2014

Flax Variety Trial

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NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2013 FLAX VARIETY TRIAL

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Flax *(Linum usitatissimum* L.*)* is a multi-purpose crop grown for its fiber, oil (linseed oil), and meal. The importance of flax as a major crop in the United States dropped drastically in the 1980's when latex paints replaced linseed oil based paint. Recently there has been renewed interest in flax, both for human consumption and for animal feed, for its high levels of heart-healthy omega-3 fatty acids. This variety trial was established to determine what flax varieties can grow and thrive in Vermont's climatic conditions.

MATERIALS AND METHODS

Twelve flax varieties were planted at Borderview Research Farm in Alburgh, VT on 23-Apr 2013. General plot management is listed in Table 1. The experimental design was a randomized complete block replicated 4 times. Plot size was 5' x 20'. The previous crop was corn silage, and prior to that, the site had been in sod. The field was disked and spike tooth harrowed prior to planting. Plots were seeded with a Kincaid Cone Seeder at a seeding rate of 50 lbs. acre^{-1}.

Population and vigor were measured on 22-May. Populations were determined by taking two 1/3 meter counts per plot. On 9-Jul plant heights were measured, and the severity of lodging was recorded as a percent of plot lodged. Flax plots were harvested with an Almaco SP50 small plot combine on 6-Sep 2013. The harvest area was 5' x 20'. Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN). Oil from a known volume of each seed sample was extruded on 5-Feb 2014 with a Kern Kraft Oil Press KK40 (at 120°F and 40 RPM), and the oil quantity was measured to calculate oil content. A subsample of flax meal from each plot was sent to Cumberland Valley Analytics in Hagerstown, MD for wet chemistry analysis of crude protein (as a percentage of dry matter content) and fat (as a percentage of dry matter content, calculated with ether extraction). The oil and meal were also analyzed with an NIRS (Near Infrared Reflectance Spectroscopy) DS2500 Feed and Forage analyzer (Foss, Eden Prairie, MN) at the University of Vermont Cereal Testing Lab (Burlington, VT). The varieties of flax grown are listed in Table 2. Results were analyzed with an analysis of variance or a Tukey-Kramer test of significance in SAS (Cary, NC). The Least Significant Difference (LSD) procedure was used to separate cultivar means when the F-test was significant ($p < 0.10$).

Table 1. General plot management.

Trial Information	Borderview Research Farm Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Corn
Planting date	23-Apr
Harvest date	6-Sep
Seeding rate	50 lbs acre^{-1}
Tillage methods	Mold board plow, disk, and spike tooth harrow

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'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 varieties. 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, 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	6.0
B	7.5*
C	9.0*
LSD	**2.0**

Table 2. Flax varieties, origin, year released and seed color.

Variety	Origin	Year released	Seed color
Carter	North Dakota	2004	Yellow
ND 2055	North Dakota	*	Brown
ND 2059	North Dakota	*	Brown
Neche	North Dakota	1988	Brown
Nekoma	North Dakota	2002	Brown
Omega	North Dakota	1989	Yellow
Pembina	North Dakota	1998	Brown
Prairie Blue	Canada	2003	Brown
Prairie Thunder	Canada	2006	Brown
Rahab 94	South Dakota	1994	Brown
Webster	South Dakota	1998	Brown
York	North Dakota	2002	Brown

*Experimental line, has not been publically released.

RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at a weather station in Alburgh, VT are shown in Table 3. From April to September, there was an accumulation of 4,511 Growing Degree Days (GDDs) in Alburgh which is 18 GDDs less than the 30-year average. Flax needs 1,603 GDD to reach maturity.

Flax yields and plot characteristics are listed in Table 4. Plant populations measured on 22-May resulted in significant differences between flax varieties with Neche having the highest population of 546 plants m^{-2}. However those differences did not relate to yield differences when the plots were harvested on 6-Sep. Flax yields ranged from 255 to 634 lbs. $acre^{-1}$ (Figure 2), which is much lower than typical yields from regions where flax is normally grown. Yields from variety trials in North Dakota range from 1200-2100 lbs $acre^{-1}$. While yields from our Vermont flax trial probably did not match North Dakota yields, our harvest yields are likely much lower than actual yields due to the challenges faced in harvesting. Yields from our Vermont flax trial were lower than North Dakota yields. Yield was mostly compromised due to harvest difficulties with the plot combine. Direct combining the light-weight flax seed proved more challenging than expected. The air on the combine needed to be shut-off so seed would not be lost out the back of the combine. Unfortunately this resulted in all of the chaff and seed getting plugged in the base of the combine. Once plugged it was very difficult to remove the seed without losing some of the plot onto the ground. This issue would have likely been alleviated if the crop was swathed and dried prior to harvest. Unfortunately, the weather at the time of harvest was not favorable for swathing so direct combining was used for harvest. Next season if direct combine is necessary, hand harvest will be performed on a subsection of the plot to determine yields prior to harvest loss. A picture taken on 1-Aug (Figure 1) shows the weed-free flax variety trial.

