



2021 Industrial Grain Hemp Variety Trial



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2021 INDUSTRIAL GRAIN HEMP VARIETY TRIAL

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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 yield potential of hemp grain varieties in the Northeast. The experimental design was a randomized complete block with four replications. The seed bed was prepared with a Pottinger TerraDisc. Twenty-two grain and dual-purpose hemp varieties (Table 2) were planted into 5 x 20' plots at a rate of 38 lbs ac⁻¹ or 250 seeds m⁻² on 8-Jun with a Great Plains NT60 Cone Seeder. The soil type was Covington silty clay loam with 0-3% slopes, and the previous crop was sweet corn. On the 7-Jul, the hemp was topdressed with 200 lbs ac⁻¹ of urea (46-0-0).

Table 1. Agronomic information for the industrial hemp grain variety trial, Alburgh, VT, 2021.

Location	Borderview Research Farm Alburgh, VT
Soil type	Covington silty clay loam, 0-3% slopes
Previous crop	Sweet Corn
Plot size (ft)	5 x 20
Planting date	8-Jun
Row spacing	7"
Replicates	4
Planting equipment	Great Plains NT60 Cone Seeder
Seeding rate (lbs ac⁻¹)	38
Harvest date	7-Sep, 13-Sep, 23-Sep, 1-Oct

Seed was sourced from the seed companies displayed below in Tables 2 and 3. On 16-Jun, emergence populations were counted in three one-foot sections per plot. Prior to harvest, populations were taken at random from each plot and heights were recorded. On 7-Sep, 13-Sep, 23-Sep, and 1-Oct, the plots were harvested with an Almaco (Nevada, IA) SPC50 small plot combine. Grain yield and moisture were determined at harvest. Thousand kernel weights determined for each variety. Oil was extruded from the

seeds with an AgOil M70 oil press (Mondovi, WI), and the amount of oil captured was weighed to determine oil content.

Table 2. Hemp grain varieties evaluated in the hemp trial, Alburgh, VT, 2021.

Variety	Seed company	Days to maturity	Thousand Kernel Weights (g)	Seeds per lb
Altair	Uniseeds/ Seedway	100	18.0	25200
Anka	Uniseeds/ Seedway	110	17.7	25627
Bialobrzieskie	International Hemp	130-145	13.5	33599
Canda	Parkland Industrial Hemp Growers	100-120	20.2	22455
CFX-1	Hemp Genetics International	100-110	18.1	25060
CFX-2	Hemp Genetics International	100-110	16.9	26840
Fedora 17	Uniseeds/ Seedway	130	17.1	26526
Felina 32	Uniseeds/ Seedway	135	16.7	27161
Futura 75	Uniseeds/ Seedway	140-145	19.1	23748
Grandi	Hemp Genetics International		16.6	27325
Henola	International Hemp	115-120	15.1	30039
Hlesia	Roher Seed	115-120	17.1	26526
Hliana	Roher Seed	115-120	18.5	24518
H51	Roher Seed	120-125	18.0	25200
Joey	Parkland Industrial Hemp Growers	110-120	17.9	25340
Lara	Omni Trade Inc	100-110	15.0	30239
NWG 2463	New West Genetics	100-120	14.4	31499
NWG 2730	New West Genetics	100-120	13.3	34105
NWG 4000	New West Genetics	100-120	15.4	29454
NWG 4113	New West Genetics	100-120	14.9	30442
Vega	Uniseeds /Seedway	100	20.5	22126
X59	IND Hemp	100	16.0	28350

Table 3. Participating seed companies and contact information.

Company	Contact Information
Bija International Hemp, LLC	(833) 937-4367 info@international-hemp.com
Roher Seed	Doug Zimmerman dzimmerman@roherseeds.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	Rich Fletcher rfletcher@newwestgenetics.com
Parkland Industrial Hemp Growers	Clare Dutchysen, Dauphin, Manitoba (204) 629-4367 info@pihg.net
Omni Trade Inc	Roman Fedorowycz roman_omni@yahoo.com
UniSeeds/Seedway	Pierre Lanoie pierre@uniseeds.ca
IND Hemp	Ben Brimlow ben@indhemp.com

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 an asterisk.

