University of Vermont
UVM ScholarWorks

Northwest Crops & Soils Program | UVM Extension

2018

Organic Winter Malting Barley Variety Trial

Heather Darby
University of Vermont

Haley Jean
University of Vermont

Hillary Emick
University of Vermont

Follow this and additional works at: https://scholarworks.uvm.edu/nwcsp

 Part of the Agricultural Economics Commons

Recommended Citation

Darby, Heather; Jean, Haley; and Emick, Hillary, "Organic Winter Malting Barley Variety Trial" (2018). *Northwest Crops & Soils Program*. 307.
https://scholarworks.uvm.edu/nwcsp/307

This Report is brought to you for free and open access by the UVM Extension at UVM ScholarWorks. It has been accepted for inclusion in Northwest Crops & Soils Program by an authorized administrator of UVM ScholarWorks. For more information, please contact scholarworks@uvm.edu.

NORTHWEST CROPS & SOILS PROGRAM

2018 Organic Winter Malting Barley Variety Trial

Dr. Heather Darby, UVM Extension Agronomist
Haley Jean and Hillary Emick
UVM Extension Crops and Soils Coordinators
802-524-6501

Visit us on the web: http://www.uvm.edu/nwcrops

© *January 2019, University of Vermont Extension*

THE UNIVERSITY OF VERMONT EXTENSION

2018 ORGANIC WINTER MALTING BARLEY VARIETY TRIAL

Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

The revival of the small grains industry in the Northeast and the strength of the locavore movement, craft breweries and distilleries have expressed an interest in sourcing local barley for malting. Malting barley must meet specific quality characteristics such as low protein content and high germination. Depending on the variety, barley can be planted in either the spring or fall, and both two- and six-row barley can be used for malting. In the fall of 2017, a winter malting barley trial was conducted to evaluate yield and quality of 27 varieties. This same malting barley variety trial was conducted in 2018 with 27 varieties. Varieties that have not performed well in previous years of this trial have been excluded from the 2018 trial and new varieties have been tested.

MATERIALS AND METHODS

In the fall of 2017, a winter malting barley variety trial was established at Borderview Research Farm in Alburgh, VT. The experimental plot design was a randomized complete block with three replications. The treatments were 27 winter malting barley varieties, listed in Table 1.

Table 1. Varietal information for the 27 winter malting barley varieties, 2017-2018.

Winter barley variety	Type	Seed source
Charles	2-row	USDA-ARS
McGregor	6-row	2016 Saved seed
Thoroughbred	6-row	2016 Saved seed
Endeavor	2-row	USDA-ARS
Wintmalt	2-row	2016 Saved seed
LGGB13-W102	6-row	Limagrain Cereal Seeds
05ARS561-208	2-row	USDA-ARS
06ARS633-3	2-row	USDA-ARS
07ARS515-7	2-row	USDA-ARS
07ARS518-13	2-row	USDA-ARS
DH120304	2-row	Oregon State University
DH130939	2-row	Oregon State University
DH140088	2-row	Oregon State University
DH130910	2-row	Oregon State University
MW12_4028-007	6-row	University of Minnesota
MW12_4007-001	6-row	University of Minnesota
MW13_4122-012	6-row	University of Minnesota
MW13_4107-010	6-row	University of Minnesota
2WI5-8688	2-row	Busch Agriculture Resource
2WI5-8674	2-row	Busch Agriculture Resource
2WI5-8775	2-row	Busch Agriculture Resource
Flavia	2-row	Kilian Hundsrucker
SU-Mateo	2-row	Kilian Hundsrucker
AC09/327/2 (Lyberac)	2-row	Kilian Hundsrucker
AC11/341/28	2-row	Kilian Hundsrucker
AC11/367/2	6-row	Kilian Hundsrucker
Hirondella	6-row	Kilian Hundsrucker

All plots were managed with practices similar to those used by producers in the surrounding area (Table 2). The previous crop planted on this site was spring barley. The trial area was plowed, disked, and spike toothed harrowed before planting in September 2017. The plots were seeded with a Great Plains NT60 Cone Seeder on 21-Sep 2017 with a seeding rate of 160 lbs ac^{-1} into Benson rocky silt loam. Plot size was 5' x 20'.

