NORTHWEST CROPS & SOILS PROGRAM

2020 Industrial Grain Hemp
Variety Trial

Dr. Heather Darby, UVM Extension Agronomist
Rory Malone, John Bruce, Ivy Luke, and Sara Ziegler
UVM Extension Crops and Soils Technicians
(802) 524-6501

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Hemp is a non-psychoactive variety of *cannabis sativa L.* The crop is one of historical importance in the U.S. and reemerging in worldwide importance as manufacturers seek hemp as a renewable and sustainable resource for a wide variety of consumer and industrial products. The crop produces a valuable oilseed, rich in Omega-3, and other essential fatty acids that are often absent in western diets. When the oil is extracted from the seed, what remains is a marketable meal co-product, which is used for human and animal consumption. The fiber has high tensile strength and can be used to create cloth, rope, building materials, and even a form of plastic. For twenty years, U.S. entrepreneurs have been importing hemp from China, Eastern Europe, and Canada. Today, industrial hemp is re-emerging as a locally grown product in the U.S. To help farmers succeed, agronomic research on hemp is needed, as much of the historical production knowledge for the region has been lost. In this trial, hemp grain varieties were evaluated to determine best cultivars for the region.

MATERIALS AND METHODS

The trial was initiated at Borderview Research Farm in Alburgh, Vermont (Table 1) to evaluate the impact variety has on hemp grain yield. The experimental design was a randomized complete block with four replications. Eighteen grain and dual-purpose hemp varieties (Table 2) were planted into 5 x 20' plots at a rate of 38 lbs ac^{-1} or 20 seeds per square foot on 4-Jun with a Great Plains NT60 Cone Seeder. There were 5' buffers. The soil type was Covington silty clay loam with 0-3% slopes, and the previous crop was silage corn. 200 lbs ac^{-1} of urea (46-0-0) was applied on 23-Jun and Select Max® was sprayed on the trial on 15-Jul at a rate of 16 oz ac^{-1} to limit the growth of grasses.

Table 1. Agronomic information for the industrial hemp grain variety trial, Alburgh, VT, 2020.

Location	Borderview Research Farm Alburgh, VT
Soil type	Covington silty clay loam, 0-3% slopes
Previous crop	Corn
Plot size (ft)	5 x 20
Planting date	4-Jun
Row spacing	7"
Replicates	4
Planting equipment	Great Plains NT60 Cone Seeder
Seeding rate (lbs ac^{-1})	38
Harvest date	8-Sep

Seed was sourced from the seed companies displayed below in Tables 2 and 3. On 8-Sep, the plots were harvested with an Almaco (Nevada, IA) SPC50 small plot combine. On 24-Jun, populations were counted in two one-foot sections per plot along a row of plants. Populations were counted again in three one-foot sections per plot before harvest and heights were measured on 2-Sep. Yield and harvest moisture were determined at harvest. Moisture was measured with a Berckes Test Weight Scale, which weighs a known

volume of grain, and determined from weight and dry weights. Thousand kernels weights were counted out by hand post-harvest. Oil was extruded from the seeds with an AgOil M70 oil press (Mondovi, WI) on 14-Jan, and the amount of oil captured was weighed to determine oil content.

Table 2. Hemp grain varieties evaluated in the hemp trial, Alburgh, VT, 2020.

Variety	Seed company	Days to maturity
Bialobreskie	Bija Hemp	130-145
Henola	Bija Hemp	115-120
Hlesia	Fiacre Seeds	115-120
Hliana	Fiacre Seeds	115-120
Hlukhoviskii-51	Fiacre Seeds	120-125
CFX-1	Hemp Genetics International	100-110
CFX-2	Hemp Genetics International	100-110
CRS-1	Hemp Genetics International	100-110
Katani	Hemp Genetics International	100-110
X-59	Legacy Hemp	100-110
NWG 2730	New West Genetics	100-120
NWG 452	New West Genetics	100-120
Canda	Parkland Industrial Hemp Growers	100-120
Joey	Parkland Industrial Hemp Growers	110-120
Altair	UniSeeds	100
Anka	UniSeeds	110
Ferimon	UniSeeds	129-134
Futura	Seedway	140-145

Table 3. Participating seed companies and contact information.

