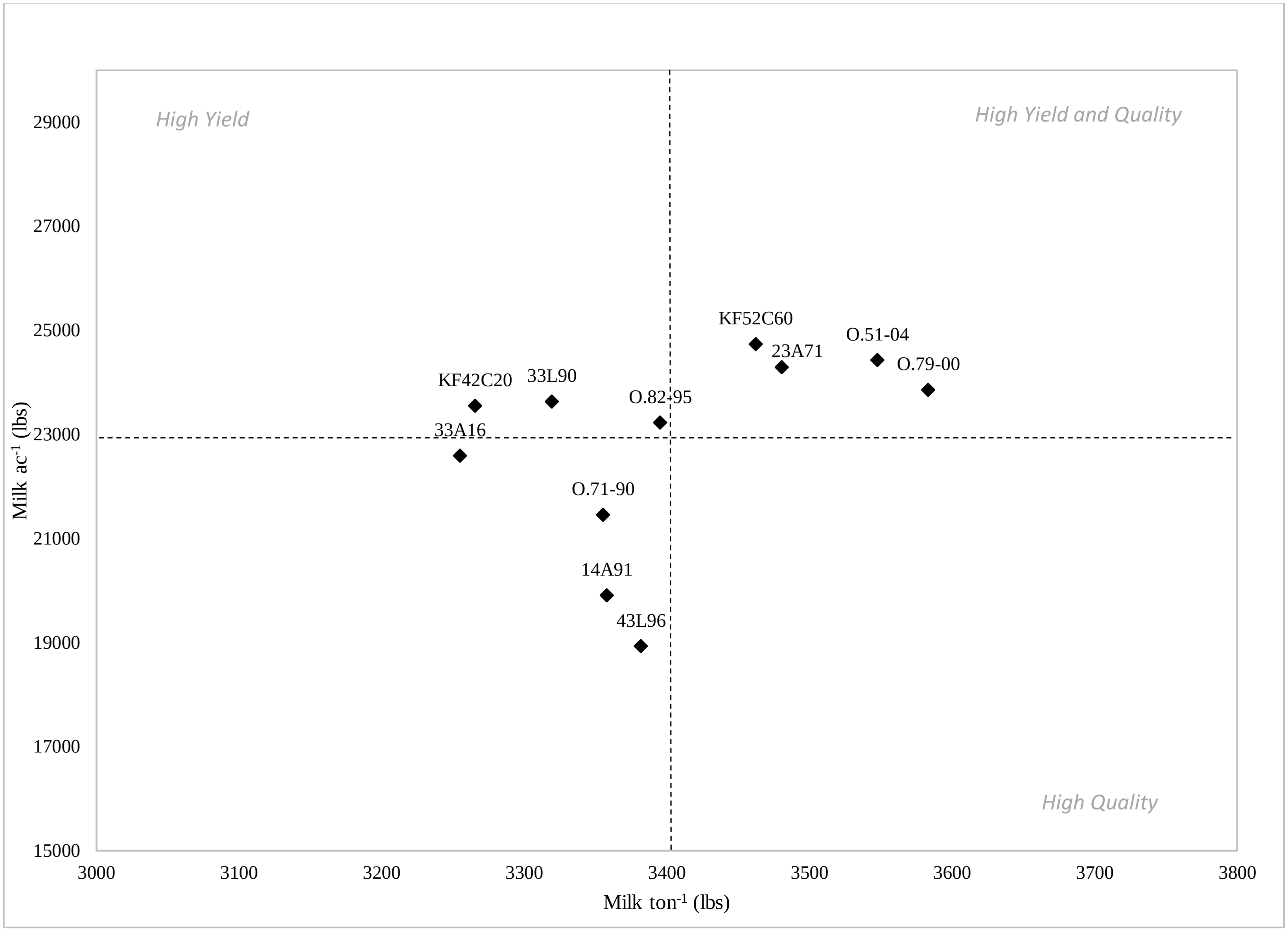

Figure 1. Milk production of 11 organic corn varieties, Alburgh, VT, 2018.
Shows relationship between milk per ton and milk per acre. Dotted lines represent the mean milk per ton and milk per acre for the trial.