NW CROPS & SOILS PROGRAM

UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

2010
Sunflower Seeding Rate x Nitrogen Rate Trial Report

Photo courtesy of Peggy Manahan

Dr. Heather Darby
Philip Halteman, Erica Cummings, Amanda Gervais, Rosalie Madden

The UNIVERSITY of VERMONT EXTENSION

WEATHER DATA

The 2010 growing season was warmer and slightly wetter than normal through the majority of the spring. The month of May was considerably drier than normal, though June's rainfall exceeded 30-year averages. No effect was apparent on germination rates. Accumulated growing degree days (GDDs) for the sunflower season totaled 3,120 from the beginning of June through the middle of October, when the sunflowers were harvested, which was 264 higher than the 30 year averages (table 1). These data were recorded at weather stations in close proximity to the research site.

Table 1. Summarized weather data for the 2010 growing season.

South Hero (Alburgh)	Feb.	March	April	May	June	July	August	Sept.	Oct.
Avg. Temperature (F)	26.2	37.8	49.3	59.6	66.0	74.1	70.4	64.0	50.6
Departure from Normal	5.9	7	5.8	3.0	0.2	3.0	1.4	3.6	1.8
Precipitation (inches)	1.85	2.79	2.76	0.92	4.61	4.30	5.48	4.32	*
Departure from Normal	0.44	0.73	0.25	-2.01	1.40	0.89	1.63	0.86	
GDDs (base 44)	0.0	43.4	231	482	659	933	820	599	222
Departure from Normal	0.0	43.4	101	91.5	4.5	94.6	45.0	107	26.4

Based on National Weather Service (NWS) data from South Hero, VT. Historical averages are for 30 years of data (1971-2000).
* Data not available from NWS

ANALYSIS

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 treatments 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 (LSD's) at the 10% level of probability are shown. Where the difference between two treatments 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 values. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In the example below, treatment A is significantly different from treatment C but not from treatment B. The difference between A and B is equal to 400, which is less than the LSD value of 2.0. This means that these treatments 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 treatments were significantly different from one another.

Treatment	Yield
A	**2100***
B	1900*
C	1700
LSD	300.0

Sunflower Seeding Rate x Nitrogen Rate Study

Recommended seeding rates and target populations in oilseed producing areas in the northern Midwest tend to be between 15,000 – 25,000 plants per acre – somewhat low due to limited moisture. In New England, higher moisture conditions could allow for higher sunflower seeding rates, which in turn could increase seed and oil yields per acre. Because nitrogen recommendations generally increase with increased plant populations, we undertook a study to investigate the interaction between population and nitrogen (N) application rate to determine optimal rates for sunflower crops in New England.

CULTURAL PRACTICES

Replicated trials were initiated at Borderview Farm in Alburgh, VT and Willsboro, NY. Due to a crop failure at the Willsboro site, the data that follows is from the Alburgh site only. Five population rates and 4 N rates were evaluated. The experimental design was a randomized complete block in a split plot arrangement with four replications. Main plots consisted of N rates and subplots consisted of populations (Table 2). Each subplot was 10' x 20'. The seedbed was prepared by conventional tillage methods. An Allis Chalmers two-row cone planter was used to plant the trial. The variety was Croplan 555CL. Nitrogen rates were applied on July 13, 2010, just prior to flowering. All plots were managed with practices similar to those used by producers in the surrounding areas. Table 1 details relevant treatment setup and plot agronomic information.

Table 2. Agronomic and trial information for the sunflower seeding rate x nitrogen rate study.

Borderview Farm, Alburgh, VT	
Soil Type	Silt loam
Previous Crop	Rye
Tillage Methods	Plow and disk
Planting Date	5/28/2010
Row Width	30 inches
Fertilizer application (side-dress)	7/13/2010 in selected plots
Herbicide application	Trust @ 2qts. / acre (05/11/2010); Beyond @ 4 oz + 8 oz. crop oil / acre (6/2/2010)
Population treatments	20,000; 24,000; 28,000; 30,000; 32,000 plants ac^{-1}
Nitrogen rate treatments	0, 60, 90, 120 lbs. N (urea 46:0:0) ac^{-1}
Harvest Date	10/14/2010

Because germination and survival is heavily dependant on environmental conditions, plots were planted at rates significantly higher than the target populations. Immediately prior to sidedressing, the plots were thinned to achieve desired populations.

