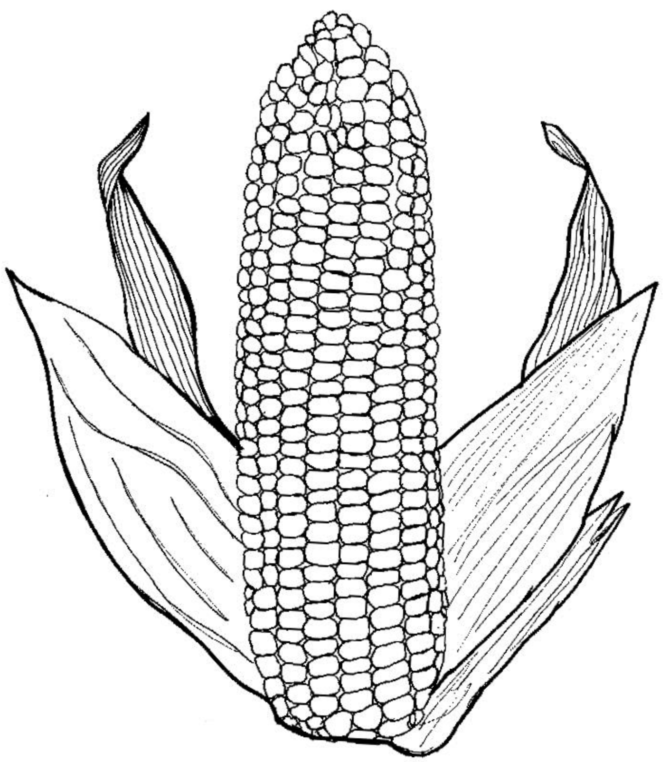
2013
Vermont Organic Silage Corn Performance Trial Results



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UNIVERSITY OF VERMONT EXTENSION
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2013 VERMONT ORGANIC SILAGE CORN PERFORMANCE TRIAL RESULTS

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In 2013, the University of Vermont Extension conducted an organic silage corn variety trial. The purpose of the study was to provide unbiased performance comparisons of commercially available organic silage corn varieties. It is important to remember, however, that the data presented are from a replicated research trial from only one location in Vermont and represent only one season. The 2013 growing season was a challenging season for corn production and hence the results were less than favorable. However varieties that were able to thrive in these adverse conditions would likely be varieties that could produce well in a variety of conditions. Crop performance data from additional tests in different locations and over several years should be compared before making varietal selections.

MATERIALS AND METHODS

In 2013, an organic corn silage performance trial was conducted at the Borderview Research Farm in Alburgh, VT. The trial site was certified organic by Vermont Organic Farmers, LLC. Several seed companies and farmers submitted varieties for evaluation (Table 1). The organic corn grown at the Alburgh site had relative maturities (RM) ranging between 77-104 days. The specific varieties and their RMs are listed in Table 2. Unfortunately, due to the poor conditions several varieties did not make it to harvest and are listed as crop failures in Table 2.

Table 1. Participating companies and local contact information.

Albert Lea Seed	American Organic	Blue River Hybrids Organic Seed
1414 West Main Street PO Box 127 Albert Lea, MN 56007 (800) 352-5247	Art Scheele PO Box 385 Warren, IL 61087 (866) 471-9465	Boucher Fertilizer 2343 Gore Road Highgate Center, VT 05459 (802) 868-3939
Cornell University	**Lakeview Organic Grain**	
Dr. Margaret Smith Dept. of Plant Breeding & Genetics G42 Emerson Hall Ithaca, NY 14853	Klaas & Mary-Howell Martens Box 361 Penn Yan, NY 14527 (315) 531-1038	

Table 2. Organic corn varieties evaluated in Alburgh, Vermont, 2013.

