2017

Non-GMO Corn Silage Variety Trial

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2017 NON-GMO CORN SILAGE VARIETY TRIAL

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In 2017, the University of Vermont Extension Northwest Crops and Soils Program evaluated yield and quality of 11 non-GMO corn silage varieties in Franklin, VT. An emerging non-GMO milk market has prompted some dairy farmers to start growing non-GMO corn. To successfully convert to growing non-GMO corn, farmers are looking for more information on non-GMO varieties that are available and perform well in our region. While the information presented can begin to describe the yield and quality performance of these non-GMO 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 variety performance data before making varietal selections.

MATERIALS AND METHODS

In 2017, 11 non-GMO corn silage varieties from three seed companies (Table 1) were evaluated in Franklin, VT. The trial design was a randomized complete block with two replications. Treatments were 11 non-GMO 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 contact information.

Albert Lea Seed (Viking)	Mycogen Seeds	Seedway, LLC
1414 West Main St, PO Box 127	6383 Ethan Allen Hwy.	171 Ledgemere Point
Albert Lea, MN 56007	St. Albans, VT 05478	Bomoseen, VT 05732
800-352-5247	802-363-2803	802-338-6930

Table 2. Eleven non-GMO silage corn varieties evaluated, 2017.

Variety	Company/Brand	Relative Maturity (RM)
0.53-05UP	Viking	105
2G161	Mycogen Seeds	84
2T493	Mycogen Seeds	99
42-92GS	Viking	92
71-90GS UP	Viking	90
SW1990	Seedway, LLC.	80
SW3750	Seedway, LLC.	92
SW3760	Seedway, LLC.	94
SW4030	Seedway, LLC.	100
TMF94	Mycogen Seeds	97
TMF96Q40	Mycogen Seeds	96

The trial was planted no-till into herbicide terminated winter rye on 24-May (Table 3). UVM staff assisted with organization, planting, scouting, and harvesting of the trial. All other crop management was performed by the farmer and farm staff. Plant populations and pest scouting occurred on 17-Aug by randomly selecting a 17.5' section of each plot. In each section, the number of plants were counted and each plant was inspected for presence of foliar diseases. Foliar disease samples were taken and submitted to the UVM Plant Diagnostic Clinic (Burlington, VT) for identification confirmation. Harvested silage was captured in a wagon and weighed with a set of portable truck scales. Harvest occurred later than optimum due to an equipment breakdown. 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 sent to Dairy One (Ithaca, NY) for quality analysis using NIR procedures.

Table 3. Non-GMO corn variety trial details, Franklin, VT, 2017.

Location	Bridgeman View Farm Franklin, VT
Soil type	Peru stony fine sandy loam
Previous crop	Corn silage w/winter rye cover crop
Tillage operations	No-till
Seeding rate (viable seeds ac^{-1})	34,000
Planting equipment	John Deere 7000 no-till corn planter
Treatments (varieties)	11
Replications	2
Row width (in.)	30
Plot size (ft)	7.5 x 600
Planting date	24-May
Weed control	1.6 qt ac^{-1} Mad Dog Plus (glyphosate)
Starter fertilizer (at planting)	3,000 gal ac^{-1} liquid dairy manure prior to planting 20 gal ac^{-1} 19.6-8.4-2.8
Additional fertilizer (topdress)	100 lbs ac^{-1} urea/ammonium sulfate blend equating to 36 lbs N ac^{-1} 5-Jul
Harvest date	19-Oct

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 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 for the location nearest the trial site, West Berkshire, VT, was collected from a Ambient Weather WS-1001-WIFI wireless remote monitoring weather station accessed through Weather Underground (http://www.wunderground.com) (Table 4). In general, temperatures were slightly below normal through the summer and above normal in the fall while accumulated precipitation followed the opposite trend. June was exceptionally rainy with almost 8 inches of rain falling that month, over 3.5 inches above the normal. These poor weather conditions are also reflected in the below normal accumulated Growing Degree Days (GDDs) through the summer and above normal accumulation in the fall months. In total there were 2454 GDDs accumulated at a base temperature of 50°F, 152 above normal. Despite the poor beginning to the season, the abnormally warm and dry fall allowed for the necessary accumulation of GDDs and provided good weather for corn, especially later maturity varieties, to reach maturity.