RESULTS AND DISCUSSION

As in previous years of this experiment, we saw significant increases in yield of seed as a result of nitrogen addition, though this year there was no significant difference between the 60, 90, and 120 lbs N ac^{-1} treatments. Similar to last year, N addition of 90 lbs ac^{-1} yielded slightly more than the 120 and 60 lbs rates (Figure 1). This indicates that applying even a small amount of nitrogen can boost yields – but in general, more nitrogen does not mean higher yield as it can in other crops. One possible explanation is that sunflowers are exceptionally good scavengers of deep nitrogen that unavailable to corn, grain, and hay crops. One and two-foot soil nitrate samples were taken at the Willsboro, NY site, which showed that a large proportion of the nitrate-N available to sunflowers is in the second foot of soil and can greatly reduce the recommended N application rate (Table 3).

In general higher plant populations resulted in increased yields per acre, though the highest yields came from the 30,000 plants per acre treatment. The yield from this treatment was significantly higher than the yield from the 20,000 plants per acre treatment, but there was no significance between any of the other treatments (Figure 2). Results from the variety trial suggest that to achieve a harvest population of 30,000 plants per acre, a

Table 3. PSNT results from Willsboro, NY.

	1st foot N (ppm)	2nd foot N (ppm)	Total available N (ppm)	% of N in the top foot
Block 1	6.7	5.4	12.0	55.3
Block 2	5.3	3.3	8.7	61.5
Block 3	5.4	2.3	7.7	70.3
Block 4	7.1	4.8	11.9	59.8

seeding rate of 34,000 seeds per acre is required.

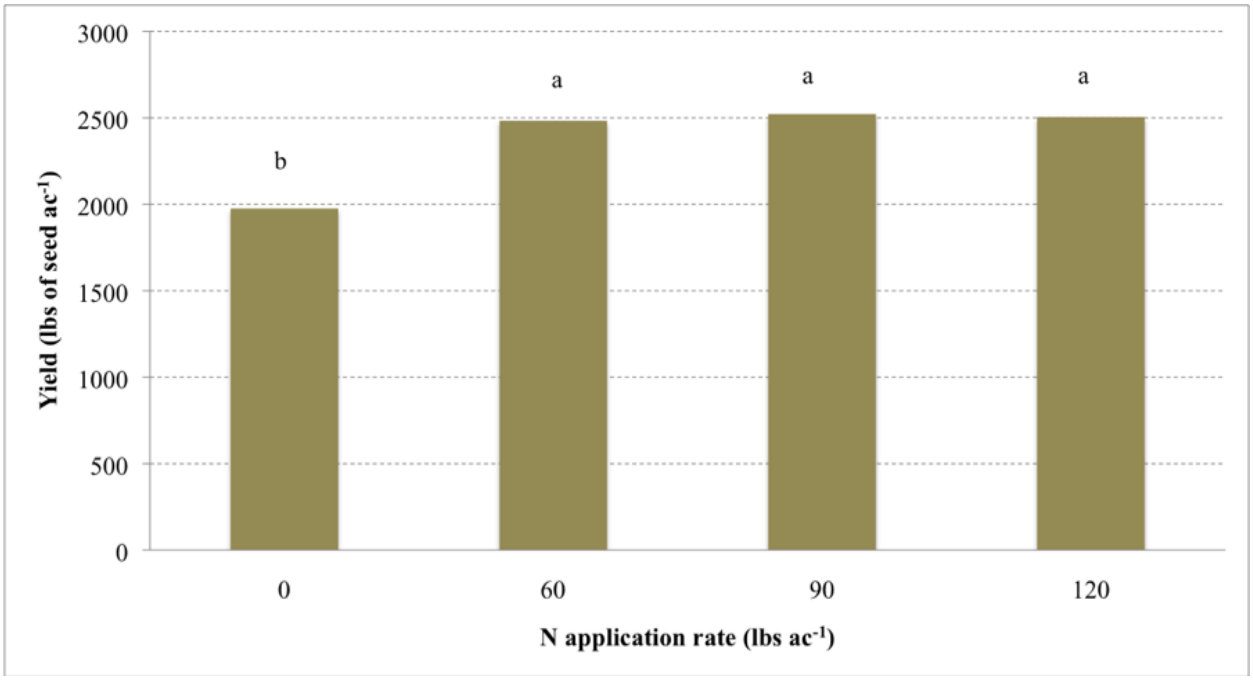

Figure 1. Yield of sunflower seed as affected by N application rate. Values with the same letter did not perform significantly differently (p value = 0.10)