Company	Variety	RM (days)	Crop	Crop failure
Albert Lea Seed	087-80N	80	grain/silage corn	No
Albert Lea Seed	MF86	86	silage corn	Yes
Albert Lea Seed	099-87N	87	grain/silage corn	No
Albert Lea Seed	Viking 079-96N	96	silage corn	No
Albert Lea Seed	Viking 22-00	100	silage corn	No
Albert Lea Seed	Viking 67-01N	101	silage corn	Yes
American Organic	1DP78	78	grain/silage corn	Yes
American Organic	2G34	84	grain/silage corn	No
American Organic	2G88	88	grain/silage corn	No
American Organic	X3G03	93	grain/silage corn	No
American Organic	3G33	97	silage corn	No
American Organic	X99-56VP	99	silage corn	No
American Organic	X104-62VP	104	silage corn	No
Blue River	07M91	77	grain/silage corn	No
Blue River	14A91	82	grain/silage corn	No
Blue River	23A71	86	grain/silage corn	Yes
Blue River	23L99	86	grain/silage corn	Yes
Cornell Univ.	D2901	90	silage corn	Yes
Lakeview	Wapsie Valley	85	silage corn	Yes
Lakeview	VK13	90	silage corn	Yes

The soil type at the Alburgh location was a Benson rocky silt loam (Table 3). Manure was applied at a rate of 7000 gallons per acre in the fall of 2012. The seedbed was spring disked followed by spike tooth harrow. The previous crop was summer annuals. Plots were 25’ long and consisted of two 30-inch rows. They were planted with a John Deere 1750 planter on 5-Jun. The seeding rate was 36,000 seeds per acre. The plot design was a randomized complete block with three replications. Treatments were twenty varieties. In order to reduce weed pressure, the plots were tine-weeded on 20-Jun and cultivated on 5-Jul.

On 18-Oct the corn was harvested with a John Deere 2-row chopper, and the forage wagon was weighed on a scale. A subsample of the harvested material was collected, dried, ground, and then analyzed at the University of Vermont’s Testing Laboratory, Burlington, VT, for quality analysis. Dry matter yields were calculated and then adjusted to 35% dry matter.

Table 3. Organic silage corn variety trial information, Alburgh, Vermont, 2013.

	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Summer annuals
Row width (in)	30
Plot size (ft)	5 x 25
Seeding rate (seeds/acre)	36,000
Planting date	5-Jun
Manure application (fall of 2012)	7000 gal/ac
Tillage operations	Spring disk, spike tooth harrow
Row cultivation	5-Jul
Additional weed control	20-Jun (tine-weeded)
Harvest date	18-Oct

Silage quality was analyzed using the FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer. Dried and coarsely ground plot samples were brought to the lab where they were reground using a cyclone sample mill (1mm screen) from the UDY Corporation. The samples were then analyzed using the FOSS NIRS DS2500 for crude protein (CP), starch, acid detergent fiber (ADF), neutral detergent fiber (NDF), 30-hour digestible NDF (NDFD), non-structural carbohydrates (NSC), total digestible nutrients (TDN), and milk per ton. Mixtures of true proteins, composed of amino acids, and nonprotein nitrogen make up the CP content of forages. 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, nonprotein 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). NDFD is the % of NDF that is digestible in 30 hours. Evaluation of forages and other feedstuffs for NDFD is being conducted to aid prediction of feed energy content and animal performance. 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.

Net energy of lactation (NE_L) is calculated based on concentrations of NDF and ADF. NE_L can be used as a tool to determine the quality of a ration, but should not be considered the sole indicator of the quality of a feed, as NE_L is affected by the quantity of a cow's dry matter intake, the speed at which her ration is consumed, the contents of the ration, feeding practices, the level of her production, and many other factors. Most labs calculate NE_L at an intake of three times maintenance. Starch can also have an effect on NE_L, where the greater the starch content, the higher the NE_L (measured in Mcal per pound of silage), up to a certain point. High grain corn silage can have average starch values exceeding 40%, although levels greater than 30% are not considered to affect energy content, and might in fact have a negative impact on digestion. Starch levels vary from field to field, depending on growing conditions and variety.

Non-structural Carbohydrate (NSC) are simple carbohydrates, such as starches and sugars, stored inside the cell that can be rapidly and easily digested by the animal. NSC is considered to serve as a readily available energy source and should be in the 30-40% range, on a dry matter basis.

Total digestible nutrients (TDN) report the percentage of digestible material in silage. Total digestible nutrients are calculated from ADF and express the differences in digestible material between silages.