Table 3. Seasonal weather data[1] collected in Alburgh, VT, 2013.

Alburgh, VT	April	May	June	July	August
Average temperature (°F)	43.6	59.1	64.0	71.7	67.7
Departure from normal	-1.2	2.7	-1.8	1.1	-1.1
Precipitation (inches)	2.12	4.79	9.23	1.89	2.41
Departure from normal	-0.7	1.34	5.54	-2.26	-1.5
Growing Degree Days (base 32°F)	349	848	967	1235	1112
Departure from normal	-35.6	91.4	-47	36.8	-27.2

[1]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.
ǂ June 2013 precipitation data based on National Weather Service data from cooperative stations in South Hero, VT (http://www.nrcc.cornell.edu/page_summaries.html)

Table 4. Plot characteristics and yield of 12 flax varieties.

	Population plants/m^2	Height in.	Lodging %	Yield lbs./acre
Carter	396	31.0	5	634
Prairie Thunder	358	29.8	0	557
Webster	511*	31.8	6	502
2055	520*	**34.9***	15	397
2059	480*	34.1*	23	390
Neche	**546***	32.4	4	378
Nekoma	480*	30.5	8	335
Prairie Blue	508*	32.3	6	330
Rahab 94	252	29.9	0	293
Omega	118	30.2	0	286
York	475*	29.4	1	270
Pembina	386	32.1	0	255
Trial Mean	419	31.5	6	386
LSD (p<0.1)	103	2.19	NS	NS

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

Figure 1. Flax plots on 1-Aug, Alburgh, VT.