Treatment	Yield
A	6.0
B	7.5*
C	9.0
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 70.3° F, which was 2.81° F warmer than normal, and was followed by a cool July, with the average temperature 4.31° F lower than the 30-year normal. The colder than average July resulted in 134 fewer Growing Degree Days (GDDs) than the 30-year normal. Precipitation was below average in June, July, and August, and 0.42 inches above average in September. From June to August, 1885 GDDs were accumulated, 24 GDDs above the 30-year normal.

Table 4. Seasonal weather data collected in Alburgh, VT, 2021.

Alburgh, VT	June	July	August	Sept
Average temperature (°F)	70.3	68.1	74.0	62.8
Departure from normal	2.81	-4.31	3.25	0.14
Precipitation (inches)	3.06	2.92	2.29	4.09
Departure from normal	-1.20	-1.14	-1.25	0.42
Growing Degree Days (32-95°F)	597	561	727	394
Departure from normal	73	-134	85	7

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 (1991-2020) from Burlington, VT.

Harvest measurements, yields, and oil content data are displayed below in Tables 5 and 6. Altair had the highest population of plants per area (Table 5), at 10.4 plants ft² or 453,413 plants ac⁻¹, but plant populations were not statistically different between Altair, Anka, Bialobreskie, Henola, and Lara. Futura 75 had the highest average plant height at 167 cm and was statistically greater than all other varieties except for Felina 32 at 157 cm. Canda produced the heaviest thousand kernel weight (TKW) at 18.5 g and was statistically similar to X59. The heavier the TKW, the more robust the grain produced. The TKW and “seeds per pound” values listed in Table 2 represent the metrics of the purchased seed, while the same columns in Table 5 represents our trial’s harvest metrics. Both have been included for comparison. The variety with the least seeds per pound was Canda, at 24518 seeds lb⁻¹, and therefore it has been highlighted in bold as the top performer in the table below (Table 5). Varieties with statistically similar numbers of seeds per pound to Canda include Altair, Joey, and X59.

Table 5. Harvest metrics by variety for industrial grain hemp, Alburgh, VT, 2021.

Variety	Populations	Populations	Average height	Harvest moisture	Thousand Kernel Weight	Seeds per lb
	plants ft ⁻²	plants ac ⁻¹	cm	%	grams	# seeds
Altair	10.40	453413	109	15.8	17.2	26372*
Anka	8.46* †	368398*	134	14.2	13.1	34625
Bialobreskie	8.55*	372446*	124	11.4	14.6	31068
Canda	5.02	218610	106	11.3	18.5	24518
CFX-1	4.00	174078	81.0	12.6	15.7	28891
CFX-2	7.80	340059	76.0	13.5	15.8	28708
Fedora 17	7.06	307673	130	15.2	15.2	29842
Felina 32	4.83	210513	157*	15.5	15.2	29842
Futura 75	4.74	206465	167	19.9	15.7	28891
Grandi	3.16	137643	51.0	15.8	14.7	30857
Henola	9.11*	396736*	83.0	17.1	12.8	35437
Hlesia	7.06	307673	112	13.3	14.9	30442
Hliana	5.20	226706	126	13.4	15.9	28528
H51	9.29*	404833*	120	11.5	15.7	28891
Joey	7.99	348156	91.0	11.3	17.2	26372*
Lara	8.55*	372446*	127	12.9	13.9	32633
NWG 2463	6.51	283383	131	12.8	14.4	31499
NWG 2730	7.06	307673	132	14.3	15.9	28528
NWG 4000	7.16	311721	123	11.6	14.3	31720
NWG 4113	5.95	259093	139	12.0	14.8	30648
Vega	6.88	299576	99.0	11.4	16.4	27658
X59	4.83	210513	4.20	12.1	17.5*	25920*
LSD (0.10)	2.36	103015	15.3	2.10	1.10	2249.8
Trial mean	6.80	296264	112	13.6	15.4	29742.2

† Within a column, treatments marked with an asterisk performed statistically similar ($p=0.10$) to the top performers, listed in **bold**.

