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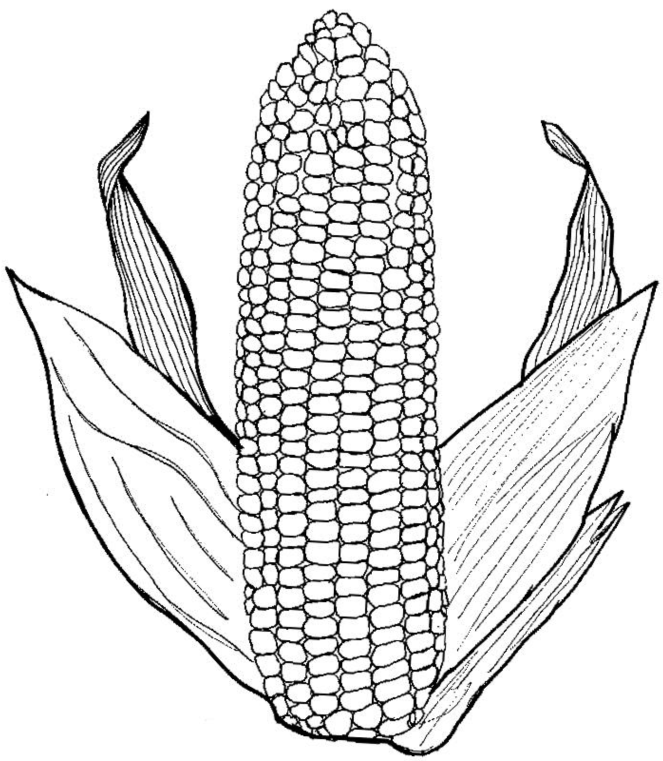
2012
Vermont Organic Corn Silage Performance Trial Results



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The UNIVERSITY of VERMONT EXTENSION

2012 VERMONT ORGANIC CORN SILAGE PERFORMANCE TRIALS

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Many organic dairies are considering corn silage production to help reduce expensive concentrate purchases. Corn silage is a good source of energy/starch for livestock. In 2012, the University of Vermont Extension Northwest Crops and Soils Program conducted organic corn silage variety trials in Alburgh and Randolph, Vermont. The purpose of these trials is to provide unbiased performance comparisons of commercially available organic silage corn varieties. It is important to remember however, that the data presented are from replicated research trials from two locations in Vermont and represent only one season. Crop performance data from different locations and over several years should be compared before making varietal selections.

MATERIALS AND METHODS

Organic corn silage performance trials were conducted at Borderview Research Farm in Alburgh, VT and Beidler Farm in Randolph, VT. All fields were certified organic by Vermont Organic Farmers, LLC. Several seed companies submitted varieties for evaluation (Table 1). Medium to late maturing corn varieties (86-105 RM) were evaluated at the Alburgh location and short season varieties (84-93 RM) at the Randolph site. Varieties in these trials ranged from 68 to 105 day relative maturity (RM). The specific varieties and their RM are listed in Table 2.

Table 1. Participating companies and local contact information.

Albert Lea Seed	American Organic
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
Blue River Hybrids Organic Seed	**Lakeview Organic Grain**
Boucher Fertilizer 2343 Gore Road Highgate Center, VT (802) 868-3939	Klaas & Mary-Howell Martens Box 361 Penn Yan, NY 14527 (315) 531-1038

The soil type for this trial is Covington silty clay loam in Alburgh and Buckland stony loam in Randolph. The previous crop in Alburgh was wheat and grass sod in Randolph. Dairy manure was spread prior to plow down at a rate of 20 tons acre^{-1} in Randolph, while 3 tons acre^{-1} of chicken manure was spread in November 2011 in Alburgh. Seedbeds were prepared by conventional tillage methods. Corn was planted at a seeding rate of 34,000 seeds per acre with a John Deere 1750 four-row corn planter on 25-May in Alburgh. The seeding rate in Randolph was 35,600 seeds acre^{-1} planted with a John Deere 7000 four-row corn planter on 12-Jun. Each plot was 5 ft. wide and 30 ft. (Alburgh) or 50 ft. (Randolph) long. The experimental design was a randomized complete block with two replications at each site. In Alburgh, plots were cultivated three times—with a tine-weeder on 15-Jun and 20-Jun and with a Brillion s-shank 4-

row cultivator in 21-Jun. Plots in Randolph were cultivated once, on 3-Jul with a belly mount 2-row cultivator.