Population also had a strong influence on plant height and head size (Table 4; Figure 3). Head size was largest at the lower populations of 20,000 and 24,000 plants per acre (Table 4). Height showed the opposite trend, with taller plants in the higher populations, and decreasing with lower populations. This is a well-established relationship that has important implications for our climate where average heights are taller than national averages. Planting at higher populations causes the plants to grow taller as they compete with their neighbors for light. The extra height can often produce spindly plants that fall over in wind storms, common around harvest time. Also, as head width decreases, the weight of the head also decreases, which could mean that the head does not hang downward during dry down. Bird damage is often greater on heads that are upright than on those that turned downward, as it's much easier for them to perch on the flower edge and reach the seeds. Narrower head widths may therefore increase likelihood of bird damage, or the extent of bird damage possible.

Table 4. Impact of sunflower population on selected plant and yield characteristics

	Height	Head width	Lodged	Yield		Moisture	Test weight	Oil content
	cm	cm	%	lbs ac^{-1}	gal ac^{-1}	%	lbs bu^{-1}	%
20000	133	**14.8***	1.00	2232	101	**12.9***	24.4	34.4
24000	138*	14.4*	1.00	2385*	114*	12.6*	24.8*	35.3
28000	138*	13.7	1.50	2352*	113*	12.3	24.9*	36.0
30000	**145***	13.1	**2.30**	**2614**	**130***	12.7*	25.1*	**36.7**
32000	139*	12.7	1.70	2322*	112	11.9	**25.2***	36.3
LSD (0.1)	7.70	0.8	NS	307	18.4	0.40	0.50	NS
Trial Mean	139	13.7	1.50	2381	110.6	12.5	24.9	35.7

* Treatments that did not perform significantly lower than the top performing treatment in a particular column are indicated with an asterisk.
NS – Treatments were not significantly different from one another.

Nitrogen application rate showed no relationship to plant height, though the largest head widths were found in the highest application rate. The plants growing in the 120 lb ac^{-1} treatments had head widths averaging nearly 15 cm (Table 5), while the middle two treatments produced slightly smaller heads, and the 0 nitrogen treatments produced the smallest heads.