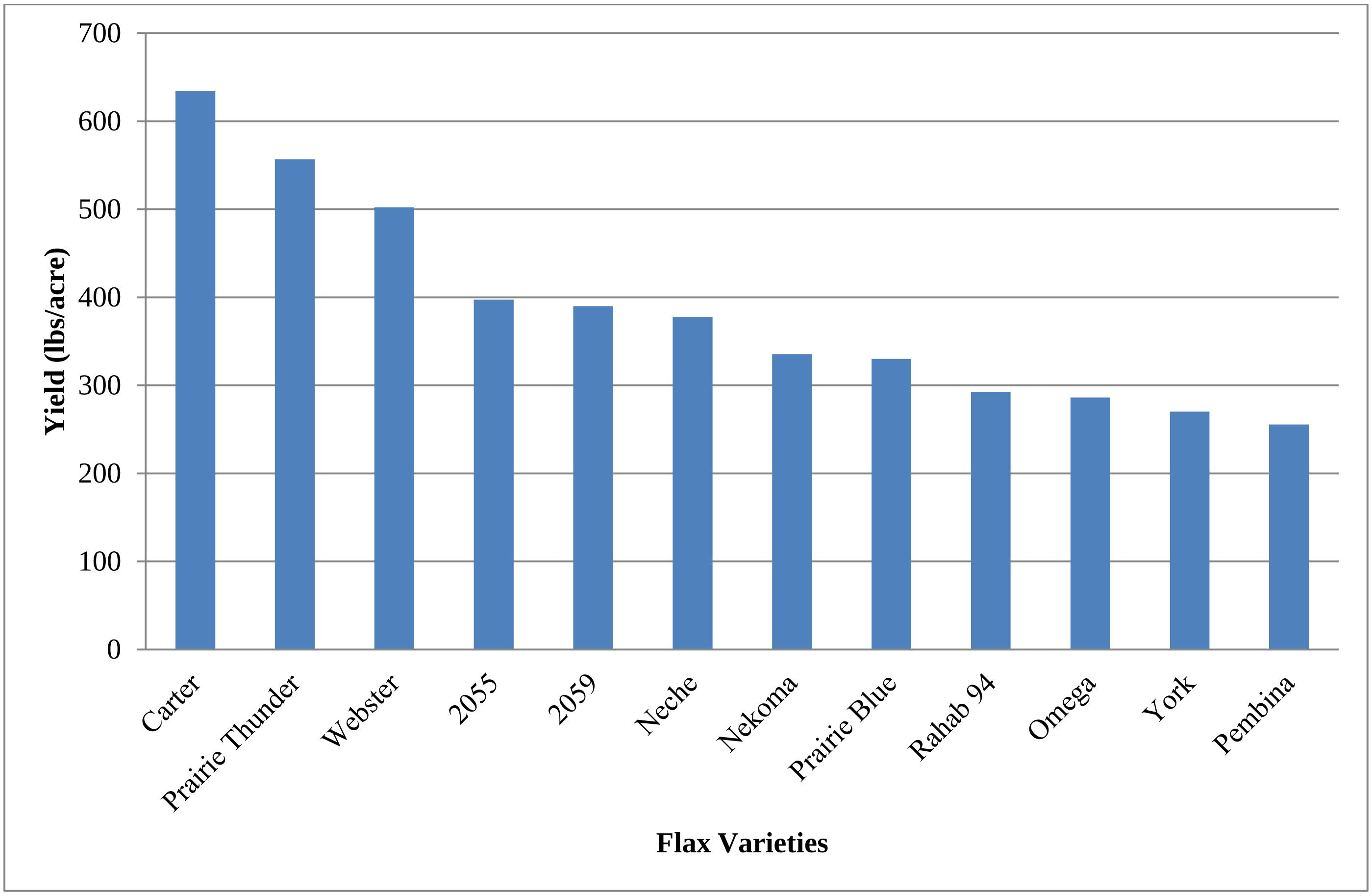

Figure 2. Average yield of flax varieties grown in Alburgh, VT, 2013.

Characteristics of oil extruded from each flax variety are listed in Table 5. Overall, there was no significant difference amongst the varieties for oil content or other characteristics except for free fatty acids. All varieties had similar fatty acid levels except for the variety 'York', which was significantly lower than the other eleven varieties (Figure 3). Peroxide value is a measure of rancidity of unsaturated fats and oils. Values below 10 are fresh. Rancid oils will measure between 30-40 Meq/kg. All of the oil from the flax varieties was fresh with peroxide values that averaged 1.5 Meq/kg of fat. The iodine value reflects the degree of unsaturation of an oil. The higher the number, the more unsaturated the oil is (the more double bonds). All the oil from the flax varieties had similar levels of unsaturation.

There was no significant difference in meal characteristics among the twelve flax varieties (Table 6). All varieties had similar meal characteristics. The average crude protein of the flax meal was 38.7% and the average fat content was 13.4%, ranging from 12.4 to 15.3%. Flax meal fiber levels averaged 14.8% and ash was 7.6%.

Table 5. Flax oil characteristics of twelve varieties grown in Alburgh, VT, 2013.

	Oil Content %	Peroxide Value Meq/kg of fat	Free Fatty Acids %	Insoluble Impurities %	Iodine Value %
Nekoma	33.4	1.5	8.1*	1.4	149
Pembina	32.7	1.9	8.5*	1.2	147
2055	32.5	1.3	5.6*	1.4	155
Neche	31.2	1.4	5.8*	1.3	154
Rahab 94	31.0	1.7	7.8*	1.4	147
York	30.7	1.2	5.0	1.4	155
Omega	30.1	1.8	8.0*	1.3	148
Prairie Blue	30.1	1.3	6.8*	1.5	153
2059	29.3	1.3	6.3*	1.4	153
Prairie Thunder	28.1	1.6	7.9*	1.3	149
Carter	28.1	2.0	**9.5***	1.2	147
Webster	25.7	1.5	9.2*	1.3	146
Trial Mean	30.2	1.5	7.4	1.3	150
Tukey-Kramer (p<0.10)	NS	NS	***	NS	NS

*** Values are significantly different based on Tukey-Kramer statistical test.
*Varieties with an asterisk are not significantly different than the top performer in **bold**.
NS – No significant difference amongst varieties.

Table 6. Flax meal characteristics of twelve varieties grown in Alburgh, VT, 2013.

	Crude Protein+ %	Fat+ %	Fiber %	Ash %
Webster	37.7	15.3	12.9	7.0
Neche	38.6	14.3	15.0	7.5
Prairie Thunder	38.2	13.8	15.0	7.6
Omega	39.3	13.7	14.3	7.6
2059	38.4	13.5	15.7	7.7
Prairie Blue	38.5	13.4	15.1	7.4
Carter	39.0	13.4	15.3	7.7
Rahab 94	38.8	13.2	14.4	7.7
Pembina	38.9	13.1	15.8	7.7
York	38.6	12.8	16.1	7.5
Nekoma	38.3	12.8	13.2	7.3
2055	39.8	12.4	14.9	7.9
Trial Mean	38.7	13.4	14.8	7.6
Tukey-Kramer (p<0.10)	NS	NS	NS	NS

+ Crude protein and fat derived from wet chemistry at Cumberland Valley Analytics.
Fiber and Ash data derived from NIRS at UVM Cereal Testing Lab.
NS – No significant difference amongst varieties.