Company	Contact Information
Bija International Hemp, LLC	(833) 937-4367 info@international-hemp.com
Fiacre Seeds	Michael P. Timko michael.timko@fiacreenterprises.com
Hemp Genetics International	Jeff Kostuik, Saskatoon, Saskatchewan (204) 821-0522 Jeff.kostuik@hempgenetics.com
Legacy Hemp	(612) 790-6574 sandi@legacyhemp.com
New West Genetics	(800) 970-1615 newwestgenetics.com/contact/
Parkland Industrial Hemp Growers	Clare Dutchysen, Dauphin, Manitoba (204) 629-4367 info@pihg.net
Seedway	(800) 836-3710 https://www.seedway.com/contact/

UniSeeds	Keenan and Cobden, Ontario (613) 646-9737 orders@uniseeds.ca

Data were analyzed using a general linear model procedure of SAS (SAS Institute, 2008). Replications were treated as random effects, and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure where the F-test was considered significant, at p<0.10.

Variations in genetics, soil, weather, and other growing conditions can result in variations in yield and quality. Statistical analysis makes it possible to determine whether a difference between treatments is significant or whether it is due to natural variations in the plant or 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. This means that when the difference between two treatments within a column is equal to or greater to the LSD value for the column, there is a real difference between the treatments 90% of the time. In the example to the right, treatment C was significantly different from treatment A, but not from treatment B. The difference between C and B is 1.5, which is less than the LSD value of 2.0 and so these treatments were not significantly different 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 treatments were significantly different from one another. Treatment B was not significantly lower than the top yielding treatment, indicated in bold. A lack of significant difference is indicated by shared letters.

Treatment	Yield
A	6.0[b]
B	7.5[ab]
C	**9.0[a]**
LSD	2.0

RESULTS

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 4). The warm June had an average temperature of 66.9° F, which was 1.08° F warmer than average, and was followed by a hot July, with the average temperature 4.17° F higher than the 30-year normal. The hotter than average July resulted in 126 more Growing Degree Days (GDDs) than average during that month. Precipitation was below average in June, July, and September, and 2.86 inches above average in August. From June to August, 3508 GDDs were accumulated, 157 GDDS above the 30-year normal.

Table 4. Seasonal weather data collected in Alburgh, VT, 2020.

Alburgh, VT	June	July	August	Sept
Average temperature (°F)	66.9	74.8	68.8	59.2
Departure from normal	1.08	4.17	0.01	-1.33
Precipitation (inches)	1.86	3.94	6.77	2.75
Departure from normal	-1.77	-0.28	2.86	-0.91
Growing Degree Days (32-95°F)	1044	1323	1141	816
Departure from normal	31	126	0	-39

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Alburgh precipitation data from August-October was provided by the NOAA data for Highgate, VT. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Harvest measurements, yields, and oil content data are displayed below in Tables 5 and 6. NWG 452 had the highest population of plants per area, at 9.33 plants ft^{-2} or 406,560 plants ac^{-1}, but plant populations were not statistically different between varieties (Table 5). Harvest moistures were also similar across varieties. The variety Hliana had the lowest harvest moisture at 14.2%. NWG 2730 had the highest average plant height at 169 cm and was statistically greater than the other varieties except for Futura (155 cm), Bialobreskie (154 cm), NWG 452 (151 cm), and Hliana (147 cm). Canda had the densest thousand kernel weight (TKW) at 17.5 g and was statistically similar to Joey and CFX-2. The heavier the TKW, the fewer seeds per pound. The variety with the most seeds per pound was NWG 2730, at 40585 seeds lb^{-1}. NWG 2730 had significantly more seeds per pound than all other varieties. It was followed by Hliana, Hlukhoviskii-51, Hlesia, Katani, NWG 452, Bialobreskie, and Henola, which were all statistically similar to each other.

Table 5. Harvest metrics by variety for industrial grain hemp, Alburgh, VT, 2020.