Milk per ton measures the pounds of milk that could be produced from a ton of silage. This value is generated by approximating a balanced ration meeting animal energy, protein, and fiber needs based on silage quality. The value is based on a standard cow weight and level of milk production. Milk per acre is calculated by multiplying the milk per ton value by silage dry matter yield. Therefore, milk per ton is an overall indicator of forage quality and milk per acre an indicator of forage yield and quality. Milk per ton and milk per acre calculations provide relative rankings of forage samples, but should not be considered as predictive of actual milk responses in specific situations for the following reasons:

1) Equations and calculations are simplified to reduce inputs for ease of use,
2) Farm to farm differences exist,
3) Genetic, dietary, and environmental differences affecting feed utilization are not considered.

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 because of 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 the example below, 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 yields of these hybrids were significantly different from one another.

Hybrid	Yield
A	6.0
B	7.5*
C	**9.0***
LSD	2.0

RESULTS

Weather data is recorded with a Davis Instrument Vantage PRO2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT. June was wetter than normal with an additional 5.54 inches (based on 1981-2010 data), however, July, August, September, and October all had less precipitation than normal (Table 4). June, August, and September had lower than normal average temperatures (based on 1981-2010 data). There were an accumulated 2089 Growing Degree Days (GDDs) at a base temperature of 50 degrees Fahrenheit. This was 76 more GDDs than the historical 30-year average for June-October.

Table 4. Summarized temperatures, precipitation, and growing degree days, Alburgh, Vermont, 2013.

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	64.0	71.7	67.7	59.3	51.1
Departure from normal	-1.80	1.10	-1.10	-1.30	2.90
Precipitation (inches)	9.23 ł	1.89	2.41	2.20	2.39 ◊
Departure from normal	5.54	-2.26	-1.50	-1.44	-1.21
Growing Degree Days (base 50°F)	427	677	554	289	142
Departure from normal	-47.0	36.8	-27.2	-28.7	142

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.
ł June 2013 precipitation data based on National Weather Service data from cooperative stations in South Hero, VT. (http://www.nrcc.cornell.edu/page_summaries.html)
◊ October 2013 precipitation data based on National Weather Service data from cooperative stations in Burlington, VT. (http://www.nrcc.cornell.edu/page_nowdata.html)

Yield and harvest dry matters (DM) results are listed in Table 5. Dry matter yields were calculated and then adjusted to 35% dry matter. The average yield for the organic silage corn trial was 13.1 tons acre^{-1} at 35% DM. The American Organic variety 'X104-62VP'yielded significantly higher (17.0 tons ac^{-1}) than most other varieties evaluated (Table 5 and Figure 1). Other high yielding varieties include: Albert Lea Seed 'Viking 22-00' (17.0 tons ac^{-1}), American Organic 'X3G03' (16.5 tons ac^{-1}), and Albert Lea Seed 'Viking 079-96N' (15.1 tons acre^{-1}). There were no significant differences in harvest dry matter (DM). The average harvest DM for the trial was 35.1% (or 64.9% moisture content). The lowest was the American Organic variety 'X99-56VP' at 29.4% DM, and the highest DM was the Blue River variety '07M91' at 41.4% DM.

Table 5. Harvest characteristics of 12 organic corn silage varieties – Alburgh, VT, 2013.

Hybrid	RM	Harvest dry matter (DM)	Yield 35% DM
		%	tons ac^{-1}
07M91	77	41.4	14.4
087-80N	80	34.4	9.9
099-87N	87	34.0	9.7
14A91	82	39.5	11.2
2G34	84	38.0	11.0
2G88	88	35.1	9.6
3G33	97	35.2	12.7
Viking 22-00	100	35.9	17.0*
Viking 079-96N	96	34.7	15.1*
X104-62VP	104	32.5	**17.0***
X3G03	93	30.6	16.5*
X99-56VP	99	**29.4**	12.7
LSD (0.10)		NS	2.5
Trial Mean		35.1	13.1

*Treatments indicated with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.
Treatments shown in **bold** are of the highest value or top performing.
NS – No significant difference was determined between treatments.