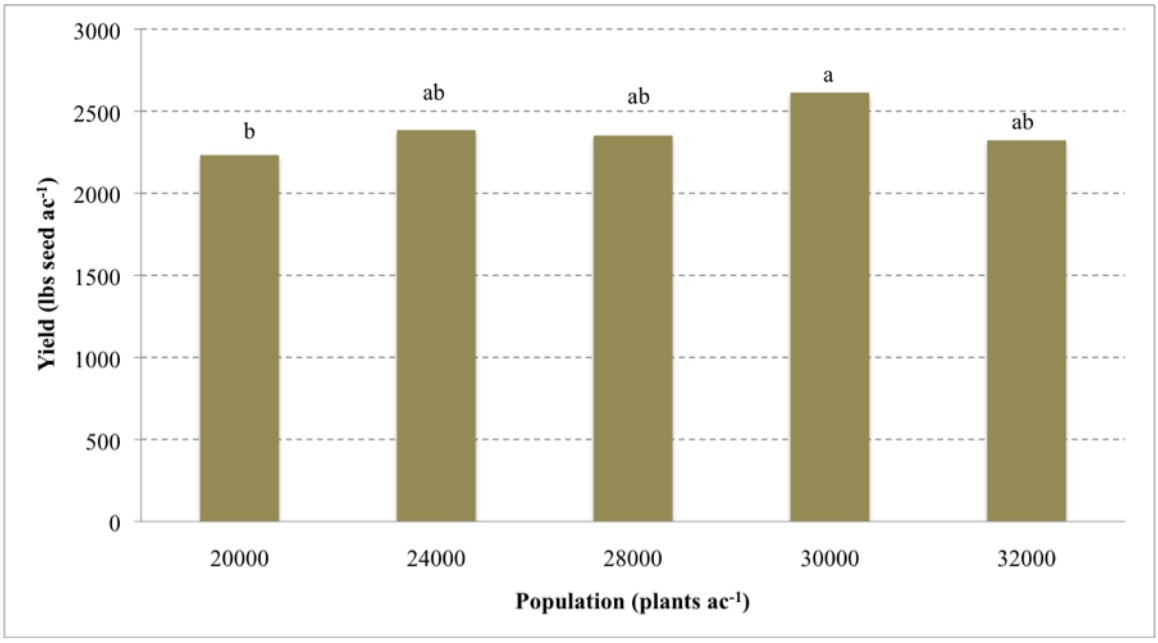

Figure 2. Yield of seed as affected by plant population. Values with the same letter did not perform significantly differently (0.10).

Table 5. Impact of varying nitrogen rates on selected plant and yield characteristics

	Height	Head width	Lodged	Yield		Moisture	Test weight	Oil content
	cm	cm	%	lbs ac^{-1}	gal ac^{-1}	%	lbs bu^{-1}	%
0	137.5	12.1	**2.1**	1975	94	12.3	**25.0**	35.5*
60	140.4	14.2	1.2	2483*	113	12.4	24.8	34.0
90	**140.8**	13.7	1.1	**2522***	122	12.3	**25.0**	36.5*
120	136.0	**14.9***	1.4	2505*	**127**	**13.0***	24.7	**37.1***
LSD (0.1)	NS	0.7	NS	274	16.5	0.4	NS	3.25
Trial Mean	138.7	13.7	1.5	2381	111	12.5	24.9	35.8

* Treatments that did not perform significantly lower than the top performing treatment in a particular column are indicated with an asterisk.
NS – Treatments were not significantly different from one another.

Taken together with results from previous years, the results of this trial indicate that a final plant population between 24,000 and 30,000 plants to the acre and sidedressing with between 60 and 90 pounds of nitrogen per acre, depending on deep soil nitrate levels, gives the highest yields. However, there are many other factors that play into total yield, such as insect pests and bird pressure that were not evaluated in this trial. Seeding rates will be dependent on planter and germination dependent mostly on seed but also soil factors.

