2013

Long Season Corn Silage Variety Trial

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2013 LONG SEASON SILAGE CORN VARIETY TRIAL

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In 2013, the University of Vermont Northwest Extension Crops and Soils Team evaluated yield and quality of long season corn silage varieties at Borderview Research Farm in Alburgh, VT. Long season corn can be difficult to grow in Vermont, due to the climate's restricted Growing Degree Days (GDDs). In addition, wet springs are becoming more common, delaying corn planting later into the season. However, on many farms, long season corn can produce higher yields and quality than many short-season varieties. The test site was at Borderview Research Farm in Alburgh, VT, which has what is considered one of the longest growing seasons in Vermont (2,259 GDDs in 2013). In this year's trial, 24 varieties were evaluated from six different seed companies. While the information presented can begin to describe the yield and quality performance of these long season corn silage varieties in this region, it is important to note that the data represent results from only one season and one location. Compare other hybrid performance data before making varietal selections.

MATERIALS AND METHODS

Several seed companies submitted varieties for evaluation (Table 1). The plot design was a randomized complete block with three replications. Treatments were 24 long season corn varieties. These varieties, ranging in relative maturity (RM) from 96-113 days, were evaluated for yield and quality. Relative maturity and varietal characteristics were provided by the company (Table 2).

Table 1. Participating companies and local contact information.

Dekalb	Mycogen	Pioneer	Seedway	Wolf River	T.A. Seeds
Klaus Busch Knox, NY (518) 320-2462	Claude Fortin Highgate, VT (802) 363-2803	Bourdeau Bros. Sheldon, VT (802) 933-2277	Ed Schillawski Shoreham, VT (802) 897-2281	Marcel Moreau Swanton, VT (802) 309-4674	Cory Chelko Jersey Shore, PA (866) 813-7333

Table 2. Long season silage corn varieties evaluated in Alburgh, VT.

Variety	Company	Relative maturity	Traits
2396FL	Wolf River	96	LFY
2702L	Wolf River	102	LFY
2K595	Mycogen	105	Refuge Advanced / SSX / LL / RR2 / IRM
DKC49-29	Dekalb	99	Genuity / SSX / RIB Complete
DKC52-30	Dekalb	102	SSX
DKC57-92	Dekalb	107	SSX
F2F488	Mycogen	99	HXT / LL / RR2
F2F665	Mycogen	109	HXT / LL / RR2
P0216AM	Pioneer	107	AM1 / LL / RR2
P0533AM1	Pioneer	98	AM1 / LL / RR2
SW4204LVRR	Seedway	102	CruiserMaxx / LFY / LFYRR
SW5501L	Seedway	105	LFY
SW6604LRR	Seedway	109	LL / RR
TA108-18	TA Seeds	108	Agrisure GT
TA477-31	TA Seeds	97	Agrisure Viptera 3111
TA-533-31	TA Seeds	103	Agrisure GT / Viptera 3111
TA550-20ND	TA Seeds	105	Agrisure 3000GT
TA557-00F	TA Seeds	105	LFY
TMF2H699	Mycogen	110	SSX / LL / RR2
TMF2L538	Mycogen	101	SSX / LL / RR2
TMF2Q413	Mycogen	96	Herculex / LL / RR
TMF2R447	Mycogen	98	SSX / LL / RR2
TMF2W727	Mycogen	113	HXT / LL / RR2
X12403GM	Mycogen	100	CruiserMaxx

