



2022 Industrial Grain Hemp Variety Trial



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2022 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 target rate of 38 lbs ac⁻¹ or 250 seeds m⁻² on 24-May with a Great Plains NT60 Cone Seeder. The soil type was Benson rocky silt loam with 8-15% slopes, and the previous crop was summer annuals. On 7-Jul, the hemp was topdressed with urea (46-0-0) at a rate of 200 lbs ac⁻¹.

Table 1. Agronomic information for the industrial hemp grain variety trial, Alburgh, VT, 2022.

Location	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slopes
Previous crop	Summer Annuals
Plot size (ft)	5 x 20
Planting date	24-May
Row spacing	7"
Replicates	4
Planting equipment	Great Plains NT60 Cone Seeder
Seeding rate (seeds m⁻²)	250
Harvest date	9-Sep, 14-Sep, 20-Sep, 20-Oct

Seed was sourced from the seed companies displayed below in Tables 2 and 3. On 7-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 9-Sep, 14-Sep, 20-Sep, and 20-Oct, the plots were harvested with an Almaco (Nevada, IA) SPC50 small plot combine based on relative maturity. Grain yield

and moisture were determined at harvest. Thousand kernel weights of the harvested seed was determined for each variety.

Table 2. Hemp grain varieties evaluated in the hemp trial, Alburgh, VT, 2022.

Variety	Seed source	Days to maturity	Thousand kernel weights g	Seeds seeds lb ⁻¹
Altair	Uniseeds/Seedway	100-105	18.2	30431
Bialobrzieskie	International Hemp	115-120	13.0	28878
CFX-1	Hemp Genetics International	100-105	18.0	27456
CFX-2	Hemp Genetics International	100-105	16.6	28946
Canda	Parkland industrial Hemp Growers	100-105	19.8	26916
Carmenecta	International Hemp	130-150	19.3	20394
Enectarol	International Hemp	130-150	20.7	21870
Fedora 17	Hemp Seed Warehouse	110-115	16.7	27146
Felina 32	Hemp Seed Warehouse	110-115	16.7	27099
Ferimon 12	Hemp Seed Warehouse	110-115	15.7	28823
Futura 83	Hemp Seed Warehouse	115-120	19.0	26571
Henola	International Hemp	110-115	15.0	28461
Joey	Parkland Industrial Hemp Growers	100-105	18.1	25315
Lara	Omni Seed	110-115	15.3	28091
NWG 2463	New West Genetics	100-120	15.6	29891
NWG 2730	New West Genetics	100-120	12.7	31677
NWG 4000	New West Genetics	100-120	17.2	30431
NWG 4113	New West Genetics	100-120	15.6	30848
Orion 33	Hemp Seed Warehouse	115-120	18.0	25239
USO 31	Hemp Seed Warehouse	110-115	17.7	28406
Vega	Uniseeds /Seedway	100-105	21.0	28688
X59	IND Hemp	110-115	14.3	26499

Table 3. Participating seed companies and contact information.

Company	Contact Information
Hemp Genetics International	Jeff Kostuik, Saskatoon, Saskatchewan (204) 821-0522 Jeff.kostuik@hempgenetics.com
Hemp Seed Warehouse	Corbett Miteff mcmiteff@gmail.com
IND Hemp	Ben Brimlow ben@indhemp.com
International Hemp	Terry Moran terry@international-hemp.com
New West Genetics	Rich Fletcher rfletcher@newwestgenetics.com https://newwestgenetics.com/contact/
Omni Seed	Roman Fedorowycz roman_omni@yahoo.com
Parkland Industrial Hemp Growers	Clare Dutchysen, Dauphin, Manitoba (204) 629-4367 info@pihg.net
UniSeeds/Seedway	Pierre Lanoie pierre@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 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). June was cool and wet resulting in below average temperatures and above average precipitation. There were 17.2 inches of rainfall from planting to harvest. June through September saw cooler temperatures than average, but from seeding and establishment in May until harvest in September, there were 2684 Growing Degree Days (GDDs) accumulated, which saw no departure from normal.

Table 4. Seasonal weather data collected in Alburgh, VT, 2022.

Alburgh, VT	May	June	July	August	Sept	Oct
Average temperature (°F)	60.5	65.3	71.9	70.5	60.7	51.5
Departure from normal	2.09	-2.81	-0.54	-0.20	-1.99	1.24
Precipitation (inches)	3.36	8.19	3.00	4.94	4.40	2.56
Departure from normal	-0.40	3.93	-1.06	1.40	0.73	-1.27
Growing Degree Days (32-95°F)	394	459	674	630	343	184
Departure from normal	93	-64	-20	-11	-44	46

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, and yields data are displayed below in Tables 5 and 6. NWG 4113 had the highest population (Table 5), at 12.1 plants ft⁻² or 526,110 plants ac⁻¹, but plant populations were not statistically different between NWG 4113, NWG 4000, and NWG 2730. Carmenecta had the highest average plant height at 275 cm and was statistically taller than all other varieties. It also outperformed last year's tallest grain trial variety (Futura 75, 167cm) by over a meter. Carmenecta also produced the largest thousand kernel weight (TKW) of 22.6 g and this value was statistically similar to that of Enectarol at 20.8 g. The heavier the TKW, the more robust the grain produced, and the lower the number of seeds per pound. The TKW and "seeds per pound" values listed in Table 6 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.