Yields ranged from 914 lbs ac⁻¹ to 1415 lbs ac⁻¹ at 10% moisture (Table 6, Figure 1). NWG 4000 was the top performer (1415 lbs ac⁻¹ at 10% moisture), with grain yields statistically similar to varieties Altair, Anka, Bialobreskie, Canda, CFX-1, Futura 75, Henola, Hliana, H51, Joey, NWG 2463, NWG 2730, NWG 4113, and Vega. The variety with the lowest yield was CFX-2 at 914 lbs ac⁻¹, but it performed statistically similarly to more than half of the other varieties represented in the trial.

Table 6. Harvest yields and oil content by variety for industrial grain hemp, Alburgh, VT, 2021.

Variety	Harvest Date	Yield @ 10% moisture lbs ac ⁻¹	Seed oil content %	Oil yield at 10% moisture lbs ac ⁻¹	Oil yield at 10% moisture gallons ac ⁻¹
Altair	7-Sep	1204*	19.1	229	30.5
Anka	13-Sep	1166*	17.3	196	26.2
Bialobreskie	23-Sep	1176*	16.2	191	25.4
Canda	7-Sep	1378*	18.4	261	34.8
CFX-1	7-Sep	1172*	19.3	218	29.0
CFX-2	7-Sep	914	16.0	146	19.4
Fedora 17	13-Sep	1058	22.0	224	29.9
Felina 32	23-Sep	1105	16.6	184	24.6
Futura 75	13-Sep	1292*	14.9	221	29.4
Grandi	7-Sep	1065	33.3	355	47.3
Henola	13-Sep	1296*	15.0	204	27.2
Hlesia	13-Sep	1076	16.0	192	25.6
Hliana	7-Sep	1145*	19.9	258	34.4
H51	13-Sep	1230*	20.1	222	29.6
Joey	7-Sep	1345*	19.6	202	27
Lara	1-Oct	1059	15.8	166	22.1
NWG 2463	1-Oct	1164*	17.2	204	27.2
NWG 2730	1-Oct	1202*	17.0	204	27.2
NWG 4000	1-Oct	1415	15.5	220	29.3
NWG 4113	1-Oct	1285*	17.7	228	30.4
Vega	7-Sep	1132*	15.7	166	22.2
X59	23-Sep	1079	16.5	179	23.9
LSD (0.10)	--	296	5.02	75.5	10.1
Trial mean	--	1180	18.2	212.2	28.3

† Within a column, treatments marked with an asterisk were statistically similar (p=0.10) to top performers listed in **bold**.

The average seed oil content was 18.2% (Table 6) which is above the 16.0% average of the 2020 trial, but below the oil content of the two years prior to 2020. A comparison of varieties trialed in multiple years is shown below in Figure 2. Grandi, the top-performer, presented an oil content of 33.3%, and was significantly higher than all other varieties trialed. However, due to human error and bird predation, this figure only represents two replications of the trial instead of the standard of four. Other top oil yielders include Canda, Altair, and NWG 4113. The data shows that on average, the varieties trialed would yield over 28 gallons of oil per acre.