Table 2. General plot management, 2017-2018.

Trial information	Alburgh, VT Borderview Research Farm
Soil type	Benson rocky silt loam
Previous crop	Spring Barley
Tillage operations	Fall plow, disk & spike tooth harrow
Seeding Rates (lbs ac^{-1})	160
Row spacing (in)	6
Replicates	3
Planting date	21-Sep 2017
Plot size (ft)	5 x 20
Harvest date	12-Jul 2018

Flowering dates were recorded when at least 50% of the plot was in bloom. A visual assessment of population, survival, vigor, and bird damage was recorded. Population was measured in both fall 2017 and spring 2018 to establish the survival rate of each plot. To determine population, the number of plants in two twelve inch sections of a row were recorded. On 20-Jun 2018, plots were scouted for bird damage. Bird damage was assessed by visually determining what percentage birds had affected.

Barley heights and lodging were measured right before harvest. The height of three plants were measured, excluding awns. Lodging was measured visually on a scale of 0 to 5, 0 indicating no lodging, 1 indicating minimal lodging, and 5 indicating completely lodged and cannot be harvested. All plots were harvested on 12-Jul using an Almaco SPC50 small plot combine. Winter barley was cleaned with a small Clipper cleaner (A.T. Ferrell, Bluffon, IN). After cleaning grains, harvest moistures, test weight, and yield were calculated. Harvest moisture and test weight was measured using a Dicky-john mini GAC moisture and test weight meter (Auburn, IL).

A one-pound subsample was collected to determine quality. Quality measures included crude protein, flour moisture, falling number, germination energy, plumpness and thins, and deoxynivalenol (DON) concentration. Percent germination (germination energy) was determined by incubating 100 seeds in 4.0 ml of water for 72 hours and counting the number of seeds that did not germinate. Each sample was completed in duplicate. Grain assortment or plumpness was determined using the Pfeuffer Sortimat (Kitzingen, Germany) using 100g of clean seed, and was determined by combining the amount of seed remaining on the 2.78mm and 2.38mm sieves. Once germination and plumpness was determined, the samples were then ground into flour using the Perten LM3100 Laboratory Mill, and were evaluated for crude protein content using the Perten Inframatic 8600 Flour Analyzer. In addition, falling number for all barley varieties were determined using the AACC Method 56-81B, AACC Intl., 2000 on a Perten FN

1500 Falling Number Machine. The falling number is related to the level of sprout damage that has occurred in the grain. It is measured by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of the tube. Deoxynivalenol (DON) concentration was analyzed using Veratox DON 5/5 Quantitative test from the NEOGEN Corp. This test has a detection range of 0.5 to 5 ppm. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption. The DON concentrations were measured on the first replicate of the experiment. If high DON concentrations were detected, additional replicates were analyzed.

All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate cultivar means when the F-test was 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 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 (e.g. yield). Least Significant Differences 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. In the example below, variety A is significantly different from variety C, but not from variety B. The difference between A and B is equal to 725, which is less than the LSD value of 889. This means that these varieties did not differ in yield. The difference between A and C is equal to 1454, which is greater than the LSD value of 889. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that variety B was not significantly lower than the top yielding variety.

Variety	Yield
A	3161
B	3886*
C	**4615***
LSD	889

RESULTS

The fall of 2017 was warmer than the 30-year average. In 2018, April was colder than the average year but May and July where both 3 degrees above the normal temperature. There were 5.22 inches less precipitation than the average year and hence, 2018 was considered an extremely dry growing season. Over the course of the 2017-2018 growing season, there was 5452 Growing Degree Days (GDDs) which was 554 GDDs above the 30-year average. Seasonal precipitation and temperature recorded at weather station in Alburgh, VT to the 2017-2018 site are shown in Table 3.

Table 3. Seasonal weather data collected in Alburgh, VT, 2017 and 2018.