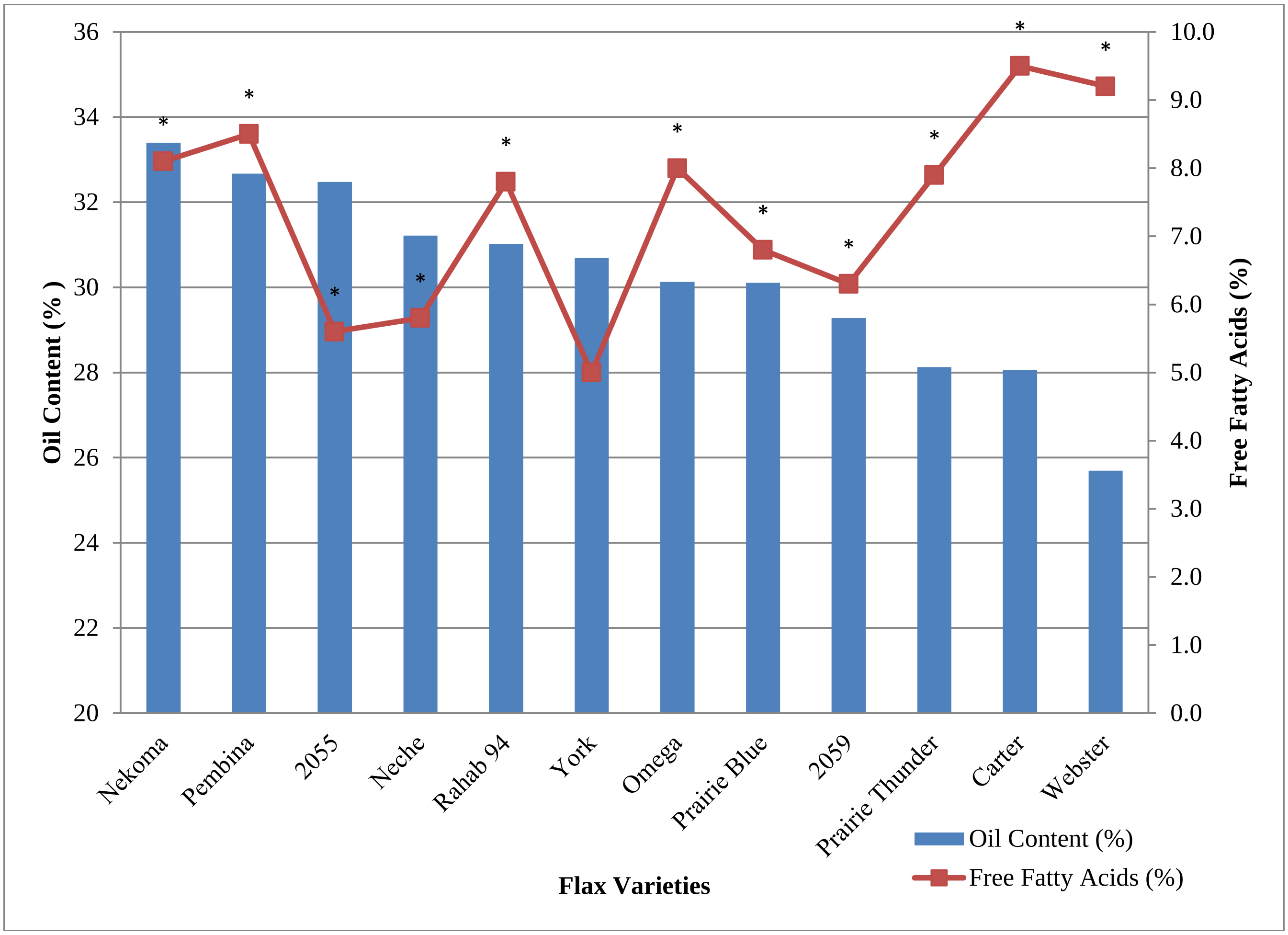

Figure 3. Flax oil content and free fatty acids of twelve varieties grown in Alburgh, VT, 2013.
*Varieties with an asterisk are not significantly different than the top performer.

ACKNOWLEDGEMENTS

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