Plant populations were measured just prior to harvest. Plots in Alburgh were harvested on 19-Sep and 2-Oct, to target whole plant moisture of 60-70%. Plots were harvested with a John Deere two-row chopper. Whole plant silage was collected in a forage wagon and weighed on drive-up platform scales. The plots in Randolph were hand-harvested on 3-Oct. Two 17.5’ row sections were harvested and weighed with a small platform scale. A subsample was chopped with a Troy-Bilt chipper-shredder and mixed thoroughly. A subsample of chopped corn was dried and analyzed for forage quality by Cumberland Valley Analytical Services, Inc. in Hagerstown, Maryland. Trial information is summarized in Table 3.

Table 2. Organic corn varieties evaluated in Alburgh and Randolph, Vermont, 2012.

Variety	Company	RM	Description	Trial Location
B915	American Organic Seed	84-86	hybrid	Randolph
2G68	American Organic Seed	85-87	hybrid	Randolph
VP3P78	American Organic Seed	85-88	hybrid	Randolph
VP3P26	American Organic Seed	87-91	hybrid	Randolph
C912	American Organic Seed	91-93	hybrid	Randolph
VP3P55	American Organic Seed	91-95	hybrid	Alburgh
C714	American Organic Seed	93-95	hybrid	Alburgh, Randolph
3G33	American Organic Seed	95	hybrid	Randolph
VP3PX98	American Organic Seed	102	hybrid	Alburgh
4G52	American Organic Seed	101-103	hybrid	Alburgh
VP4P12LFY	American Organic Seed	102-105	hybrid	Alburgh
23L99	Blue River Hybrid	86	hybrid	Alburgh, Randolph
23A71	Blue River Hybrid	86	hybrid	Alburgh, Randolph
25A16	Blue River Hybrid	87	hybrid	Alburgh, Randolph
33L90	Blue River Hybrid	93	hybrid	Alburgh
34C17	Blue River Hybrid	94	hybrid	Alburgh
Wapsie Valley	Lakeview Organic Seed	87	OP*	Alburgh, Randolph
D2901	Lakeview Organic Seed	90	hybrid	Alburgh
VO.23-86N	Viking Organic, Albert Lea	86	hybrid	Alburgh
VO.44-86N	Viking Organic, Albert Lea	87	hybrid	Alburgh, Randolph
VO.85-90N	Viking Organic, Albert Lea	90	hybrid	Alburgh
V80-92N	Viking, Albert Lea Seed	92	hybrid	Alburgh

**OP open-pollinated*

Table 3. Organic silage corn variety trial information, Alburgh and Randolph, Vermont, 2012.

Trial Information	Alburgh, VT	Randolph, VT
Soil type	silty clay loam	stony loam
Previous crop	wheat	sod
Row width (in)	30	30
Plot size	5’ x 30’	5' x 50'
Planting date	25-May	12-Jun
Row cultivation	tineweed 15-Jun tineweed 20-Jun S-shank cultivate 21-Jun	2-row cultivator 3-Jul
Seeding rate (seeds/acre)	34,000	35,600
Tillage operations	spring plow, tine-weed	spring plow, 2-row cultivator
Manure application	chicken – 3 tons ac^{-1}	dairy - 20 tons ac^{-1}
Harvest date	19-Sep and 2-Oct	3-Oct

Silage quality was analyzed using wet chemistry techniques at the Cumberland Valley Forage Laboratory. Plot samples were analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), starch, and various other nutrients. 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 total N 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. Evaluation of forages and other feedstuffs for NDF digestibility 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 NDF digestibility (dNDF). Forages with increased NDF digestibility will result in higher energy values, and perhaps more importantly, increased forage intakes. Forage NDF digestibility can range from 20–80%. Non-fiber carbohydrates (NFC) include starches, sugars, and pectins. Non-structural carbohydrates (NSC) and total digestible nutrients (TDN) are calculated variables from the measured forage analysis.