Agrisure 3000GT – Agrisure® 3000GT provides hybrids with excellent tolerance to in-season applications of glyphosate and glufosinate herbicides and protects against corn borer and corn rootworm.
Agrisure GT - Agrisure® GT corn provides tolerance to in-crop applications of a broad range of glyphosate-based herbicides.
Agrisure Viptera – The Agrisure Viptera® 3111 trait stack controls 14 above- and below-ground insects with a choice of either glyphosate or glufosinate applications.
AM1- Optimum® AcreMax® provides an insect control solution allowing growers to simplify and reduce their corn rootworm refuge by placing refuge in a bag (RIB).
CruiserMaxx – Resistant to the pesticide CruiserMaxx™ (thiamethoxam, azoxystrobin, fludioxonil, mefenoxam).
Genuity - Genuity® corn products are protected from a broad range of above and below-ground insect pests of corn, including European corn borer, fall armyworm, corn earworm, Northern corn rootworm, Western corn rootworm, and black cutworm.
HXT – Herculex Xtra® provides season-long control of a variety of pests, including European corn borer, Western bean cutworm, corn rootworm, and black cutworm.
IRM –Insect Resistance Management strategies are used to delay or prevent the onset of insect resistance to controls such as *Bt* proteins.
LFY – Conventional, leafy (forage trait).
Refuge Advanced - Dow AgroSciences Refuge Advanced® hybrids deliver the required insect refuge hybrid incorporated in the bag.
SSX – SmartStax corn provides a broad spectrum of insect control, using multiple modes of action, as well as glyphosate herbicide (Roundup Ready®, Touchdown®) and glufosinate-ammonium (LibertyLink®) tolerance.
LFYRR – Leafy, with pesticide tolerance for glyphosate systems.
LL – Glufosinate-ammonium herbicide (LibertyLink®) tolerant.
RIB – RIB Complete® (Refuge In a Bag) means that refuge seed is blended into each bag of insect-protected corn seed.
RR – Roundup Ready corn is glyphosate herbicide (Roundup®) tolerant.
RR2 – Roundup Ready 2 corn is glyphosate herbicide (Roundup®, Touchdown®) tolerant.

The soil type at the Alburgh location was a Benson rocky silt loam (Table 3). The seedbed was fall chisel plowed and spring disked followed by spike tooth harrow. The previous crop was silage corn. Starter fertilizer (10-20-20) was applied at a rate of 200 lbs per acre. Plots were 30 feet x 5 feet and replicated 3 times.. They were planted with a John Deere 1750 planter on 9-May. The seeding rate was 34,000 seeds per acre. An herbicide mix of Lumax® (S-metolachlor, atrazine, and mesotrione) at 3 quarts per acre and Accent® (nicosulfuron) was sprayed, post-emergence, on 6-Jun. On 1-Oct, the corn was harvested with a John Deere 2-row chopper, and forage was weighed in a wagon fitted with scales. Dry matter yields were calculated and then yields were adjusted to 35% dry matter.

Table 3. Long season corn variety trial specifics, Alburgh, VT, 2013.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Silage corn
Tillage operations	Fall chisel plow, disk and spike tooth harrow
Seeding rate (viable seeds ac^{-1})	34,000
Planting equipment	John Deere 1750 corn planter
Treatments (varieties)	24
Replications	3
Row width (in.)	30
Plot size (ft)	5' x 30'
Planting date	9-May
Starter fertilizer (at planting)	200 lbs ac^{-1} 10-20-20
Weed control	3 qt ac^{-1} Lumax®, 0.33 oz ac^{-1} Accent®, 6-Jun
Additional fertilizer (topdress)	200 lbs ac^{-1} urea (46-0-0), 20-Jun
Harvest dates	1-Oct

An approximate 2-lb. 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.

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), acid detergent fiber (ADF), neutral detergent fiber (NDF), 30-hour digestible NDF (NDFD), starch, nonstructural carbohydrates (NSC), and total digestible nutrients (TDN).

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the CP content of forages. The CP content of forages 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). 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 for 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. 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.

The silage performance indices of milk per acre and milk per ton were calculated using a model derived from the spreadsheet entitled "MILK2006," developed by researchers at the University of Wisconsin. 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. 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). The season was very close in temperature to the historical average (1981-2010 data), though May was 2.7° F warmer than normal with more Growing Degree Days (GDDs) than normal. May and June were extremely wet, delaying planting for many growers. June had 5.54 inches more than the 30-year average (1981-2010). There were an accumulated 2,259 GDDs, at a base temperature of 50° F. This was only 47 more units than the historical 30-year average for May-September.

Table 4. 2013 weather data for Alburgh, VT.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	59.1	64.0	71.7	67.7	59.3
Departure from normal	2.7	-1.8	1.1	-1.1	-1.3
Precipitation (inches)	4.79	9.23*	1.89	2.41	2.20
Departure from normal	1.34	5.54	-2.26	-1.50	-1.44
Growing Degree Days (base 50°F)	312	427	677	554	289
Departure from normal	113	-47	37	-27	-29

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.
* June 2013 precipitation data based on National Weather Service data from cooperative stations in South Hero, VT.