Variety	Populations	Populations	Average height	Moisture @ harvest	Thousand kernel weight	Seeds per lb
	plants ft^{-2}	plants ac^{-1}	cm	%	grams	#seeds
Altair	8.67	377520	130[bcd]	18.6	15.5[bcd]	29321[efgh]
Anka	8.13	354288	136[bcd]	17.9	15.3[bcde]	29861[defgh]
Bialobreskie	4.53	197472	154[ab]	17.3	13.8[efgh]	33135[bcde]
CFX-1	6.80	296208	117[cd]	18.7	14.8[efd]	31025[cdefg]
CFX-2	7.47	325248	76[f]	18.5	16.5[abc]	27596[gh]
CRS-1	5.87	255552	108[ed]	22.9	15.8[bcd]	28848[fgh]
Canda	4.67	203280	115[cd]	18.1	**17.5[a]**	26010[h]
Ferimon	6.93	302016	139[bc]	21.3	15.0[cdef]	30334[cdefg]
Futura	6.80	296208	155[ab]	17.6	15.3[bcde]	30012[defgh]
Henola	6.67	290400	83[ef]	22.0	14.3[defg]	32602[bcdef]
Hlesia	6.93	302016	130[bcd]	16.2	13.8[efgh]	34324[bc]
Hliana	6.13	267168	147[ab]	**14.1**	12.5[hi]	36378[b]
Hlukhoviskii-51	8.40	365904	136[bcd]	18.1	13.0[gh]	35601[b]
Joey	8.00	348480	108[de]	20.4	16.8[ab]	27170[gh]
Katani	6.67	290400	75[f]	14.7	13.5[fgh]	33780[bcd]
NWG 2730	6.40	278784	**169[a]**	16.0	11.3[i]	**40585[a]**
NWG 452	**9.33**	**406560**	151[ab]	14.7	13.5[fgh]	33759[bcd]
X-59	7.60	331056	107[de]	17.6	15.5[bcd]	29595[efgh]
LSD (0.10)	NS	NS	29.4	NS	1.72	4073
Trial mean	7.00	304920	124	18.0	14.6	31663

ŧ Within a column, treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold.**
NS -There was no statistical difference between varieties.

Yields ranged from 321 lbs ac^{-1} to 1482 lbs ac^{-1} on a dry matter basis, and from 356 lbs ac^{-1} to 1646 lbs ac^{-1} at 10% moisture (Table 6, Figure 1). Futura was the top performer (1646 lbs ac^{-1} at 10% moisture), with yields statistically greater than all other varieties. The next top yielding varieties at 10% moisture were NWG 452 (1204 lbs ac^{-1}), X-59 (1161 lbs ac^{-1}), Ferimon (1122 lbs ac^{-1}), NWG 2730 (1113 lbs ac^{-1}), Anka (1111 lbs ac^{-1}), Hlukhoviskii-51 (1034 lbs ac^{-1}), Altair (965 lbs ac^{-1}), Joey (947 lbs ac^{-1}), and CRS-1 (945

lbs ac^{-1}), which were all statistically similar to each other. Katani yielded the least at 356 lbs ac^{-1} and was significantly lower than all other varieties except for CFX-2 and Canda.

Table 6. Harvest yields and oil content by variety for industrial grain hemp, Alburgh, VT, 2020.

Variety	Dry matter yield	Yield @ 10% moisture	Seed oil content	Oil yield at 10% moisture	Oil yield at 10% moisture
	lbs ac^{-1}	lbs ac^{-1}	%	lbs ac^{-1}	gallons ac^{-1}
Altair	869[bcde]	965[bcde]	13.2[efd]	128[bcd]	16.7[bcd]
Anka	1000[bc]	1111[bc]	16.1[bcd]	178[b]	23.3[b]
Bialobreskie	759[cde]	842[cde]	18.1[b]	151[bc]	19.8[bc]
CFX-1	753[cde]	837[cde]	15.8[bcde]	136[bc]	17.8[bc]
CFX-2	358[fg]	398[fg]	17.0[bc]	67.4[d]	8.8[d]
CRS-1	851[bcde]	945[bcde]	16.1[bcd]	150[bc]	19.7[bc]
Canda	611[efg]	679[efg]	15.1[b-f]	104[cd]	13.6[cd]
Ferimon	1012[bc]	1122[bc]	16.4[bc]	176[b]	23.0[b]
Futura	**1482[a]**	**1646[a]**	16.0[bcd]	**264[a]**	**34.6[a]**
Henola	736[cde]	818[cde]	16.4[bcd]	134[bcd]	17.5[bcd]
Hlesia	750[cde]	833[cde]	12.8[ef]	105[cd]	13.8[cd]
Hliana	649[def]	721[efd]	12.1[f]	85.4[cd]	11.2[cd]
Hlukhoviskii-51	930[bcd]	1034[bcd]	17.0[bc]	181[b]	23.7[b]
Joey	852[bcde]	947[bcde]	14.8[cdef]	141[bc]	18.5[bc]
Katani	321[g]	356[g]	**24.2[a]**	86.4[cd]	11.3[cd]
NWG 2730	1010[bc]	1113[bc]	15.0[b-f]	145[bc]	19.0[bc]
NWG 452	1085[b]	1204[b]	16.5[bc]	194[b]	25.5[b]
X-59	1045[bc]	1161[bc]	16.3[bcd]	189[b]	24.7[b]
LSD (0.10)	318	353	3.23	66.7	8.74
Trial mean	837	930	16.0	145	19.0

ŧ Within a column, treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold.**
NS -There was no statistical difference between varieties.