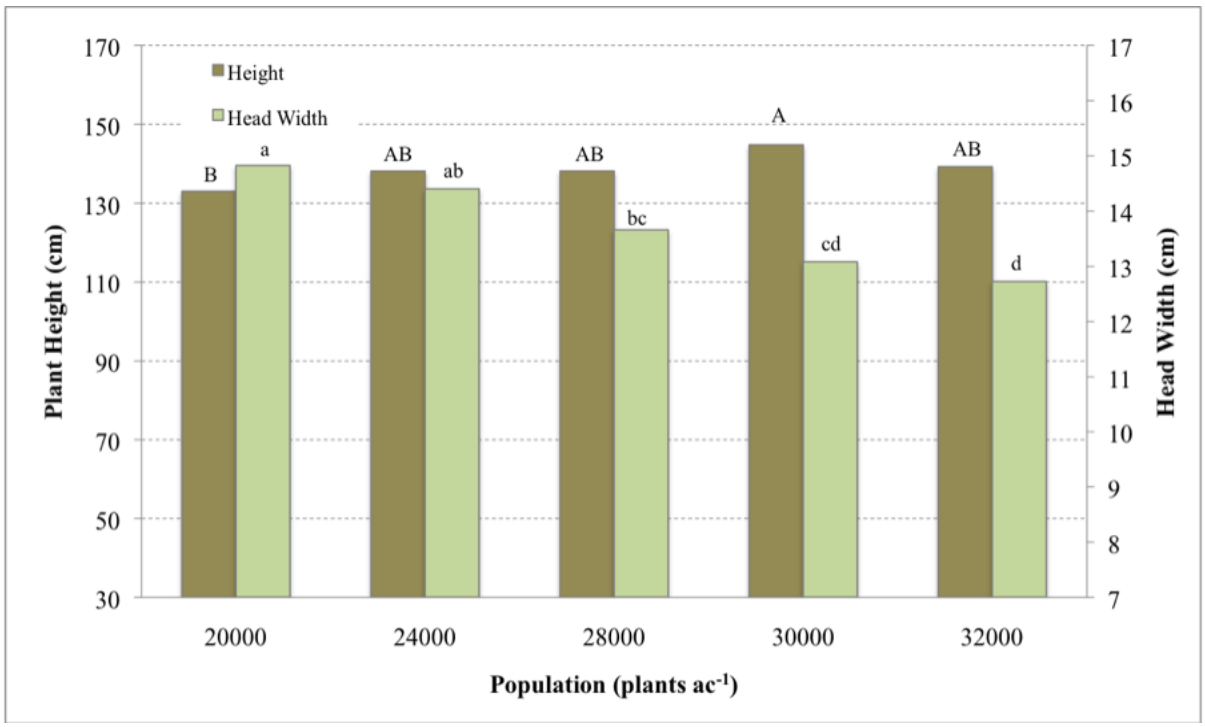

Figure 3. Sunflower height (left axis, capital letters) and head width (right axis, lowercase letters) as affected by population. Values with the same letter did not perform significantly differently (0.10).

Both N rate and population showed small effects on oil content of seed. Overall, the higher N application rates resulted in higher oil content (Figure 4). The 120 lbs ac^{-1} treatments yielded seed with just over 37% oil.

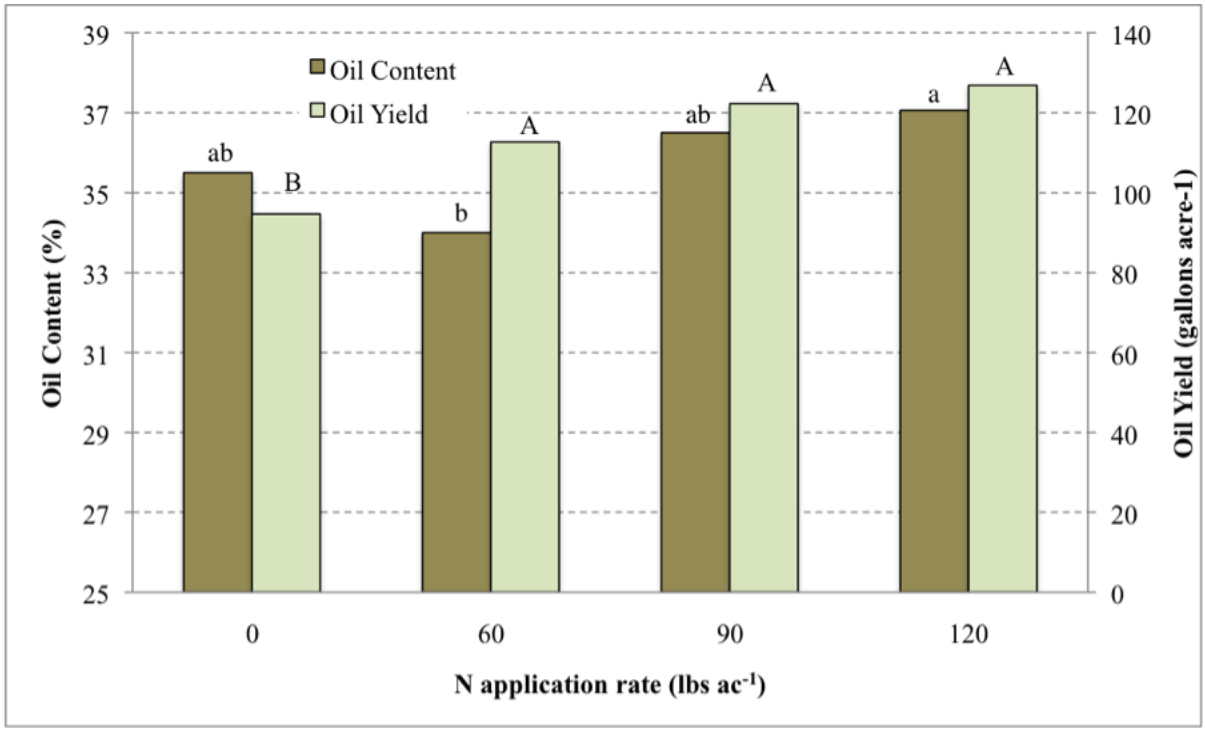

Figure 4. Effect of N rate on seed oil content. Values with the same letter did not perform significantly differently (P = 0.10).