Net energy of lactation (NEL) is calculated based on concentrations of NDF and ADF. NEL 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 NEL 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 NEL at an intake of three times maintenance. Starch can also have an effect on NEL, where the greater the starch content, the higher the NEL (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, “MILK2007” 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 from corn silage that meets animal energy, protein, and fiber needs. The value is based on a standard cow weight and level of milk production. Milk per acre is calculated by multiplying milk per ton 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 exists,
3) Genetic, dietary, and environmental differences affecting feed utilization are not considered.

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 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 (LSD) at the 10% level of probability 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 in 9 out of 10 chances that there is a real difference between the two varieties. Varieties that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. In the example below, A is significantly different from C but not from B. The difference between A 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 A and C 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 asterisk indicates that B was not significantly lower than the top yielding variety.

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

RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at weather stations near each trial location are presented in Table 4. The 2012 season was warmer and drier than normal. In Alburgh, June, July, and August precipitation was 1.9 inches below normal. For the same period, precipitation in Randolph was 0.8 inches below normal. The total accumulated Growing Degree Days (GDDs) for corn growth based on a 50°-86°F temperature scale, was 2,717 days in Alburgh and 2,260 days in Randolph. For the growing season, the accumulated GDD was above average by 324 GDD in Alburgh and 326 GDD in Randolph.

Table 4. 2012 Weather data for Alburgh and Randolph, Vermont.

Alburgh, VT	May	June	July	August	September	October
Average temperature (°F)	60.5	67.0	71.4	71.1	60.8	52.4
Departure from normal	4.10	1.20	0.80	2.30	0.20	4.20
Precipitation (inches)	3.9	3.2	3.8	2.9	5.4	4.1
Departure from normal	0.5	-0.5	-0.4	-1.0	1.7	0.5
Growing Degree Days (base 50°F)	370	504	657	650	364	172
Departure from normal	102	30	17	69	46	60

Based on weather data from Davis Instruments Vantage pro2 with Weatherlink data logger. Historical averages for 30 years of NOAA data (1981-2010). Precipitation data from June-September 2012 is based on Northeast Regional Climate Center data from an observation station in Burlington, VT.

Randolph, VT	June	July	August	September	October
Average Temperature (°F)	64.6	70.9	70.5	59.8	51.5
Departure from normal	1.0	2.9	3.7	0.4	5.6
Precipitation (inches)	4.2	4.1	3.4	3.9	4.7
Departure from normal	0.1	-0.2	-0.7	0.3	0.5
Growing Degree Days (base 50°F)	445	626	627	370	192
Departure from normal	37	68	108	37	76

Based on Northeast Region Climate Center data from observation stations in Bethel, VT. Historical averages for 30 years of NOAA data (1981-2010).

Alburgh Yield and Quality

Corn populations varied significantly in Alburgh (Table 5). Two varieties, VO85-90 (Viking Organic) and VP3P55 (American Organic) had populations significantly higher than other varieties in the trial. Their populations were about 35,000 plants ac^{-1}, whereas the trial mean was about 25,000 plants ac^{-1}. The recommended final plant population for corn silage is 32,000 to 34,000 plants per acre. VO85-90 and VP3P55 exceeded this, however, the next highest population was 30,000 plants acre^{-1}, and all the other varieties in the trial had populations less than the recommended amount. Plant populations may have been partially impacted by cultivation strategies implemented at the Alburgh site. Reduced plant populations may also be a result of poor seed quality or vigor early in the season. Germination rates should be recorded in future variety trials.