Alburgh, VT	Sep-17	Oct-17	Nov-17	Mar-18	Apr-18	May-18	Jun-18	Jul-18
Average Temperature (°F)	64.4	57.4	35.2	30.4	39.2	59.5	64.4	74.1
Departure from normal	3.76	9.16	-2.96	-0.66	-5.58	3.10	-1.38	3.51
Precipitation (inches)	1.8	3.3	2.3	1.5	4.4	1.9	3.7	2.4
Departure from normal	-1.80	-0.31	-0.84	-0.70	1.61	-1.51	0.05	-1.72
Growing Degree Days (base 32°F)	971	786	202	90	272	853	973	1305
Departure from normal	113	284	17	90	-112	97	-42	107

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.

Most varieties bloomed (50% or more of the total plot) by the last week of May. The latest flowering varieties was 05ARS561-208, which flowered 4-Jun. (Table 4). There were significant differences among varieties for plant height, lodging, and bird damage. The tallest variety was MW134122-012 (78.9 cm) and eight other varieties were significantly similar. These varieties included Su Mateo (76.6 cm), DH130910 (75.4 cm), Thoroughbred (74.9 cm), MW124007-001 (74.4 cm), McGregor (73.3 cm), Endeavor (73.4 cm), Hirondella (72.0 cm), and AC09/327/3 (Lyberac) (71.8 cm). MW124028-007 was the shortest variety at 60.8 cm tall. Only two varieties had any signs of lodging, MW124028-007 that was a 4 on a scale of 0-5. The only other variety with any signs of lodging is MW124007-001 but as only a 2 on the 0-5 scale. There were six varieties that did not have any bird damage; MW124007-001, Thoroughbred, McGregor, MW124028-007, Hirondella, and AC11/341/28. The variety with the highest bird damage was 07ARS518-13 with an average 48.3% damage.

Table 4. 2018 spring barley agronomic characteristics in Alburgh, VT.

Variety	Flowering date	Plant height	Lodging	Bird damage
	date	cm	rating 0-5‡	%
2W15-8674	29-May	65.7	0	13.3*
2W15-8688	30-May	70.8	0	33.3
2W15-8775	29-May	68.4	0	18.0*
AC09/327/3 (Lyberac)	30-May	71.8*	0	14.0*
AC11/367/2	29-May	71.3	0	18.0*
AC11/341/28	29-May	65.6	0	**0.00***
07ARS518-13	1-Jun	66.2	0	48.3
05ARS561-208	4-Jun	63.2	0	28.3
06ARS617-25	30-May	68.0	0	11.7*
07ARS515-7	27-May	69.7	0	5.70*
Charles	29-May	62.6	0	15.0*
DH120304	29-May	66.4	0	13.3*
DH130910	29-May	75.4*	0	28.3
DH130939	27-May	67.2	0	3.30*
DH140088	26-May	70.1	0	1.70*
Endeavor	29-May	72.4*	0	28.3
Flavia	27-May	65.3	0	9.00*
Hirondella	27-May	72.0*	0	**0.00***
LGGB13-W102	29-May	68.9	0	1.30*
McGregor	29-May	73.3*	0	**0.00***
MW124007-001	27-May	74.4*	2	**0.00***
MW124028-007	29-May	60.8	**4***	**0.00***
MW134159-012	27-May	68.2	0	0.70*
MW134122-012	30-May	**78.9***	0	1.30*
Su Mateo	30-May	76.6*	0	35.0
Thoroughbred	26-May	74.9*	0	**0.00***
Wintmalt	28-May	67.8	0	5.70*
LSD (0.10)	N/A	7.54	0.53	22.2
Trial Mean	N/A	69.5	0.20	12.4

*Varieties with an asterisk are not significantly different from the top performer in **bold**.
‡Lodging was rated on a 0 to 5 scale, where 0 indicated no lodging and 5 indicated 100% lodging with no ability to harvest.
N/A - no statistical analysis performed for this variable.