Sunflowers grown in various population rates did not differ significantly in oil content. The published values for oil content of seed are in general slightly higher than the contents observed in this trial, which averaged 35.8%. Rainfall, temperature at harvest time, and several other factors have all been identified as having impacts on the quantity and quality of oil. Despite the fact that oil contents were the same across populations, oil yields were highest in the 30,000 plants per acre treatment, because of the effects of high yield from that treatment.

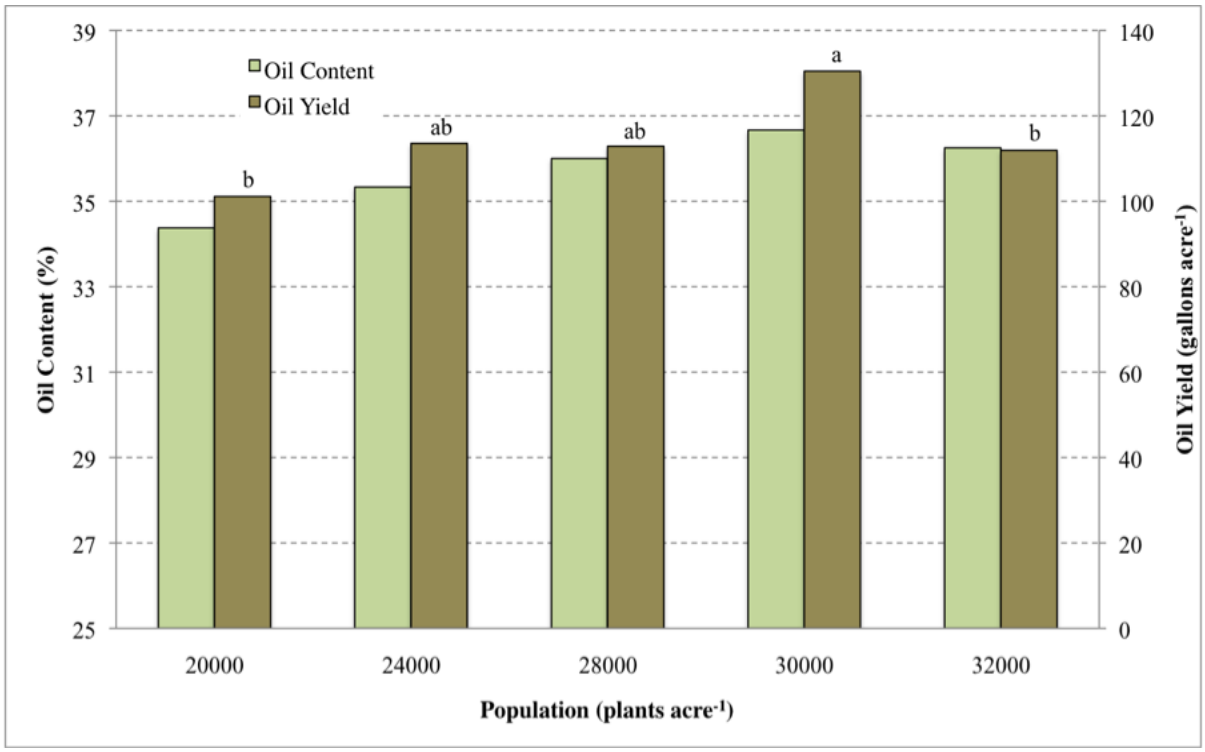

Figure 5. Effect of population on seed oil content. Values with the same letter did not perform significantly differently (P = 0.10).

ACKNOWLEDGEMENTS

UVM Extension would like to thank Borderview Research Farm for their assistance in implementing these trials.

Support for this project was generously provided by the Vermont Sustainable Jobs Fund. .

The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned, or criticism of unnamed products, is implied.

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.