Corn silage yields are reported on 35% dry matter basis (Table 5; Figure 1). The highest yielding corn variety, VP4P12LFY (American Organic), was a 102-day corn. However, the next highest yielding varieties, 33L90 (Blue River Hybrids), C714 (American Organic), and VO85-90 (Viking Organic) had relative maturities of 90-93 days and were statistically similar to the highest yielding variety. Variety 23A71 (Blue River Hybrids) had a crude protein of 10.4%, significantly higher than any other variety in the trial. The corn silage varieties were not significantly different from each other for other forage quality characteristics. Milk per acre is an indicator of forage yield and quality (milk ton^{-1} * dry matter yield acre^{-1}). Varieties that yielded the highest, also generally had the highest milk per acre values.

Table 5. Organic corn silage yield and quality, Alburgh, Vermont, 2012.

Variety	Pop plants ac^{-1}	Yield tons ac^{-1}	Forage Quality Characteristics CP %	ADF %	NDF %	dNDF %	Starch %	NEL Mcal lb^{-1}	TDN %	NFC %	NSC %	Milk per ton lbs.	Milk per acre lbs.
Vp4P12LFY	30637	**33.0***	7.7	27.9	48.4	51.8	29.1	0.735	70.5	40.1	29.5	2721	**31017***
33L90	29911	29.5*	8.6	26.6	45.5	52.1	30.1	0.740	71.0	42.4	30.9	2831	29213*
C714	30637	27.1*	7.8	26.0	43.6	55.1	33.9	0.750	72.0	44.4	34.2	2895	27465*
VO85-90N	**35284***	26.4*	8.1	26.9	45.1	53.7	31.2	0.735	70.9	42.8	31.8	2824	26260*
25A16	27733	23.1	8.2	27.6	45.9	52.2	30.4	0.740	71.1	42.2	31.5	2784	22481*
VO23-86	26426	22.0	9.3	29.3	50.8	54.3	24.3	0.715	68.7	36.0	25.2	2727	21046
4G52	21344	21.7	7.7	23.1	39.4	57.2	36.9	0.770	74.0	48.7	37.6	2996	22882*
Vp3Px98	27443	21.2	8.6	26.2	44.5	57.6	32.1	0.760	72.4	42.2	32.5	3006	22217
Vp3P55	34703*	21.0	8.0	27.9	47.4	53.4	30.9	0.740	71.0	39.9	31.0	2809	20625
VO44-86	21199	19.1	9.2	28.9	50.0	54.5	24.7	0.710	68.5	36.6	25.4	2745	18385
80-92N	24394	19.0	8.7	29.1	48.9	52.1	25.5	0.725	69.7	38.7	26.7	2793	18579
23L99	18295	18.5	9.0	27.6	47.7	53.8	27.5	0.725	69.7	39.4	28.3	2776	18120
Wapsie Valley	23813	17.2	8.8	30.6	51.8	52.2	23.4	0.710	68.2	35.2	24.2	2667	16107
23A71	15246	14.6	**10.4***	27.0	47.9	54.7	25.3	0.725	69.6	37.5	26.4	2785	20070
D2901	20618	9.0	9.4	25.1	43.0	54.8	33.0	0.750	72.1	43.3	33.5	2907	9138
Trial mean	25846	21.5	8.6	27.3	46.6	53.9	29.2	0.735	70.6	40.6	29.9	2818	21574
LSD (0.10)	4307	7.10	0.979	NS	NS	NS	NS	NS	NS	NS	NS	NS	8756

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

Figure 2 displays the relationship between milk per ton and milk per acre. The dotted lines dividing the figures into four quadrants represent the mean milk per ton and milk per acre for the location. Therefore, varieties that fall above and to the right of the lines performed above average and hybrids below or to the left of 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. The varieties C714 (American Organic), VP4P12LFY (American Organic), 33L90 (Blue River Hybrids), 25A16 (Blue River Hybrids), C714 (American Organic), and VO.85-90N (Viking Organic), and 4G52 (American Organic) all fell in the ‘High Yield and Quality’ quadrant (Figure 2).