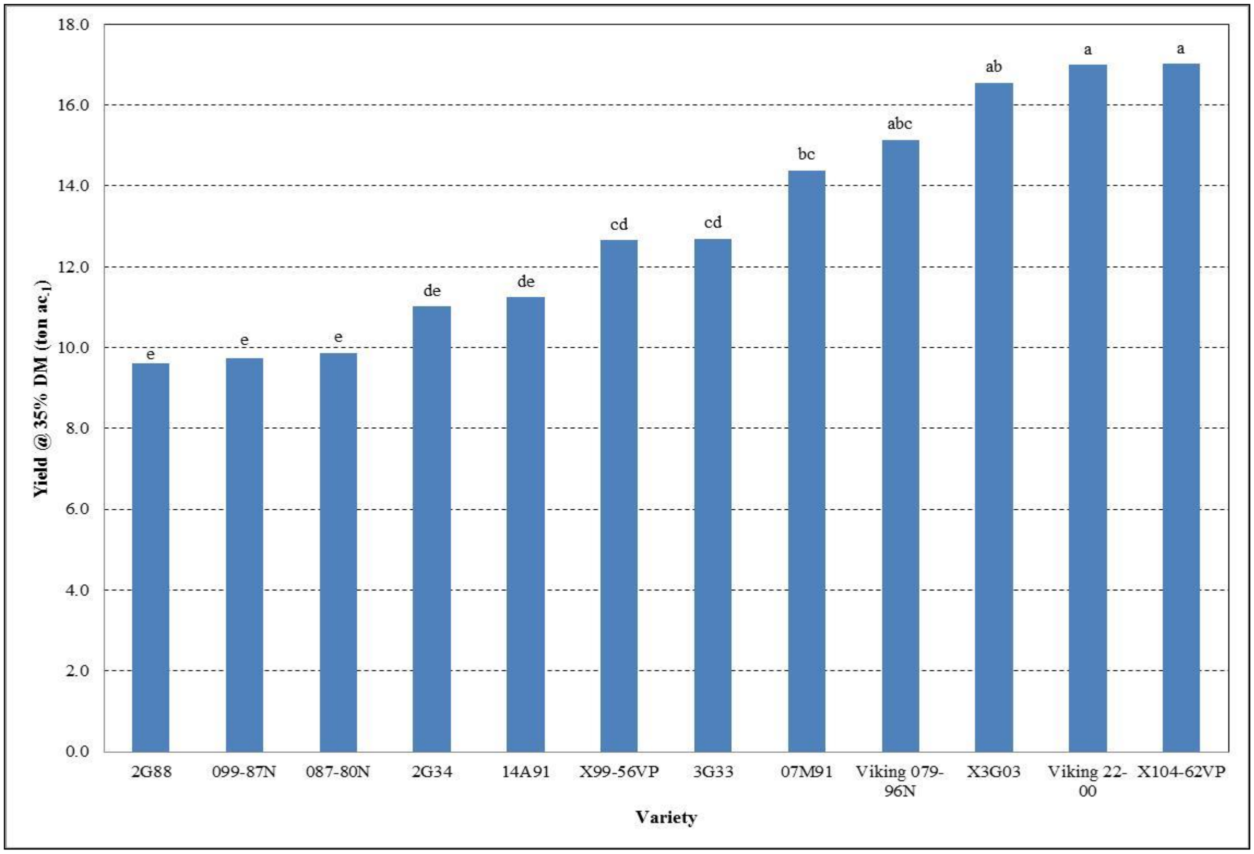

Figure 1. Organic corn silage yields, Alburgh, Vermont.
Varieties with the same letter did not differ significantly in yield.

The quality results for the twelve organic corn silage varieties are shown in Table 6. With the exception of Milk per acre^{-1} (lbs) there were no significant differences in forage quality among the varieties evaluated. The organic silage corn variety 'Viking 22-00' (Albert Lea Seed) had the highest Milk per acre^{-1} (15044 lbs). Other varieties with high Milk per acre^{-1} include; the American Organic varieties 'X104-62VP' (13672 lbs) and 'X3G03' (13637 lbs), and the variety 'Viking 079-96N' (13557 lbs) from Albert Lea Seed. It's interesting to note, even though not significantly different, variety 2G34 (American Organic) had the lowest ADF and NDF, and had the highest NSC, TDN, NE_L, and Milk per ton^{-1} (lbs).