Disease and harvest data was analyzed for all 24 corn varieties (Table 5). All corn plots were rated for leaf disease (on a scale of 1 to 10, with 10 being the most severe disease incidence) immediately prior to harvesting. The average disease severity was 3.03, and the disease incidence varied significantly by variety. The variety ‘SW4204LVRR’ exhibited the most severe disease incidence. The lowest disease rating was in ‘TMF2W727,’ though 17 other varieties had similar disease incidence than this top-performer.

Dry matter varied significantly by variety, with the greatest dry matter (lowest moisture) was the variety ‘TMF2L538’ (44.6%). The average dry matter for the trial, harvested 2-Oct, was 38.6%. All varieties had reached an adequate dry matter prior to harvest. Some of the shorter season varieties were harvested above the ideal dry matter (65%) for corn silage storage. Yields did not vary significantly by variety, and the trial averaged 22.4 tons of silage at 65% moisture per acre.

Table 5. Disease severity and harvest data for 24 long season corn varieties, 2013, Alburgh, VT.

Variety	RM	Disease severity	DM at harvest	Yield at 35% DM
		(1-10 scale)	%	tons ac^{-1}
2396FL	96	3.67*	43.1*	23.5
2702L	102	4.33	41.3*	23.0
2K595	105	1.67*	37.5	26.7
DKC49-29	99	3.67*	38.5	24.4
DKC52-30	102	3.00*	38.9*	20.7
DKC57-92	107	3.00*	37.3	22.9
F2F488	99	1.67*	37.3	20.5
F2F665	109	2.33*	35.4	18.5
P0216AM	107	1.67*	36.5	21.2
P0533AM1	98	3.00*	38.1	20.5
SW4204LVRR	102	7.33	42.3*	26.2
SW5501L	105	4.33	36.6	23.0
SW6604LRR	109	2.67*	38.4	25.5
TA-533-31	103	3.33*	37.8	20.6
TA108-18	108	2.00*	35.0	19.8
TA477-31	97	3.33*	41.0*	23.8
TA550-20ND	105	1.33*	33.7	19.3
TA557-00F	105	4.67	40.2*	21.5
TMF2H699	110	1.33*	36.1	24.7
TMF2L538	101	1.67*	**44.6***	**26.9**
TMF2Q413	96	4.33	40.7*	22.1
TMF2R447	98	2.33*	42.6*	21.2
TMF2W727	113	**1.00***	31.6	24.0
X12403GM	100	5.00	42.1*	17.4
LSD (0.10)		2.73	5.8	NS
Trial mean		3.03	38.6	22.4

* Treatments that did not perform significantly lower (p=0.10) than top-performing treatment in a particular column.
NS – Treatments were not significantly different from one another (p=0.10).
Treatments shown in **bold** are top-performing in a particular column.

Forage quality characteristics varied significantly by variety (Table 6). Crude protein was highest in 'TMF2R477' (7.91%), though this was not statistically greater than 'TA108-18' or 'TA550-20ND.' TMF2R477 also had the lowest concentrations of ADF (23.1%) and NDF (40.6%). Digestible NDF (NDFD), or the amount of NDF that is digestible in a 30-hour period, varied significantly by variety, and averaged 24.0% of NDF. The top performer in NDFD was 'P0533AM1' (29.8%); only the NDFD of TA108-18 was not statistically lower.

The variety 'DKC57-92' had the highest starch levels (37.4%). This was statistically similar to 13 other varieties. Nonstructural carbohydrates (NSC) did not vary significantly by variety, but averaged 34.1% for the trial. There was a varietal impact on the total digestible nutrients (TDN) in the trial; DKC57-92 had the highest concentration of TDN (72.7% of silage dry matter). This was not statistically greater than 14 other varieties. Net energy for lactation (NE_L) varied significantly by variety, with top performing varieties having 0.76 to 0.73 Mcal of energy per lb. of feed (Figure 1).

Table 6. Forage quality data for 24 long season corn varieties, 2013, Alburgh, VT.