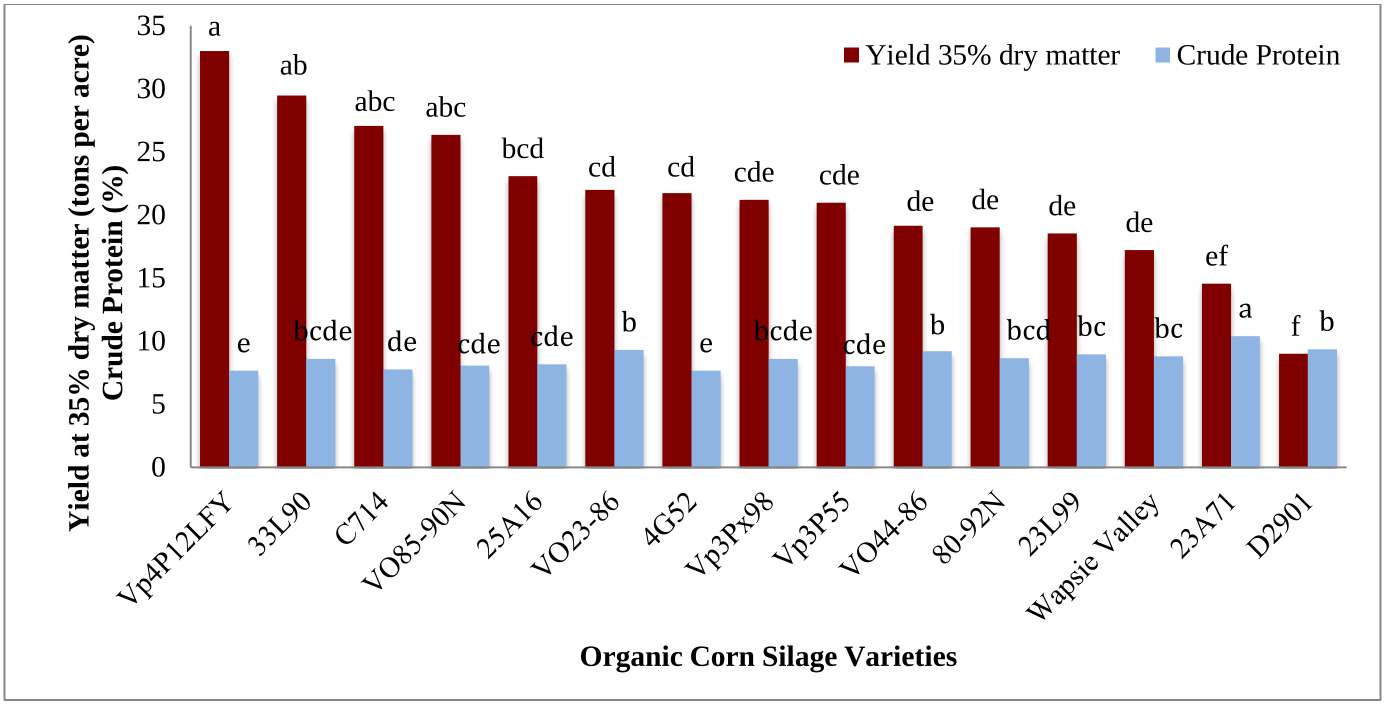

Figure 1. Yield and protein of organic corn silage varieties, Alburgh, VT, 2012. Varieties with the same letter above the bar are not significantly different from each other.