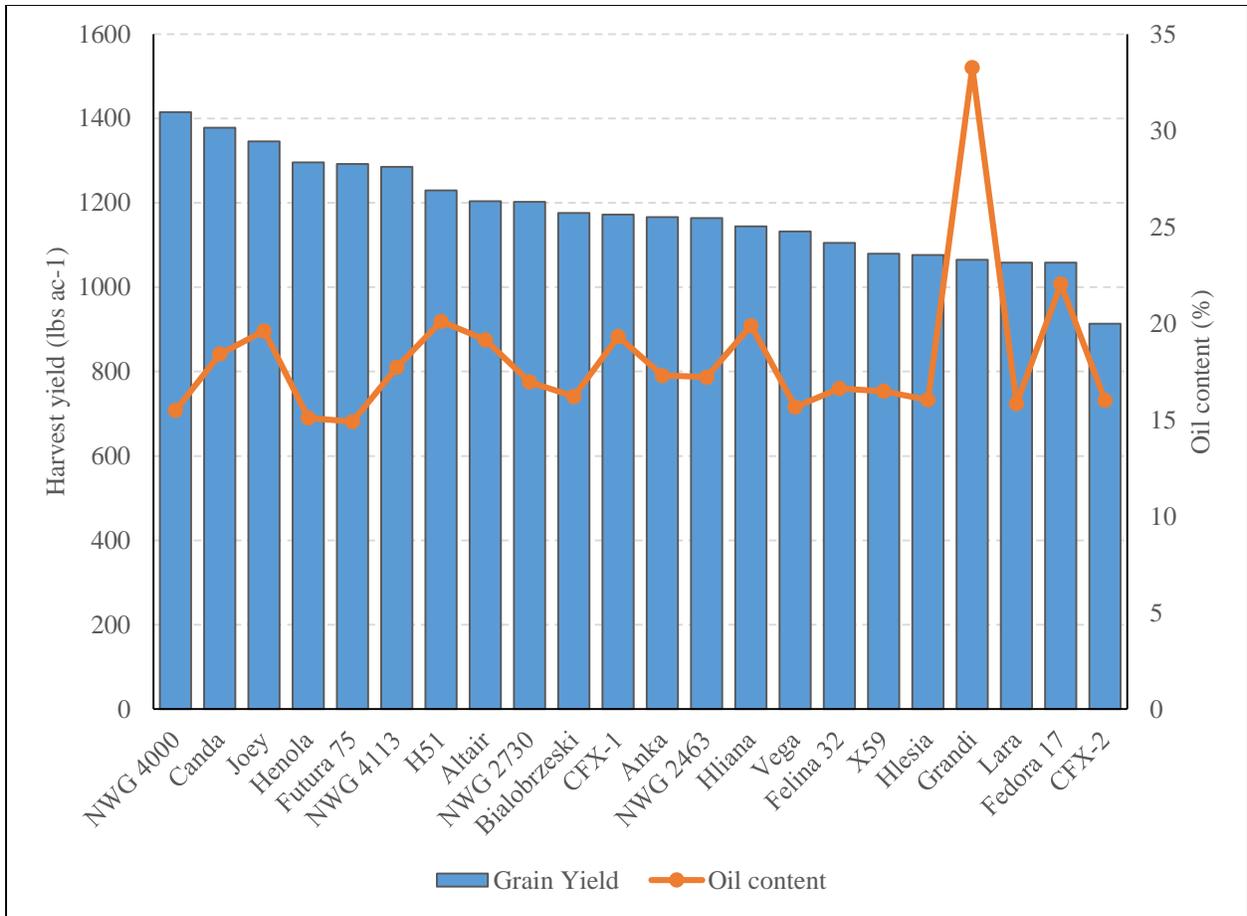


Figure 1. Grain hemp yields at 10% moisture and oil content, Alburgh, VT, 2021.

