NORTHWEST CROPS & SOILS PROGRAM

2019 Vermont Organic Silage Corn Performance Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2019 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 2019 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 2019, 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 11 corn silage varieties submitted for evaluation 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, 2019.

Company	Variety	Traits	Relative Maturity (RM)
Blue River Hybrids	05ES7	None	73
Blue River Hybrids	08B55	None	78
Blue River Hybrids	14A91	None	82
Blue River Hybrids	27B16	None	88
Blue River Hybrids	33A16	None	92
Blue River Hybrids	33ND10	NutriDense	92
Albert Lea/Viking	42-92GS	None	92
Albert Lea/Viking	O.51-04PGS	None	104
Albert Lea/Viking	O.69-01UP	None	101
Albert Lea/Viking	O.71-90UPGS	None	90
Albert Lea/Viking	O.82-95P	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 corn silage.

Prior to planting, plots were fertilized with ProGro (5-4-3) and ProBooster (10-0-0) at a rate 1000 lbs ac^{-1} each. Both products are approved for use in organic production and produced by North Country Organics located in Bradford, VT. Plots were planted on 23-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.

Weeds were controlled by early season tine weeding on 7-Jun, hand hoeing on 12-Jun, 17-Jun, and mechanical row cultivation on 25-Jun. On 10-Jul plots were top-dressed with 300 lbs of sodium nitrate (13-0-0). On 20-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, 2019.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam
Previous crop	Corn silage
Row width (in)	30
Plot size (ft)	10 x 20
Seeding rate (viable seeds ac^{-1})	40,000
Planting date	23-May
Tillage operations	Spring disk, spike tooth harrow
Harvest date	20-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 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 optimal Growing Degree Days (GDDs) through the season with 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.

Varieties varied significantly in yield and dry matter (DM) content at harvest (Table 5). The average dry matter content at harvest was 35.8%, which indicates that all the varieties reached maturity by mid-

September. Dry matter content ranged from 31.1% to 43.9%. Ideally, silage should be harvested around 35% dry matter. At the time of harvest, most varieties had a dry matter around 35%, which is 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, 2019.

Variety	RM	Plant Population	Harvest DM	Yield, 35% DM
		plants ac^{-1}	%	tons ac^{-1}
05ES7	73	**32779**	**43.9**	15.5
08B55	78	27062	32.8	18.3
14A91	82	30928*	34.5	20.9*
27B16	88	28314	33.2	**24.8**
33A16	92	31418*	37.2	21.6*
33ND10	92	27388	33.4	18.9
42-92GS	92	24285	38.3	18.7
O.51-04PGS	104	31309*	37.0	23.0*
O.69-01UP	101	24121	35.0	20.7*
O.71-90UPGS	90	23196	31.1	17.3
O.82-95P	95	27606	37.6	18.8
LSD (p = 0.10)	N/A	3182	3.3	4.2
Trial mean	90	28037	35.8	19.9

*Varieties with an asterisk are not significantly different than the top performer in **bold.**
N/A - statistical analysis was not performed for the measure.

Corn yields were still relatively high for organic corn in this region averaging 19.9 tons ac^{-1}. The highest yielding variety was 27B16 which produced 24.8 tons ac^{-1} but was not statistically different from four other high yielding varieties.

Corn silage varieties varied significantly in terms of crude protein, ash, starch, 30-hr NDFD, milk yield lbs ton^{-1} and milk yield lbs ac^{-1} (Table 6). Protein content averaged 7.82% with the highest content of 9.00% produced by variety 08B55, which was statistically higher than all the other varieties. Overall ADF and NDF values were indicative of adequate quality corn silage, averaging 24.7 and 42.3% respectively and did not vary statistically among varieties. Ash and starch contents averaged 4.84 and 31.0% respectively with the top performer being 42-92GS. Although there was a significant difference in terms of ash and starch, the top performer was statistically similar to all but two of remaining varieties. Varieties also differed significantly in terms of NDF digestibility (30-hr NDFD). The highest digestibility was 64.1% for variety 14A61. This was statistically similar to three other varieties. The predicted milk yield per ton was highest for 14A91with 3674 lbs ton^{-1} and this was statistically similar to five other varieties. Variety O.82-95P had the highest milk yield per acre with 29944 lbs ac^{-1}, and five varieties were statistically similar to this variety.

Table 6. Quality characteristics of 11 organic corn silage varieties, 2019.

Variety	CP	ADF	NDF	Ash	Starch	30-hr NDFD	Milk	
			% of DM			% of NDF	lbs ton^{-1}	lbs ac^{-1}
05ES7	7.88	28.1	45.9	5.65	24.0	58.9	2949	18534
08B55	**9.00**	23.7	40.6	4.91*	30.0*	58.9	3578*	22048
14A91	8.20	21.5	38.8	4.94*	33.7*	**64.1**	**3674**	25390*
27B16	7.93	22.5	38.8	4.85*	31.7*	62.7*	3666*	27653*
33A16	7.35	26.2	44.7	4.66*	31.1*	60.5	3354	21631
33ND10	8.10	26.4	45.3	5.01	28.1	63.7*	3587*	24802*
42-92GS	7.45	23.9	40.9	**4.38**	**34.6**	59.6	3397	25033*
O.51-04PGS	7.25	24.5	42.0	4.42*	33.8*	61.1	3467	25241*
O.69-01UP	7.58	26.1	44.7	4.92*	30.1*	62.0*	3508*	22863
O.71-90UPGS	7.80	24.5	42.2	4.83*	30.3*	60.5	3597*	22931
O.82-95P	7.53	24.1	41.3	4.65*	33.6*	61.7	3460	**29944**
LSD (p = 0.10)	0.51	NS	NS	0.60	5.3	2.3	178	5686
Trial mean	7.82	24.7	42.3	4.84	31.0	61.2	3476	24188