Variety	Forage quality characteristics								Milk	
	CP	ADF	NDF	NDFD	Starch	NSC	TDN	NE_L	ton^{-1}	ac^{-1}
	% of DM	% of DM	% of DM	% of NDF	% of DM	% of DM	% of DM	Mcal lb^{-1}	lbs	lbs
2396FL	6.01	26.5	46.5	52.7	30.2	32.8	68.7	0.71	2494	20567
2702L	6.85	24.9*	42.4*	53.8	33.5*	34.7	70.4*	0.73*	2668	21507
2K595	6.33	26.3	43.1*	54.0	34.8*	35.5	71.2*	0.74*	2674	24983
DKC49-29	7.03	25.7	44.6	55.2	27.5	28.5	66.1	0.68	2602	22238
DKC52-30	6.60	26.2	44.3	53.4	32.3	34.0	69.6	0.72	2609	19048
DKC57-92	6.14	24.9*	41.3*	50.6	**37.4***	**37.1**	**72.7***	**0.76***	2729	21897
F2F488	6.88	24.2*	41.3*	54.1	36.3*	36.9	72.2*	0.75*	2769	19901
F2F665	6.71	25.8	43.4*	60.2*	30.4	32.4	69.7	0.72	2700	17635
P0216AM	6.67	25.5	44.7	56.6	30.2	32.8	70.1*	0.73*	2644	19607
P0533AM1	6.93	25.9	46.2	64.3*	28.3	32.4	71.4*	0.74*	2775	19914
SW4204LVRR	6.69	26.0	45.0	53.4	31.1	33.5	68.9	0.71	2561	23489
SW5501L	6.38	27.1	46.3	55.1	29.6	31.5	67.9	0.70	2521	20363
SW6604LRR	6.31	26.6	45.9	51.9	27.3	29.1	66.3	0.68	2531	22618
TA-533-31	6.81	24.3*	42.1*	50.7	34.9*	35.2	71.1*	0.74*	2726	19725
TA108-18	7.79*	23.3*	41.0*	**65.5***	33.6*	35.1	72.7*	0.75*	**2923***	20223
TA477-31	6.58	26.0	43.8*	52.0	34.2*	35.5	70.6*	0.73*	2642	22085
TA550-20ND	7.42*	25.8	43.8*	53.3	32.7*	34.5	70.1*	0.73*	2686	18107
TA557-00F	6.67	26.4	45.2	53.6	30.0	32.6	68.5	0.71	2581	19501
TMF2H699	6.71	26.4	44.1	54.3	33.1*	35.2	71.3*	0.74*	2694	23213
TMF2L538	6.91	25.4	44.3	53.6	32.7*	34.1	70.1*	0.73*	2662	**25072**
TMF2Q413	6.82	25.2	43.0*	53.3	35.3*	36.8	71.8*	0.75*	2683	20751
TMF2R447	**7.91***	**23.1***	**40.6***	55.8	35.9*	36.1	71.5*	0.74*	2786*	20661
TMF2W727	6.52	26.5	44.6	53.0	32.8*	34.5	69.8	0.72	2597	21832
X12403GM	6.32	24.7*	42.5*	49.8	36.0*	36.6	71.7*	0.74*	2658	16241
LSD (0.10)	0.86	1.9	3.2	5.4	5.0	NS	2.8	0.03	138	NS
Trial mean	6.75	25.5	43.7	54.6	32.5	34.1	70.2	0.73	2663	20882

* Treatments that did not perform significantly lower (p=0.10) than top-performing treatment in a particular column.
NS – Treatments were not significantly different from one another (p=0.10).
Treatments shown in **bold** are top-performing in a particular column.