Table 6. Silage quality of twelve organic corn varieties, Alburgh, Vermont.

Variety	RM	Forage quality characteristics								Milk	
		CP	ADF	NDF	NDFD	Starch	NSC	TDN	NE_L	ton^{-1}	$acre^{-1}$
		% of DM	% of DM	% of DM	% of NDF	%	%	%	Mcal lb^{-1}	lbs	lbs
07M91	77	6.10	26.3	44.8	59.4	**28.2**	29.1	68.1	0.70	2602	13089*
087-80N	80	5.43	28.2	48.3	64.0	22.2	24.3	65.7	0.68	2506	8631
099-87N	87	5.93	31.0	52.0	64.8	17.6	22.2	63.1	0.65	2363	8059
14A91	82	5.98	28.1	48.6	62.0	23.5	26.2	65.6	0.68	2420	9469
2G34	84	6.88	**25.9**	**43.5**	62.7	28.1	**30.7**	**68.5**	**0.71**	**2645**	10318
2G88	88	5.16	29.1	49.7	64.7	20.1	23.9	65.4	0.67	2446	8166
3G33	97	5.44	29.2	49.7	66.4	19.8	23.0	63.6	0.65	2351	10428
Viking 22-00	100	5.91	26.9	46.7	62.3	25.3	29.5	68.1	0.70	2518	**15044***
Viking 079-96N	96	6.19	27.0	45.3	65.0	24.7	29.3	67.7	0.70	2567	13557*
X104-62VP	104	5.11	30.4	51.6	67.2	16.6	24.1	63.6	0.65	2288	13672*
X3G03	93	**7.41**	29.0	50.1	**67.6**	18.2	25.3	64.0	0.66	2417	13637*
X99-56VP	99	5.85	30.9	52.8	66.2	17.6	22.1	64.1	0.66	2394	10610
LSD (0.10)		NS	NS	NS	NS	NS	NS	NS	NS	NS	2829
Trial Mean		5.95	28.5	48.6	64.4	21.8	25.8	65.6	0.68	2460	11223

*Treatments indicated with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.
Treatments shown in **bold** are of the highest value or top performing.
NS – No significant difference was determined between treatments.

Figure 2 displays the relationship between milk per ton and milk per acre. The dotted lines dividing the figure into four quadrants represent the mean milk per ton and acre for the location. Therefore, hybrids that fall above the lines performed higher than the average and hybrids below the lines performed below average. Milk per ton measures the pounds of milk that could theoretically be produced from one ton of silage. Milk per acre is calculated by multiplying the milk per ton value by silage dry matter yield. Thus milk per ton is an overall indicator of forage quality and milk per acre is an indicator of forage yield and quality. Shown in Figure 2 is a comparison of how each variety ranked in terms of milk per ton and milk per acre. Viking 22-00 (Albert Lea Seed), Viking 079-96N (Albert Lea Seed), and 07M91 (Blue River) all had above average yields and quality.