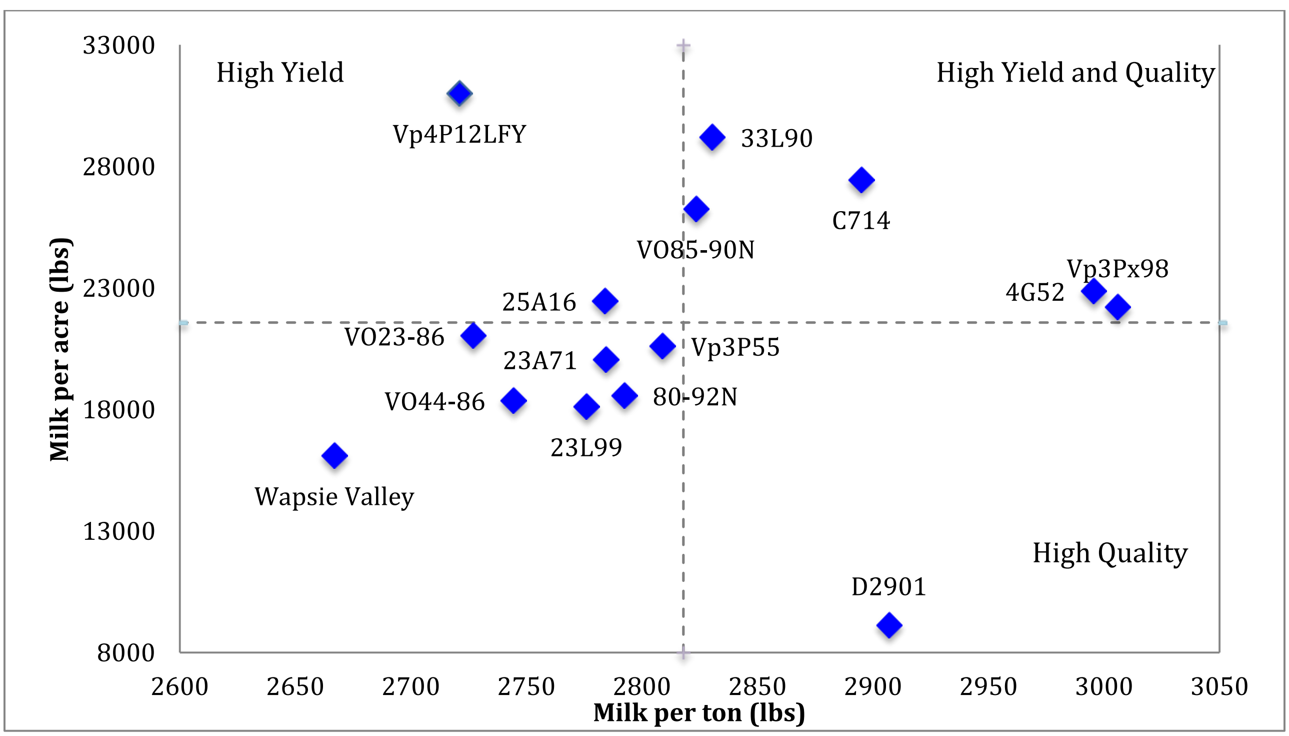

Figure 2. Milk performance of corn silage varieties, Alburgh, VT, 2012. Dotted lines indicate milk per ton and milk per acre averages.

Randolph Yield and Quality

Corn silage grown in Randolph, VT had an average population of 31,000 plants acre^{-1} and an average yield of 16.4 tons acre^{-1} (Table 6). There were no significant differences in population, yield, or quality characteristics for the corn grown in Randolph (Table 6; Figure 3). The corn was harvested outside of the optimum moisture range of 60 to 70%. The average moisture content of the trial was 76% moisture (data not shown), which may account for some of the lack of differences noted between varieties.

Table 6. Organic corn silage yield and quality, Randolph, Vermont, 2012.