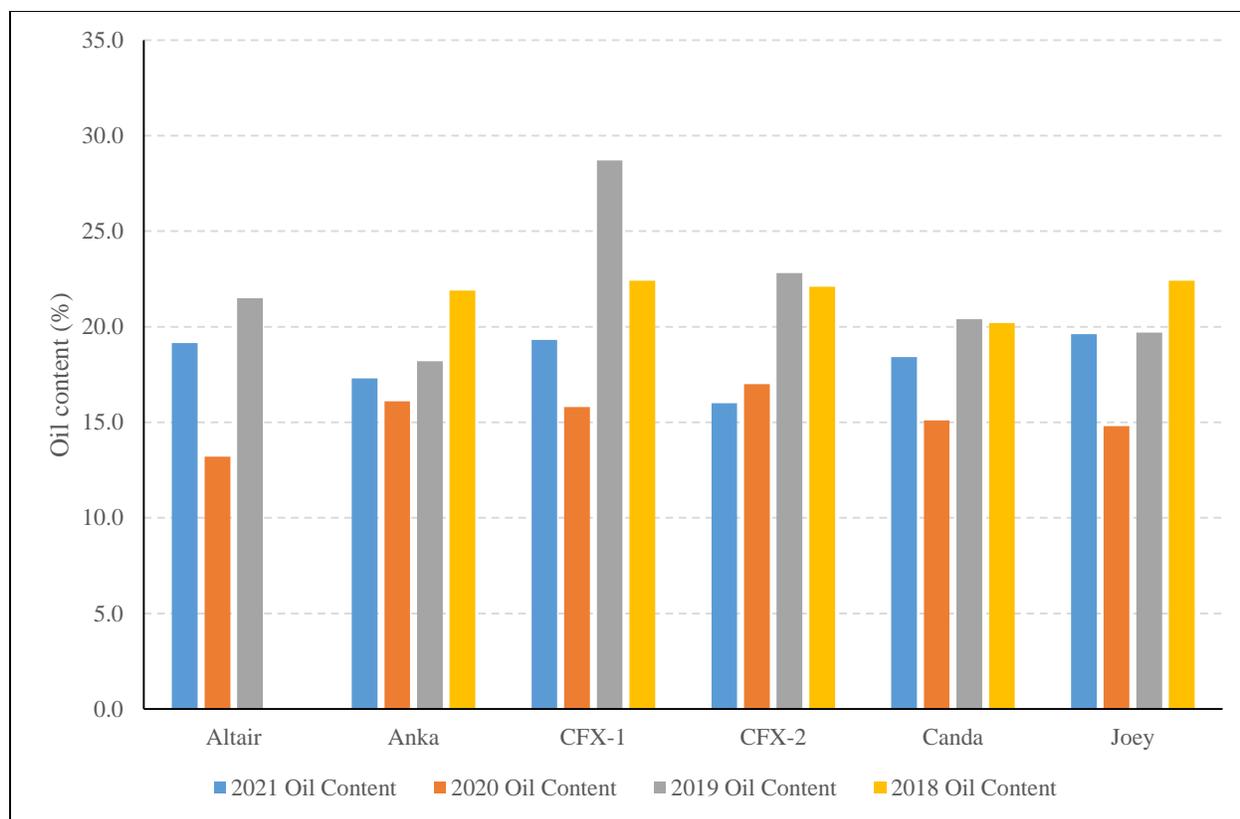


Figure 2. Hemp grain seed oil content in varieties trialed multiple years, 2018-2021, Alburgh, VT.

DISCUSSION

In 2021, grain maturity differed widely amongst varieties with harvest spanning from 7-Sep to 1-Oct. The cold July may have slowed growth of the crop causing these wider than normal differences in harvest maturities. Yields averaged 1180 lbs ac⁻¹ at 10% moisture, which was greater than the 2019 trial yields of 932 lbs ac⁻¹ at 10% moisture, and within the median range compared to average yields from Canada of 500-1200 lbs ac⁻¹. NWG 4000 was the top performer in yield through this year's trial. Grain yields were compromised by bird damage and potentially delayed harvest due to a combine break-down. 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.

This year there was not a strong correlation between height and yield, though in past years, taller heights have corresponded to greater grain yields with those shorter varieties being outcompeted by weeds, increasing the difficulty of harvest. Canda had the fewest seeds per pound, and was also counted amongst the top performers in dry matter yield. Grandi represented both some of the shortest plants and the highest percentage of oil yield, though Grandi's oil values in Table 6 only represent two replications of the trial rather than the standard four. 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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