*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 five varieties that produced both above average yield and quality: O.82-95P, 27B16, O.51-04PGS, 14A91, and 33ND10. Interestingly, these five varieties had a range of relative maturities ranging from 82-104 days. Even with a cool, wet start to the season, as conditions through the season and into the fall remained hot and dry, long season varieties were able to reach maturity. 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.

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 Catherine Davidson, Hillary Emick, Haley Jean, Shannon Meyler, 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 these 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.

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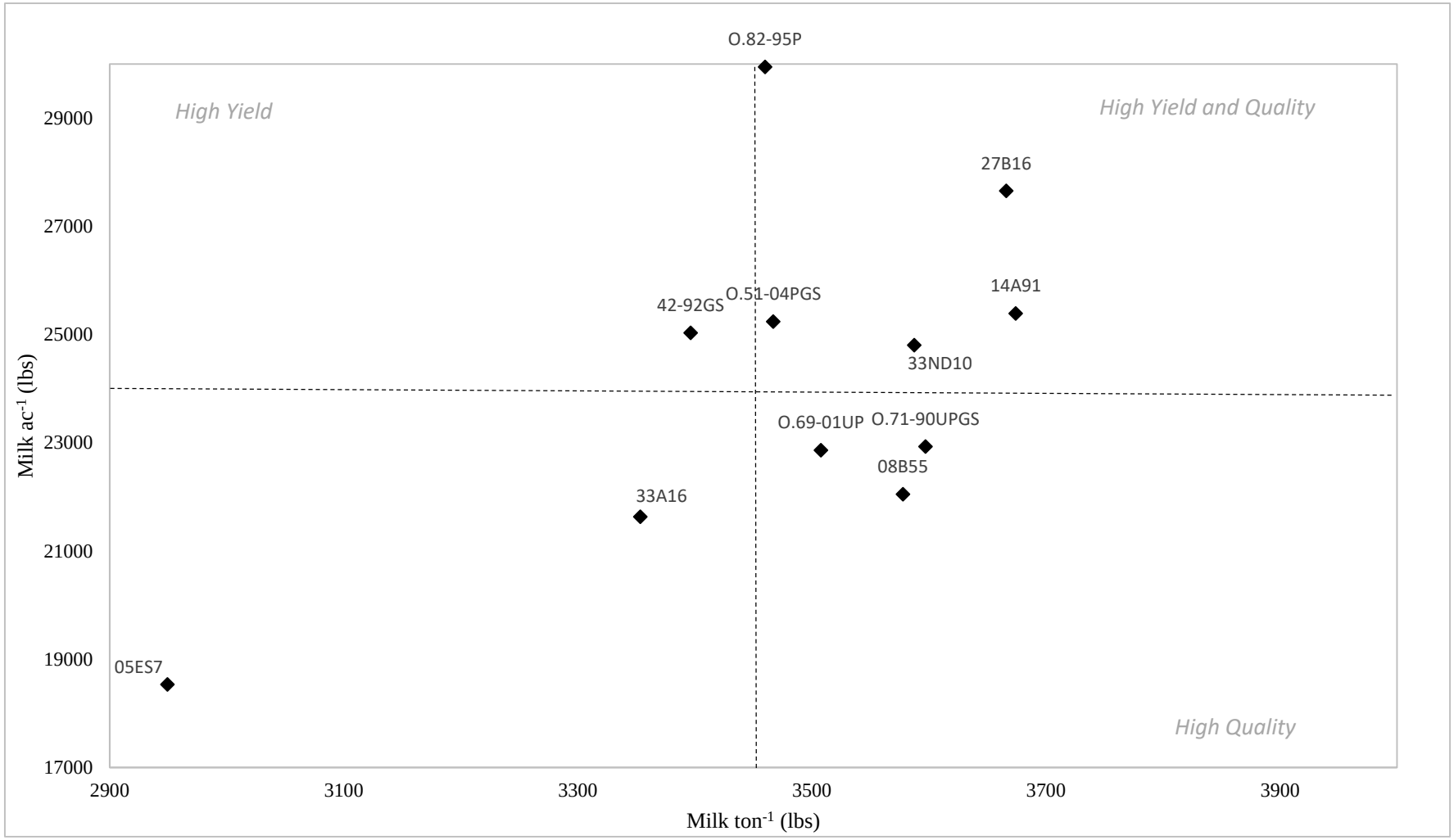

Figure 1. Milk production of 11 organic corn varieties, Alburgh, VT, 2019.
Shows relationship between milk per ton and milk per acre. Dotted lines represent the mean milk per ton and milk per acre for the trial.