Winter Barley Yield and Quality:

Varieties differed significantly in harvest moisture, test weight, and yield. The variety AC11/341/28 (11.6% moisture) had the lowest harvest moisture and 07ARS518-13 (20.9% moisture) had the highest moisture. The ideal harvest and storage moisture is 14% or below, only eleven of the twenty-seven had a moisture of 14% or below. The variety with the highest test weight was DH130939 (51.6 lbs/bu). The desired barley test weight is 48 lbs per bushel. There are eight other varieties with the desired test weight

including: AC09/327/3 (Lyberac) (50.0 lbs/bu), 07ARS515-7 (49.6 lbs/bu), DH130910 (50.1 lbs/bu), Endeavor (48.4 lbs/bu), Flavia (50.7 lbs/bu), LGGB13-W102 (48.5 lbs/bu), Su Mateo (48.0 lbs/bu), and Thoroughbred (49.6 lbs/bu). The highest yielding variety was Hirondella (3887 lbs/ac) and the lowest yielding variety was 07ARS518-13 (904 lbs/ac). Other high yielding varieties included AC11/341/28 (3769 lbs/ac), 07ARS515-7 (3290 lbs/ac), LGGB13-W102 (3876 lbs/ac), McGregor (3548 lbs/ac), and MW134122-012 (3782 lbs/ac).

Table 5. 2018 spring barley agronomic characteristics in Alburgh, VT.

Variety	Harvest moisture	Test weight	Yield @ 13.5% moisture
	%	lbs/bu	lbs/acre
2W15-8674	14.5*	42.0	1908
2W15-8688	15.7	43.3	2053
2W15-8775	15.3*	47.2	2370
AC09/327/3 (Lyberac)	14.5*	50.0*	2799
AC11/367/2	14.7*	46.5	2457
AC11/341/28	**11.6***	41.7	3769*
07ARS518-13	20.9	39.8	904
05ARS561-208	18.1	40.6	1551
06ARS617-25	18.9	44.6	1531
07ARS515-7	13.6*	49.6*	3290*
Charles	14.9*	42.0	1928
DH120304	15.0*	47.2	1454
DH130910	14.6*	50.1*	2459
DH130939	14.6*	**51.6***	1986
DH140088	15.4*	46.1	2019
Endeavor	19.9	48.4*	1915
Flavia	13.4*	50.7*	2837
Hirondella	12.3*	46.7	**3887***
LGGB13-W102	12.4*	48.5*	3876*
McGregor	11.6*	42.6	3548*
MW124007-001	12.9*	45.6	2257
MW124028-007	12.1*	44.9	2154
MW134159-012	12.5*	47.6	2266
MW134122-012	13.0*	45.0	3782*
Su Mateo	14.7*	48.0*	2738
Thoroughbred	12.4*	49.6*	3053
Wintmalt	15.8	47.4	2302
LSD (0.10)	3.91	4.05	778
Trial Mean	14.6	41.2	2485

*Varieties with an asterisk are not significantly different from the top performer in **bold**.
(-) no statistical analysis performed for this variable.