Table 4. Weather data for West Berkshire, VT, 2017.

West Berkshire, VT	May	Jun	Jul	Aug	Sept	Oct
Average temperature (°F)	54.4	63.7	68.1	66.3	64.0	57.0
Departure from normal	-1.60	-0.90	-0.90	-0.80	4.40	8.90
Precipitation (inches)	4.02	7.96	5.20	4.11	1.54	2.88
Departure from normal	0.14	3.77	0.68	-0.60	-2.27	-1.31
Growing Degree Days (50-86°F)	231	426	564	509	444	280
Departure from normal	-59	-13	-25	-20	124	145

Based on weather data collected from http://www.wunderground.com via a weather station in West Berkshire, VT .
When daily weather data was unavailable for this station, data was used from the Highgate Center Dam station.
Historical averages are for 30 years of NOAA data (1981-2010) from Enosburg Falls, VT.

Varieties did not differ significantly in yield (Table 5). Yields ranged from 14.3 to 25.8 tons ac^{-1} with a trial average of 20.5 tons ac^{-1} (Figure 1). Although yields varied quite considerably, they were not statistically significantly different likely due to variation within treatments and small number of replications. Plant populations averaged 29,820 plants ac^{-1} which is below the target population of 32,000-34,000 plants ac^{-1}. Cool and wet weather following planting may have contributed to suboptimal populations. Moisture content at harvest varied significantly by variety. Moistures ranged from 39.0% to 56.8% with an average of 47.8%. None of the varieties were harvested at the target 65% moisture for corn silage. Harvest was delayed due to extenuating circumstances on the participating farm which resulted in the corn being drier than optimum at harvest. Several killing frosts also contributed to the low moisture at harvest

Table 5. Harvest data for 11 non-GMO corn varieties, 2017.

Variety	**RM**	**Plant Populations** plants ac^{-1}	**Harvest moisture** %	**Yield 35% DM** tons ac^{-1}
0.53-05UP	105	21904	54.3	20.4
2G161	84	30368	41.2*	15.8
2T493	99	31363	51.1	**25.8**
42-92GS	92	**33852**	45.4	14.3
71-90GS UP	90	29870	**39.0***	17.4
SW1990	80	30368	41.0*	20.1
SW3750	92	29870	39.7*	19.3
SW3760	94	28210	55.4	25.1
SW4030	100	33355	56.8	22.1
TMF94	97	29870	51.9	21.6
TMF96Q40	96	27878	49.7	23.5
LSD (p = 0.10)	N/A	N/A	5.2	NS
Trial mean	94	29820	47.8	20.5

*Varieties with an asterisk are not significantly different than the top performer in **bold**.
N/A - statistical analysis was not performed for the variable.
NS - no significant difference.