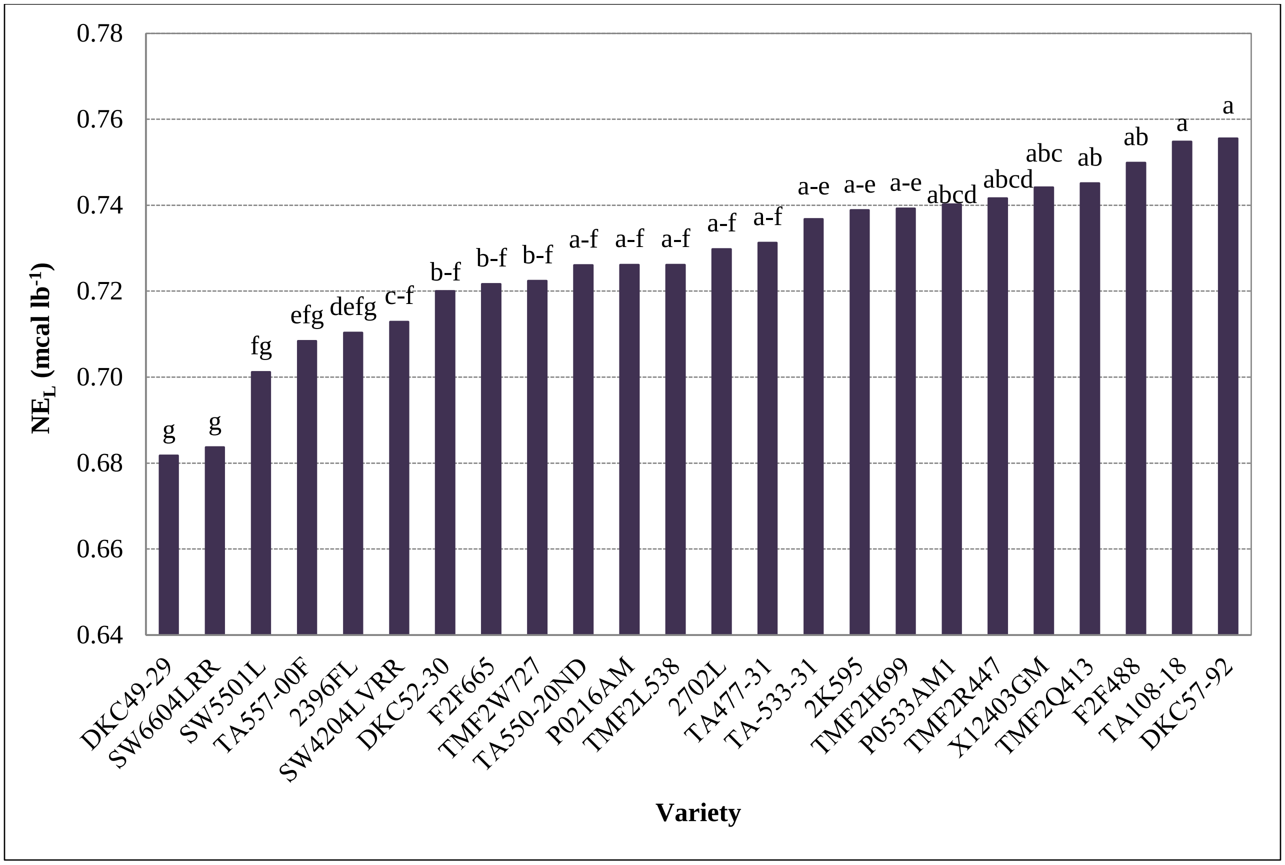

Figure 1. Net energy for lactation in 24 long season corn varieties, Alburgh, VT, 2013. Treatments that share a letter do not differ significantly from one another (p=0.10).

Milk per ton and milk per acre can indicate the yield and quality of corn silage varieties (Figure 2). Milk per ton, an indicator of corn silage quality, was significantly highest in the varieties TA108-18 (2923 lbs per ton) and TMF2R447 (2786 lbs per ton). Milk per acre, which takes into consideration the dry matter yield of each variety, was not statistically different by variety. Though there was no significant impact of variety on the milk per acre, the trial average was 20,882 lbs per acre, and the highest value was in the variety TMF2L538.