	Pop	Yield	Forage Quality Characteristics									Milk per	
	plants	tons	CP	ADF	NDF	dNDF	Starch	NEL	TDN	NFC	NSC	ton	acre
Variety	ac^{-1}	ac^{-1}	%	%	%	%	%	Mcal lb^{-1}	%	%	%	lbs.	lbs.
C912	30119	22.1	8.0	28.4	47.3	51.4	29.3	0.740	70.8	41.4	31.0	2735	21207
Vp2p78	32110	18.1	7.3	30.7	49.6	52.9	28.2	0.725	69.9	39.5	29.4	2737	17267
VO44-86	35346	17.0	6.7	27.8	44.9	55.1	31.7	0.750	72.1	44.8	33.7	2898	17175
23A71	29621	17.0	7.2	28.5	46.9	53.2	31.0	0.740	71.3	42.6	32.2	2824	16829
B915	31861	16.9	7.7	29.5	48.6	52.9	29.0	0.735	70.6	40.4	30.1	2790	16560
C714	31612	16.8	7.2	29.5	48.2	53.9	29.1	0.740	71.0	41.5	30.7	2829	24842
25A16	30865	16.1	6.9	27.8	45.7	54.8	32.1	0.755	72.4	44.3	33.7	2895	16250
Vp3P26	32359	15.9	7.4	28.2	47.1	54.3	29.8	0.750	72.0	42.1	31.6	2879	16049
3G33	27878	15.6	7.0	30.4	49.9	53.1	27.2	0.730	70.1	40.0	29.0	2758	14799
23L99	28625	15.6	8.2	27.4	45.1	52.0	27.8	0.745	71.5	43.6	30.8	2819	15433
Wapsie Valley	27381	13.7	7.1	31.1	50.4	49.9	26.2	0.720	69.1	39.2	28.0	2645	12520
2G68	29372	12.1	8.0	26.7	44.6	57.0	32.2	0.750	71.9	44.0	33.8	2874	12193
Trial mean	30596	16.4	7.4	28.8	47.3	53.4	29.4	0.740	71.0	41.9	31.1	2807	16761
LSD (0.10)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS – No significant difference between treatments.

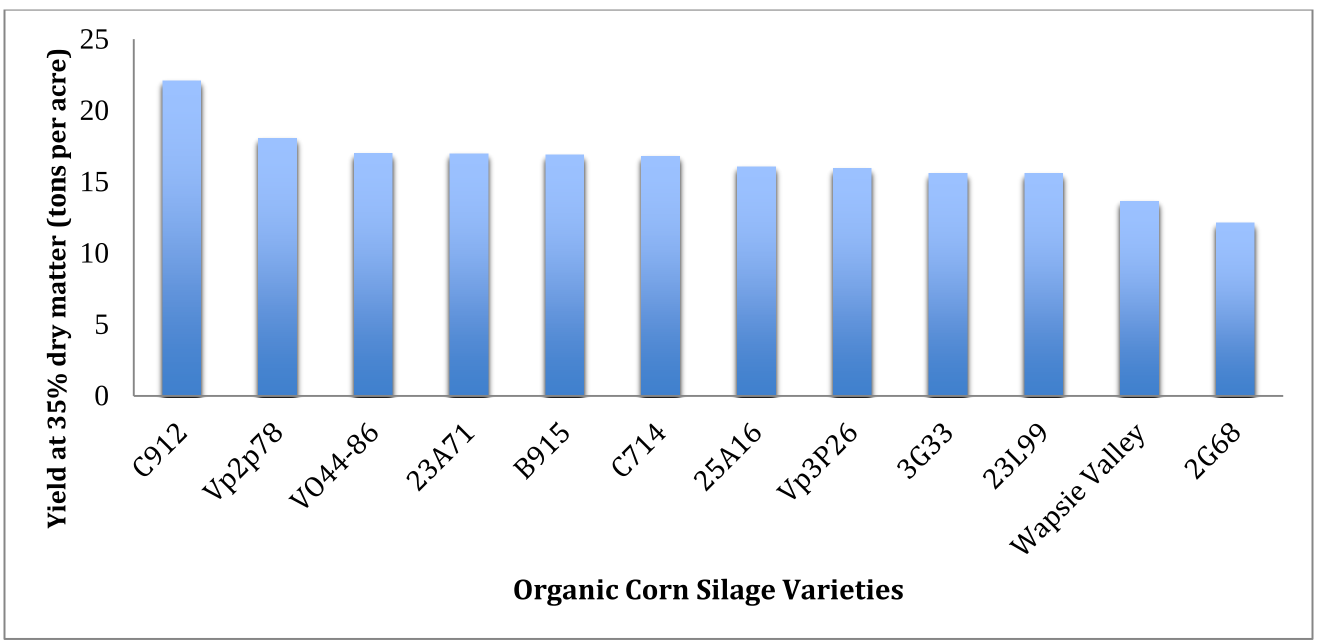

Figure 3. Yield of organic corn silage varieties, Randolph, VT, 2012. There were no significant differences between varieties.