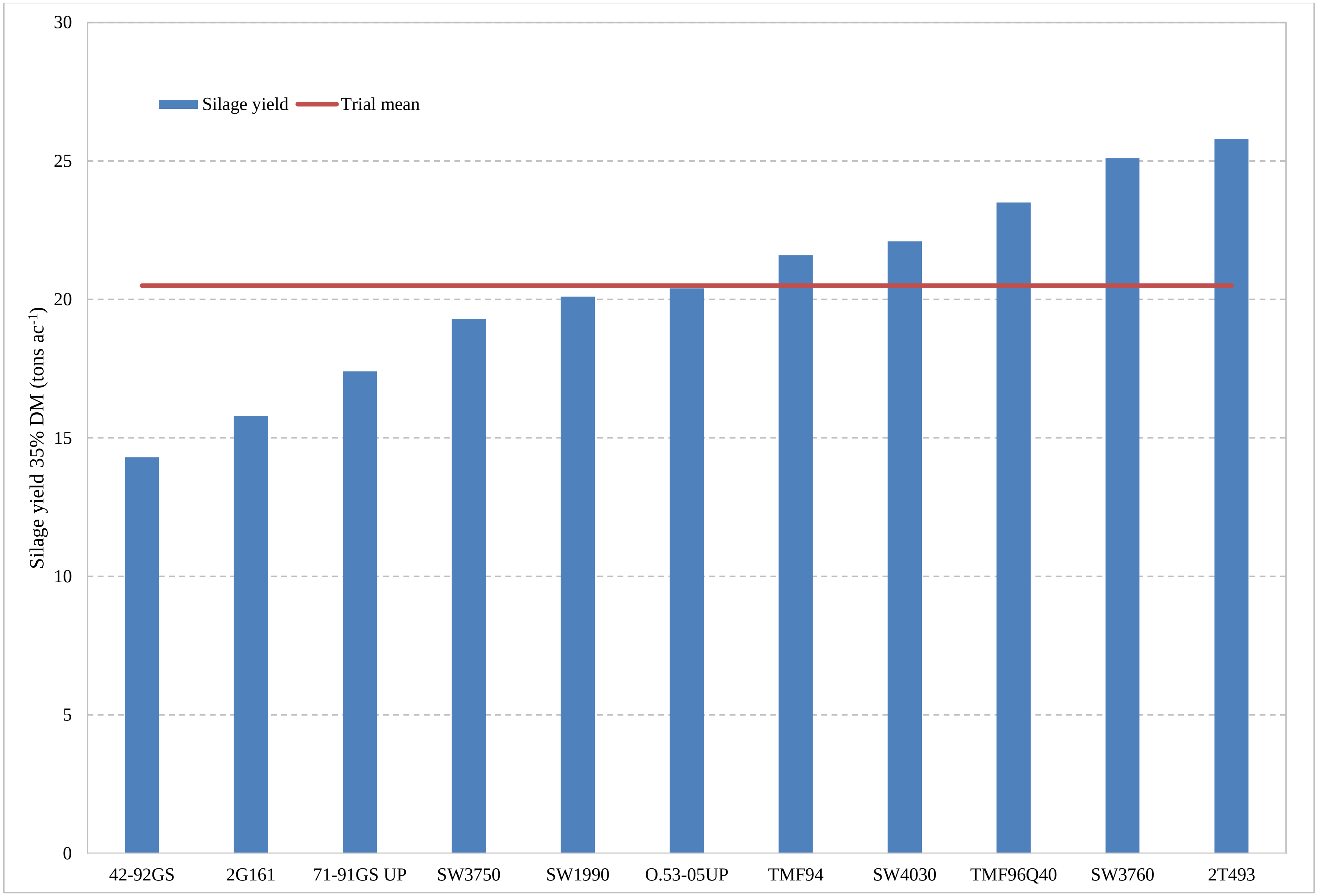

Figure 1. Yields of 11 non-GMO corn silage varieties, 2017.

Varieties did not perform statistically different from one another.

Corn silage quality characteristics varied statistically across varieties (Table 6). Crude protein averaged 7.0% with the highest level of 7.7% produced by variety 0.53-05UP which was statistically similar to six other varieties. The ADF and NDF concentrations were lowest in the variety 2G161 at 21.9% and 41.1% respectively. This ADF concentration was statistically similar to seven other varieties while NDF did not vary significantly. NDF digestibility also varied significantly by variety with the highest level of 55.5% produced by variety SW4030, although statistically similar to six other varieties. All varieties except for three performed similarly to the top performer (2G161) for NE_L and milk lbs ton^{-1}. All varieties, except for variety 42-92GS, had statistically similar milk yields per acre as the top performer, SW3760.

Table 6. Corn silage quality characteristics of 11 non-GMO corn varieties, Franklin, VT, 2017.