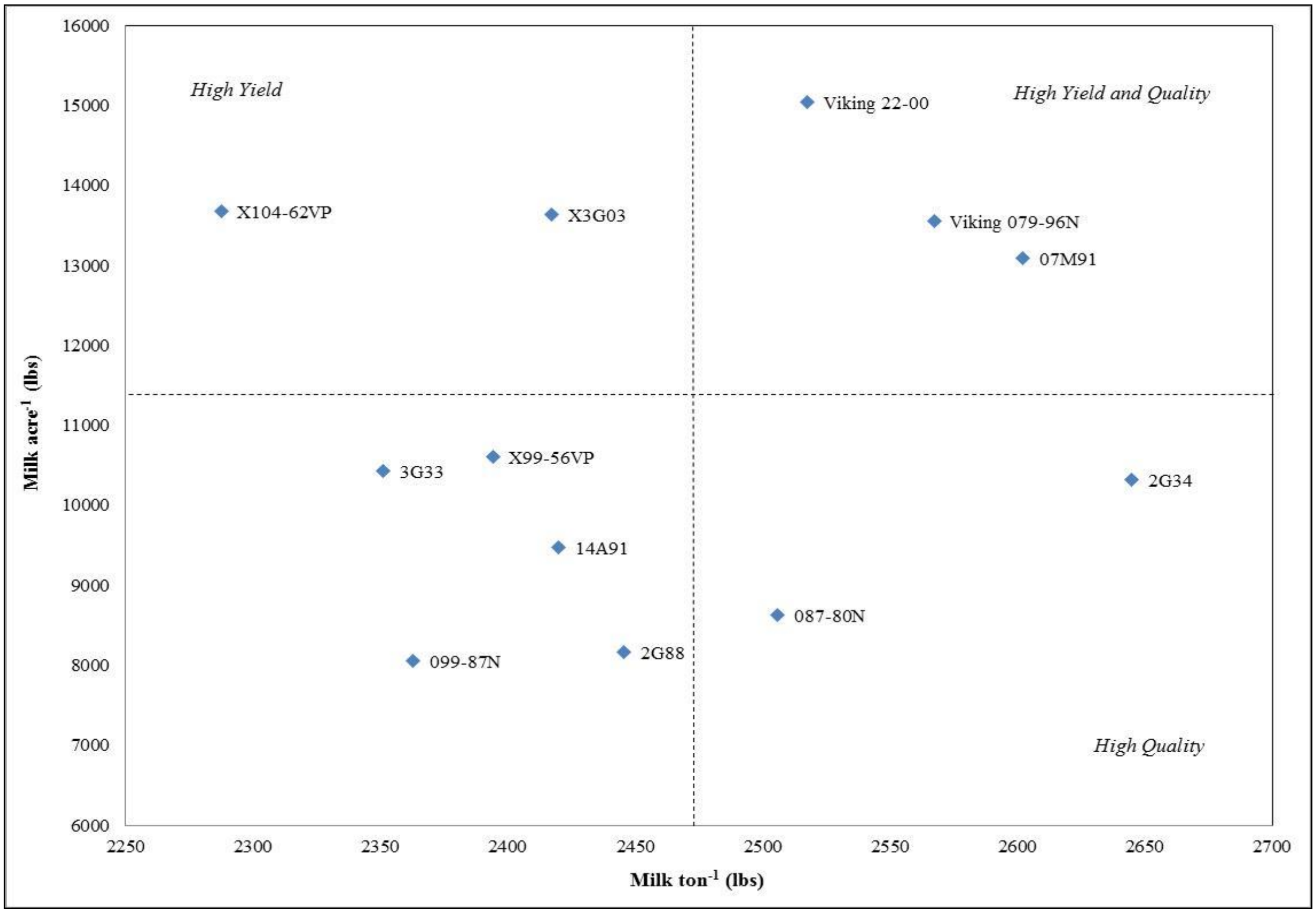

Figure 2. Relationship between milk per ton and milk per ac^{-1} for organic corn silage varieties grown in Alburgh, VT. *Dotted lines represent the mean milk per ton^{-1} and milk per ac^{-1}.*

DISCUSSION

It is important to remember that the results only represent one year of data. 2013 was a particularly challenging year for growing organic corn, there were several crop failures. This organic corn trial was planted in early June and was followed by a prolonged period of wetness that was marked by 9.23 inches of rain, 5.54 inches higher than normal, which flooded the plots and reduced seed germination. The saturated soils inhibited our ability to use mechanical tillage which allowed for increased weed pressure. These conditions resulted in loss of plots and for those that survived resulted in reduced yields. The mean yield for 2013 was 13.1 tons ac^{-1}, which was 8.4 tons ac^{-1} lower than the mean yield in 2012 (21.5 tons ac^{-1}). Interestingly there were still several varieties that were able to produce exceptional yields even under severe weed pressure. These varieties ranged from 77 to 104 days for relative maturity. Varieties that have a high level of early season vigor and compete well against weeds and other stresses will be highly advantageous to organic farmers.

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