The figures below display the relationship between milk per ton and milk per acre. The dotted lines dividing the figures into four quadrants represent the mean milk per ton and milk per acre for the location. Therefore, varieties that fall above and to the right of the lines performed above average and hybrids below or to the left of the lines performed below average. It is important to remember that varieties at the Randolph site did not differ significantly in yield or quality. 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. C714 (American Organic) was the only variety that fell in the 'High Yield and Quality' quadrant at both locations (Figure 2 and 4).

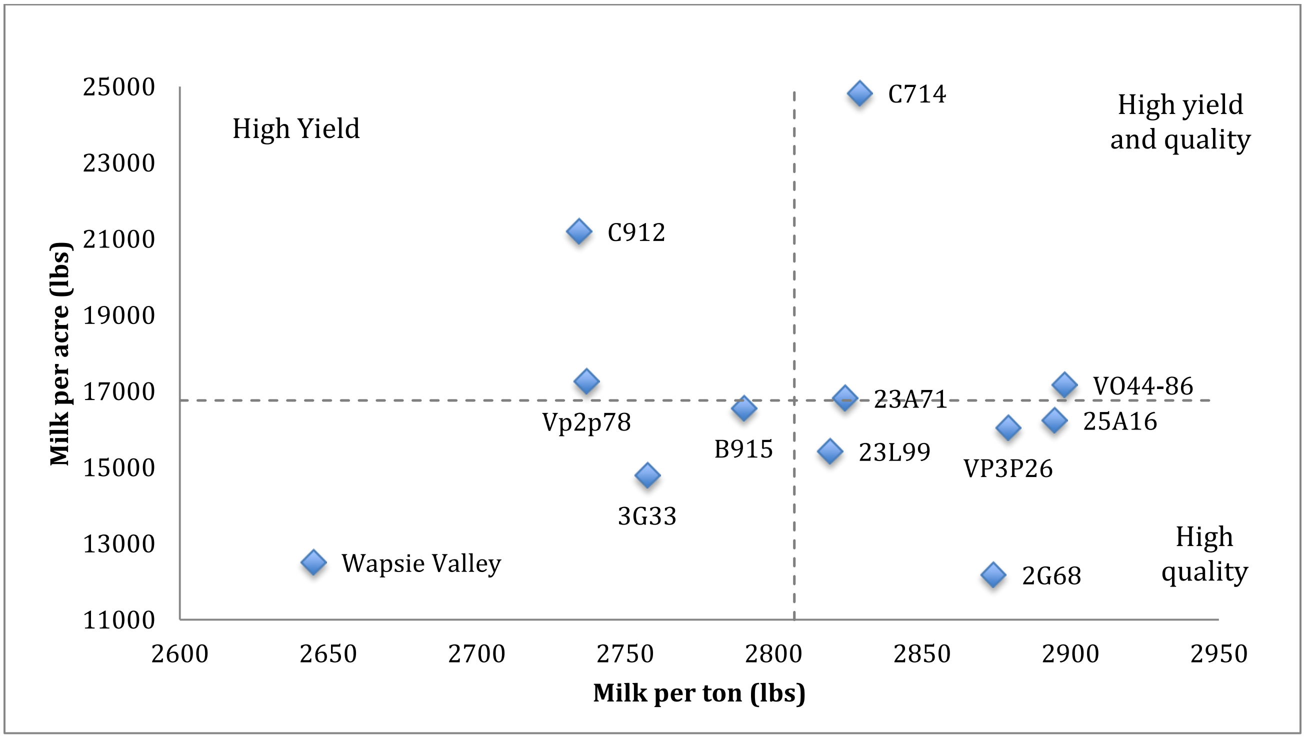

Figure 4. Milk performance of corn silage varieties, Randolph, VT, 2012. Dotted lines indicate milk per ton and milk per acre averages.

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