Variety	Crude Protein	ADF	NDF	Lignin	NFC	Starch	TDN	30 hr NDFD	NEL	Milk	
				% DM				% NDF	Mcal lb^{-1}	lbs ton^{-1}	lbs ac^{-1}
0.53-05UP	**7.7***	23.9*	42.3	3.2	44.4	36.6	72.0	48.0	0.74*	3003	21398*
2G161	6.7	**21.9***	**41.1**	2.8*	**46.9**	38.1	**76.0***	53.5*	**0.79***	**3281***	18110*
2T493	7.1*	25.1*	44.3	3.1*	42.1	35.2	70.5	47.5	0.73	2925	26291*
42-92GS	6.6	21.9*	41.4	**2.6***	46.8	**38.7**	75.0*	52.0*	0.77*	3185*	15897
71-90GS UP	7.3*	25.5	45.9	3.4	42.0	35.1	73.0*	53.0*	0.74*	3103*	18883*
SW1990	6.9	24.3*	43.4	3.3	43.3	36.1	72.0	49.0	0.74*	3003	20905*
SW3750	7.0*	26.6	46.0	3.7	41.7	36.2	70.5	48.0	0.72	2936	19775*
SW3760	7.3*	23.2*	41.2	3.1*	45.9	36.8	75.5*	54.5*	0.79*	3242*	**28456***
SW4030	7.2*	24.7*	44.1	3.2*	42.8	34.0	74.5*	**55.5***	0.77*	3182*	24582*
TMF94	6.9	22.5*	43.3	2.9*	44.4	36.0	75.0*	55.0*	0.78*	3214*	24322*
TMF96Q40	7.0*	25.7	46.0	3.0*	41.6	33.0	72.0	52.5*	0.73	3018	24470*
LSD (0.10)	0.8	3.6	NS	0.6	NS	NS	3.8	4.5	0.06	229	12068
Trial mean	7.0	24.1	43.5	3.1	43.8	36.0	73.3	51.7	0.75	3099	22099

*Varieties with an asterisk are not significantly different than the top performer in **bold**.
NS – no significant difference.

Figure 2 below displays the projected milk production, in lbs ton^{-1} and lbs ac^{-1} of the corn silage varieties evaluated in this project. 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). Using this figure, eight of the 11 varieties trialed produced high yield or quality while three of these eight produced both high yield **and** quality. Three of the 11 varieties produced below average yield and quality. Additional research is needed to determine the yield and quality potential of these varieties in Vermont. Furthermore, there are additional performance characteristics that may be of interest to non-GMO farmers which we were unable to consider in this trial.