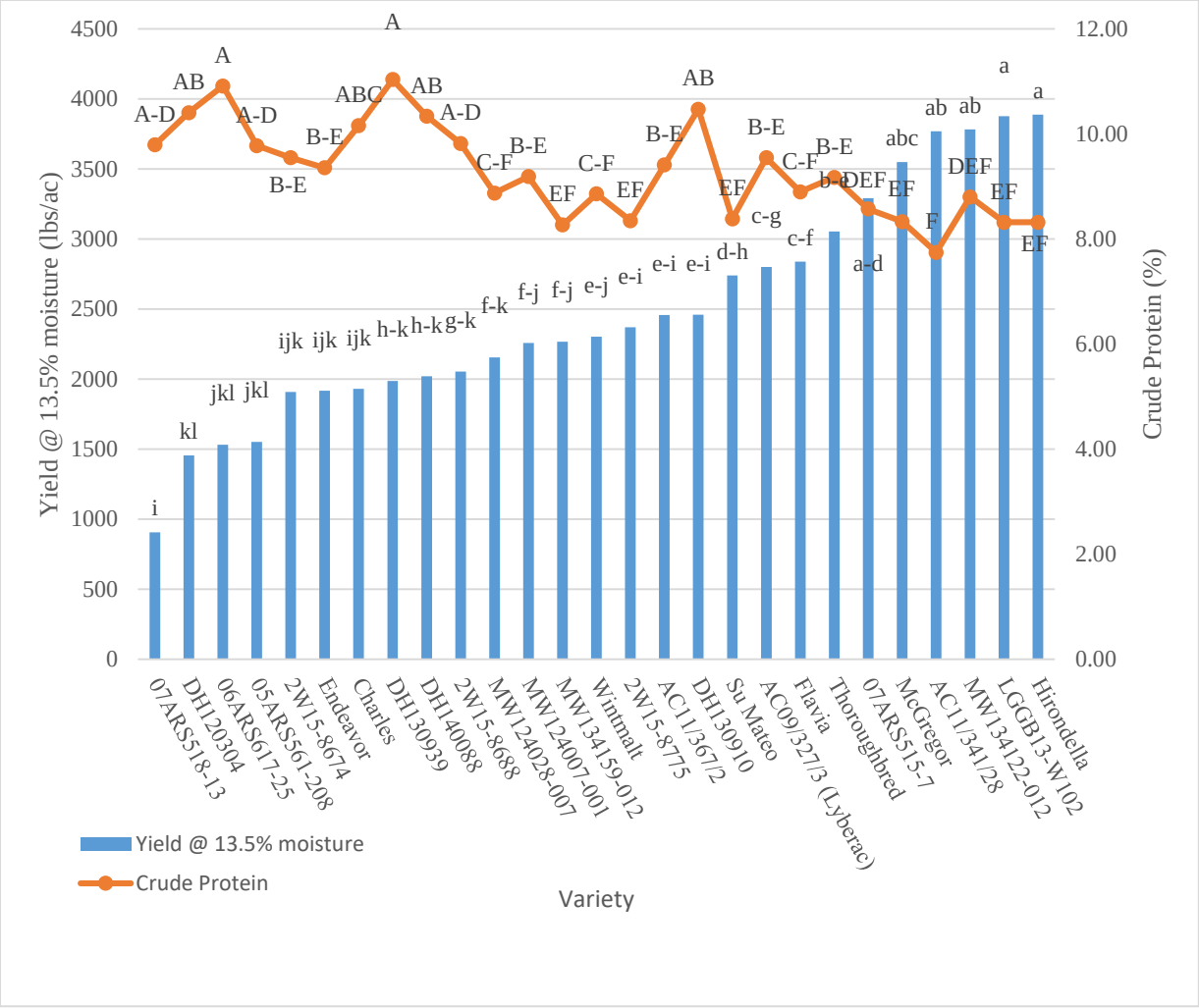

Figure 1. Yield and protein concentrations of twenty-seven winter barley varieties, Alburgh, VT, 2018. Varieties with the same letter did not differ significantly.

There were significant differences among crude protein, falling number, germination energy grain plumpness and thins. The industry standard for germination energy is 95% and all but two of the varieties meet this standard. DH130910 (93%) and 05ARS561-208 (85%) were both below the desired 95%. The variety with the plumpest kernel size was LGGB13-W102 (98.5%) and the smallest kernel size was 05ARS561-208 (83.9%) but all varieties are above the industry standard of 80% for 6-row and 70% for 2-row. The variety 05ARS561-208 had the highest falling number of 477 seconds and the variety MW124028-007 (435 seconds) was statistically similar. The variety with the lowest falling number was DH130939 (284 seconds). The variety DH130939 had the highest crude protein at 10.8%. Other varieties that have high crude proteins were 06ARS617-25 (10.7%), 2W15-8688 (9.59%), 07ARS518-13 (9.57%), 05ARS561-208 (9.55%), Charles (9.92%), DH120304 (10.2%), DH130910 (10.2%), and DH140088 (10.1%). The DON analysis was conducted on one of the three replications and since all samples fell below the 1 ppm standard, no other analysis was conducted.

Table 5. 2018 spring barley agronomic characteristics in Alburgh, VT.