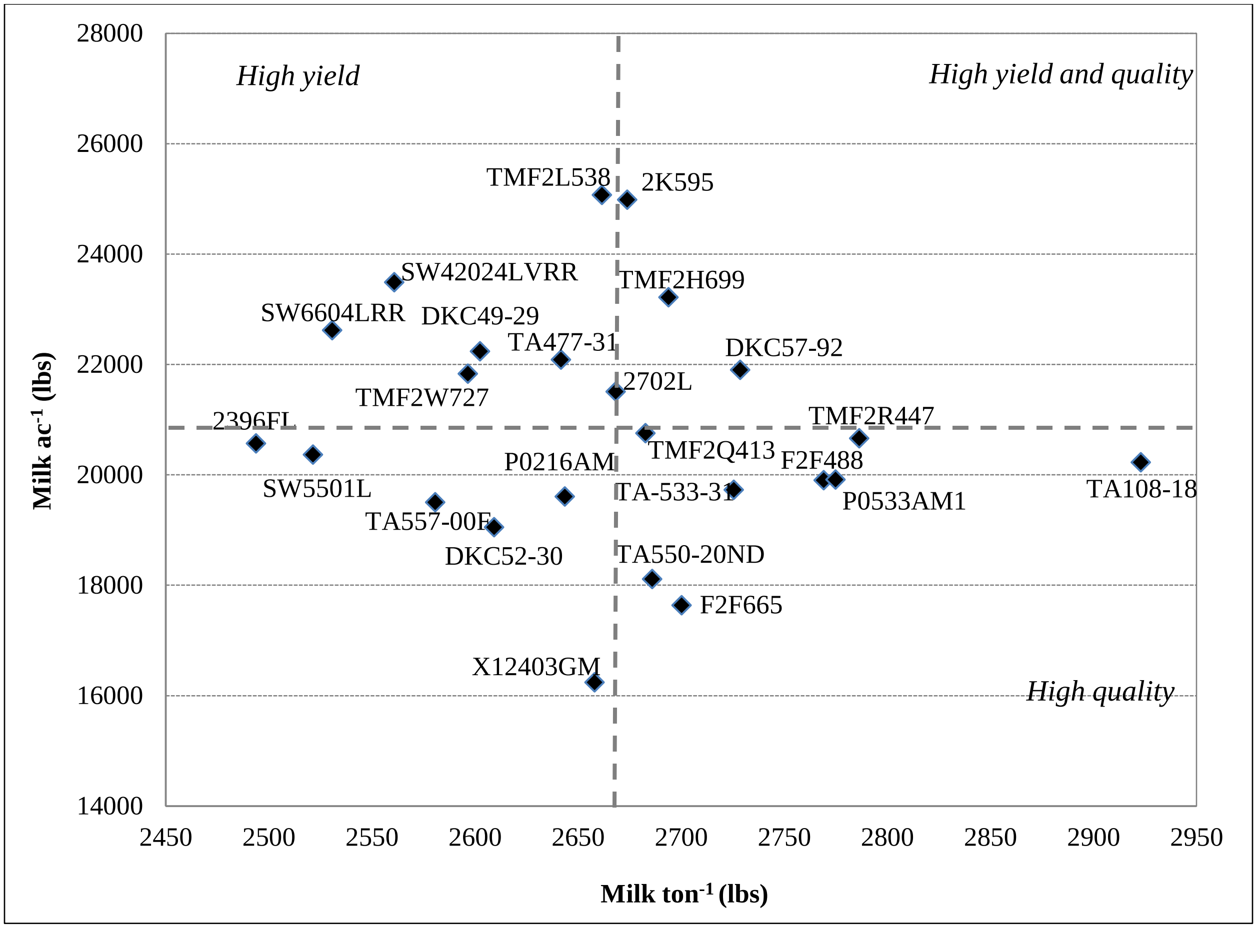

Figure 2. Milk production of 24 long season corn varieties, Alburgh, VT, 2013. Shows relationship between milk per ton and milk per acre. Dotted lines represent the mean milk per ton and milk per acre for the trial.

DISCUSSION

The average yield for this year's long season corn variety trial was 22.4 tons at 35% dry matter content. This is a competitive yield, showing that long season corn varieties, ranging in this trial from 96 days to 113, can yield well in parts of northern Vermont. This above-average yield could be due in part to the favorable 2013 growing season; once producers got through the excessively wet spring and planting season, the summer was generally average in temperature and just a bit drier than normal. This trial was planted in early May prior to the excessive rain events. This early planting provided the longer season varieties with more time to reach proper maturity prior to a killing frost. Generally, long season corn varieties tend to have more abundant yields and higher quality than short season corn, but often these varieties cannot maximize yield and quality potential due to the short growing season found in most regions of Vermont.

Forage quality differed significantly by variety in all measurements with the exception of NSC. Crude protein varied significantly by variety, with highest concentrations in TMF2R447, TA108-18, and TA550-20ND. Overall the varieties TA108-18 and TMF2R447 had the highest milk per ton. However, because of the differences in overall corn yield, the values for milk per acre did not vary significantly by variety.

It is important to note that these results, while significant, represent only one year of data at only one location. Consult additional research before making varietal selections or other agronomic decisions.

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