The average seed soil content was 16.0% (Table 6) which is below the averages of the 2018 and 2019 trials, which were 21.8% and 22.2% respectively. A comparison of varieties trialed in multiple years is shown below in Figure 2. This year the seeds were extremely dry at the time of oil pressing. The harvest moistures were similar to previous years, though every year this trial has been done the seed is harvested at a wetter moisture then dried down. Seed moisture at pressing was often at less than 5%. Oil yields on a per acre basis are also shown in Table 6. Katani, the top-performer, had an oil content of 24.2%, and was significantly higher than all other varieties trialed. On a per acre basis, Futura yielded the most oil based on harvest yields at 10% moisture. Futura yielded 264 lbs ac^{-1} or 34.6 gallons ac^{-1} of oil and was also statistically different from all other varieties. Below in Figure 1, oil content is graphed by variety along with harvest yields.
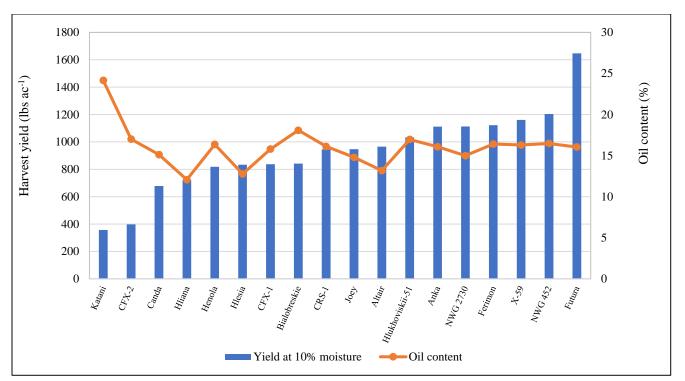
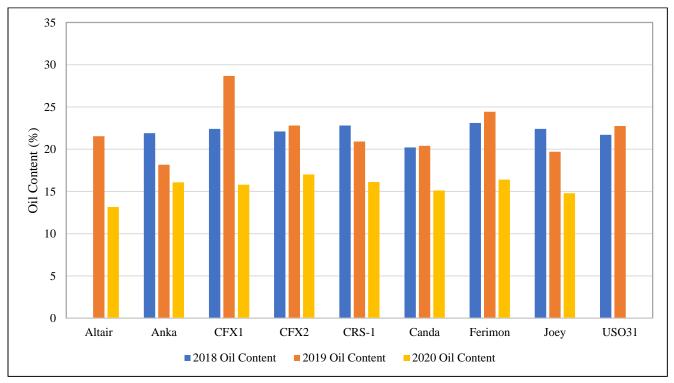**Figure 1. Grain hemp yields at 10% moisture and oil content, Alburgh, VT, 2020.**

Figure 2. Hemp grain seed oil content in varieties trialed multiple years, 2018-2020, Alburgh, VT.

DISCUSSION

All hemp varieties reached full plant maturity. This year the varieties were harvested at the target range of moisture content, but after drying down yielded less oil than previous years. Grain hemp should be combined at a seed moisture range of 10-20% and then dried down to less than 10% for storage. Harvesting seed that is too dry increases risk of yield loss from shattering and bird damage and can reduce the quality of the grain. Harvesting plants at moistures near 20% also helps prevent dry hemp fibers from getting wrapped in the combine. Yields averaged 930 lbs ac^{-1} at 10% moisture, which was similar to the 2019 trial yields of 932 lbs ac^{-1} at 10% moisture, and in the median range compared to average yields from Canada of 500-1200 lbs ac^{-1}. Futura was the top performer in yield.

Varieties that had taller growth habits tended to yield much higher than those varieties specifically aimed towards grain production, such as Katani. NWG 2730 had the most seeds per pound, and it was also the variety with the highest heights and one of the higher performers in yield. It is important to remember that these data represent only one year of research, and in only one location. Additional research needs to be conducted to evaluate varieties under more growing conditions.

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