Variety	Crude Protein	Falling number	Germination energy	Plumpness	Thins
	%	sec	%	%	%
2W15-8674	9.32	360	99*	91.2	8.02
2W15-8688	9.59*	350	100*	89.7	9.38
2W15-8775	8.16	397	99*	94.2*	5.37*
AC09/327/3 (Lyberac)	9.33	396	99*	98.2*	1.73*
AC11/367/2	9.19	357	95*	97.5*	2.26*
AC11/341/28	7.57	361	95*	98.2*	1.68*
07ARS518-13	9.57*	304	99*	87.1	10.9
05ARS561-208	9.55*	**477***	85	83.9	14.0
06ARS617-25	10.7*	399	98*	87.1	11.4
07ARS515-7	8.38	357	**100***	89.4	9.19
Charles	9.92*	403	99*	92.2	7.18
DH120304	10.2*	353	97*	98.0*	1.82*
DH130910	10.2*	335	93*	97.6*	2.38*
DH130939	**10.8***	284	99*	97.9*	1.91*
DH140088	10.1*	364	99*	97.1*	2.69*
Endeavor	9.14	372	97*	87.8	10.5
Flavia	8.69	356	96*	98.1*	1.84*
Hirondella	8.13	356	99*	97.2*	2.67*
LGGB13-W102	8.13	411	100*	**98.5***	**1.39***
McGregor	8.14	382	99*	95.6*	4.20*
MW124007-001	8.98	403	99*	94.9*	4.77*
MW124028-007	8.67	435*	**100***	90.2	9.39
MW134159-012	8.08	375	99*	95.7*	4.17*
MW134122-012	8.60	379	100*	94.5*	5.36*
Su Mateo	8.19	347	98*	97.4*	2.45*
Thoroughbred	8.96	337	99*	97.5*	2.38*
Wintmalt	8.66	369	98*	97.8*	2.03*
LSD (0.10)	1.29	53	7.18	5.48	4.56
Trial Mean	9.07	371	97.8	94.2	5.23

*Varieties with an asterisk are not significantly different from the top performer in **bold**.

DISCUSSION

The 2017-2018 winter barley growing season was a success compared to previous years. In 2017, malting winter barley trial suffered from severe winterkill and was terminated. The warmer temperatures in the fall of 2017 might have allowed the barley to become better established and survive the winter. The average yield for the trial was 2485 lb ac^{-1}. Test weight and grain plumpness, is an indicator of malting quality. All of the varieties had above industry standards of grain plumpness but only nine varieties had a

test weight of 48 lbs/bu or above. A low test weight could indicate low malting quality and likely a result of the dry and hot conditions the grain experienced during the 2018 growing season.

The malting industry has standards for crude protein. Barley with low to moderate crude protein tend to be a higher quality malting barley. Generally, high quality 6-row malting barley should be 9-12% protein and high quality 2-row malting barley should be 9-11% protein. High protein barley can cause a beer to become hazy. Higher protein levels are also often associated with lower starch content. Starch is the principal contributor to brew house extract, and higher levels of starch result in more beer produced from a given amount of malt, although some small-scale breweries are minimally concerned with brew house extract efficiency. In 2018, the average protein concentration was 9.07%. There were no varieties that exceeded the ideal protein range, however there were many below the ideal protein range. Generally, it is difficult to obtain higher levels of protein in winter grains. High germination energy levels are also an indicator of good malting quality. Preferably, the germination energy should be over 95%. Falling number is not at standard for malting barley, but studies have shown that a variety with a falling number of 220 seconds or greater has a higher malting quality. All of the varieties tested had a falling number above 220 seconds. The dry growing season likely resulted in far less starch degradation than normal years, resulting in barley with high falling numbers and germination capacity.

ACKNOWLEDGEMENTS

Thank you to the American Malting Barley Association, Brewers Association, Northeast SARE (project number LNE15-339-29994), and the US Wheat and Barley Scab Initiative for their financial contribution to this project. UVM Extension would like to thank the Borderview Research Farm and staff in Alburgh, VT. We would like to acknowledge Abha Gupta, Freddy Morin, Lindsey Ruhl, and Sara Ziegler for their assistance with data collection and entry. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

UVM Extension helps individuals and communities put research-based knowledge to work.

THE UNIVERSITY OF VERMONT EXTENSION

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. University of Vermont Extension, Burlington, Vermont, University of Vermont Extension, and U.S. Department of Agriculture, cooperating, offer education and employment to everyone without regard to race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or familial status.