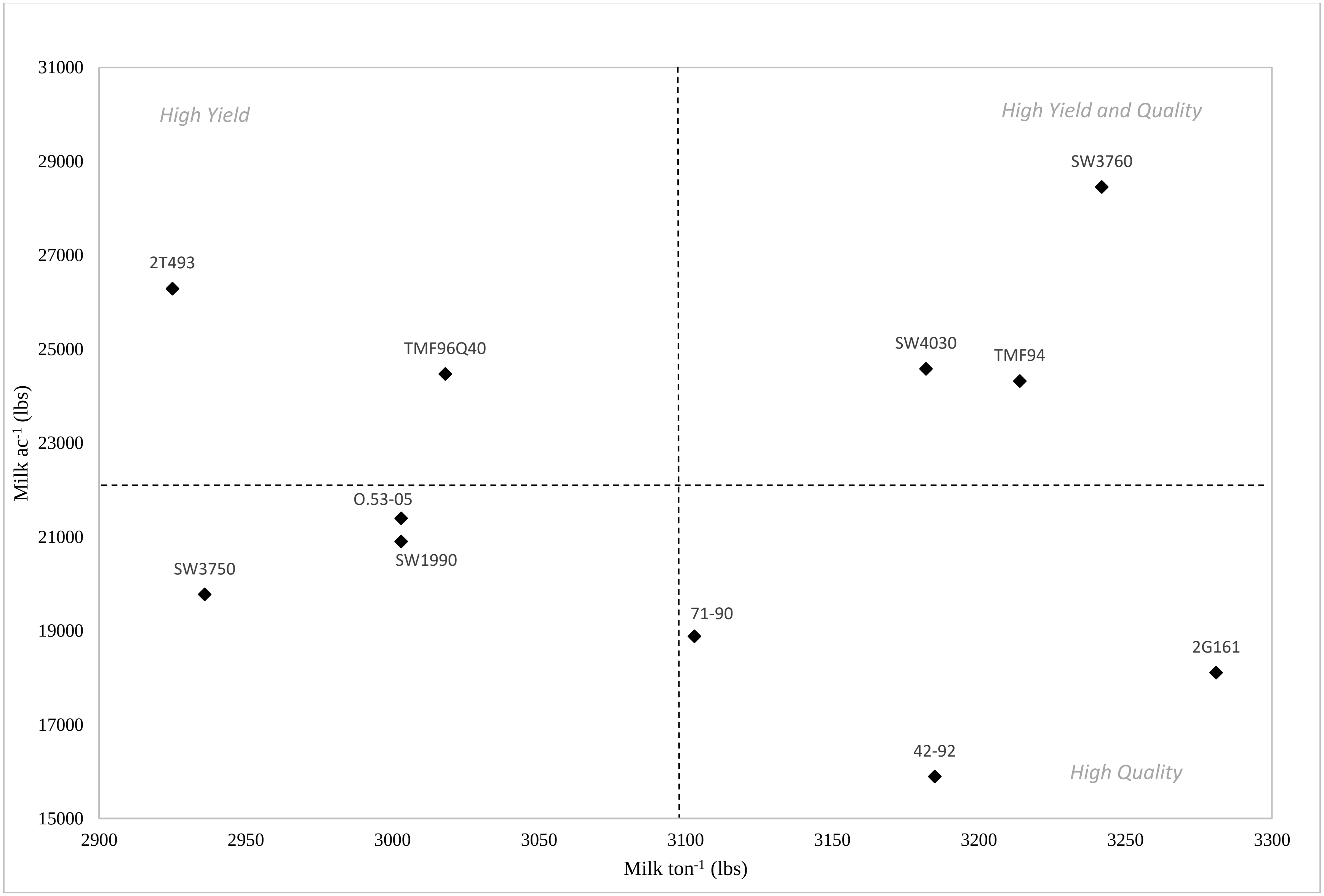

Figure 2. Milk production of 11 non-GMO corn varieties, Franklin, VT, 2017. *Shows relationship between milk per ton and milk per acre. Dotted lines represent the mean milk per ton and milk per acre for the trial.*

The trial was scouted for foliar diseases on 17-Aug. Table 7 below summarizes the diseases that were present in the field at the time of scouting and the calculated percentage of the total corn population for that variety that was infected with each variety. The most common diseases seen throughout the trial were Frogeye leaf spot and Anthracnose. Three varieties, 2G161, SW2T493, and 71-90GS UP, had at least 25% infection of both of these diseases. However, statistical analyses were not completed for disease infection. Furthermore, infection rate does not capture potential differences in severity of the infections. More information is needed to determine the potential differences in disease susceptibility and the impacts of on corn silage yield and quality. Images 1-4 below show samples of the foliar diseases.

Table 7. Corn foliar disease infection rates, 2017.

Variety	Frogeye leaf spot	Northern corn leaf blight	Anthracnose	Common rust
		% of plants infected		
O.53-05UP	63.6	0.00	18.2	9.1
2G161	27.1	0.00	38.3	8.14
2T493	36.1	16.5	18.1	0.00
42-92GS	36.1	0.00	25.6	1.47
71-90GS UP	60.3	4.55	18.7	11.1
SW1990	23.7	1.47	41.3	28.2
SW3750	19.0	3.70	34.0	3.70
SW3760	14.3	7.14	50.0	0.00
SW4030	83.3	13.3	30.0	0.00
TMF94	50.0	5.90	23.5	0.00
TMF96Q40	63.6	0.00	18.2	9.10
Trial mean	33.2	4.3	30.7	8.4


Image 1. Common rust


Image 2. Anthracnose


Image 3. Frogeye leaf spot


Image 4. Northern corn leaf blight

DISCUSSION

Corn silage yield and quality varied across the 11 non-GMO corn varieties evaluated in this trial. Performing this trial on-farm presented limitations for the number of replications possible, which consequently limits the ability for robust statistical analyses. However, these data demonstrate the variability that can be observed across varieties and thus, the importance of careful varietal selection based on information generated from our region. It is also important to remember that these data only reflect one site and season and therefore, more information should be considered before management decisions are made.

ACKNOWLEDGEMENTS

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