Table 5. Harvest metrics by variety for industrial grain hemp, Alburgh, VT, 2022.

Variety	Populations	Populations	Average height	Average stem diameter	Female plants	Monoecious plants	Male plants
	plants ft ⁻²	plants ac ⁻¹	cm	mm	%	%	%
Altair	2.69	117363	165	10.1	0	100	0.00
Bialobreskie	2.69	157833	186	8.40	26.8	63.3	9.94*
Canda	0.74	32376	121	9.90	37.5	62.5	0.00
CFX-1	7.06	307572	91.7	5.50	49.9	8.30	41.8
CFX-2	7.90	343995	102	6.20	47.0	11.5	41.5
Carmenecta	2.32	101175	275	15.7	60.7*	10.0	29.3
Enectarol	6.88	299478	216	9.30	72.0*	1.60	26.4
Fedora 17	6.69	291384	146	6.50	34.6	65.4	0.00
Felina 32	8.18	356136	144	6.50	52.1	33.9	14.0*
Ferimon 12	5.76	250914	169	7.50	49.4	47.6	2.96*
Futura 83	6.41	279243	215	9.00	50.3	36.7	13.0*
Henola	5.76	250914	135	7.50	17.8	73.5	8.71*
Joey	6.50	283290	140	7.30	29.9	32.8	37.3
Lara	4.83	210444	178	6.90	20.1	70.2	9.66*
NWG 2463	8.45	368277	136	6.30	49.8	0.00	50.2
NWG 2730	11.8*	513969*	164	6.70	60.8*	0.00	39.2
NWG 4000	10.0*	437076*	150	6.60	58.5*	0.00	41.5
NWG 4113	12.1	526110	170	6.40	48.1	0.00	51.9
Orion 33	4.09	178068	202	9.70	38.2	61.8	0.00
USO 31	5.20	226632	166	6.20	40.0	58.8	1.19*
Vega	5.48	238773	148	7.80	21.7	78.3*	0.00
X59	2.51	109269	109	5.90	76.9	0.00	23.1
LSD (0.10)	3.30	143573	28.8	1.50	24.7	23.4	15.7
Trial mean	6.14	267286	161	7.80	42.8	37.1	20.1

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

Table 6. Harvest yields and oil content by variety for industrial grain hemp, Alburgh, VT, 2022.

Variety	Harvest date	Grain moisture	Thousand kernel weight	Seeds	Grain yield	Grain yield @ 10% moisture
		%	g	seeds lb ⁻¹	lbs ac ⁻¹	lbs ac ⁻¹
Altair	9-Sep	16.4	15.0	30431	968	896
Bialobrzieskie	14-Sep	12.1	15.8	28878	1074	1060
Canda	9-Sep	15.3	17.0	26916	584	542
CFX-1	9-Sep	18.7*	16.8	27456	913	812
CFX-2	9-Sep	14.4	15.8	28946	744	707
Carmenecta	20-Oct	19.6*	22.6	20394	1837	1596
Enectarol	20-Oct	19.8*	20.8*	21870*	1121	961
Fedora 17	14-Sep	15.1	16.8	27146	1759	1675
Felina 32	14-Sep	13.3	16.8	27099	1850	1787
Ferimon 12	14-Sep	7.90	15.8	28823	1533	1569
Futura 83	14-Sep	8.60	17.3	26571	3265	3314
Henola	14-Sep	15.8	16.0	28461	1998	1888
Joey	9-Sep	19.4*	18.3	25315	1326	1209
Lara	14-Sep	12.2	16.3	28091	1262	1235
NWG 2463	20-Sep	20.8*	15.3	29891	2163	1909
NWG 2730	20-Sep	24.8	14.5	31677	1608	1338
NWG 4000	20-Sep	22.7*	15.0	30431	1816	1533
NWG 4113	20-Sep	22.2*	14.8	30848	2099	1804
Orion 33	14-Sep	11.7	18.0	25239	2598	2535
USO 31	14-Sep	17.0	16.0	28406	723	680
Vega	9-Sep	19.5*	16.3	28688	1305	1172
X59	14-Sep	15.1	17.3	26499	2366	2290
LSD (0.10)	--	7.60	1.82	3006.2	654	620.5
Trial mean	--	16.4	16.7	27640	1587	1481

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

Hemp varieties are classified as either Monoecious or Dioecious. The definitions of these classifications are as follows: Monoecious plants are defined by having both the male and female reproductive organs in the same individual, while dioecious plants have male and female reproductive organs in separate individuals. All hemp is naturally dioecious, and varieties will revert to this natural state without human intervention. Therefore, Monoecious characterization is actually a result of careful plant breeding and maintenance with the goal of increasing grain yield and fiber quality. A monoecious variety stand will still consist of all three sexes of plants, with the majority of the stand presenting as monoecious. The number of pure males to be expected in each variety is usually acknowledged in the variety description written by the plant breeder. Routinely, there is up to 10% pure males within a monoecious variety, but the number of males in a stand can increase from year to year and from field to field in both monoecious and dioecious varieties due to stress. Stress can manifest as things like weather events or lack of nutrients, and the plants are most vulnerable to stress in the early stages of crop growth. In dioecious varieties, male plants can account for up to 50% of the plant population.

Futura 83 produced the highest yield of grain at 3314 lbs ac⁻¹ at 10% moisture (Table 6). No varieties performed statistically similarly to this high production French variety. Interestingly, Futura 83 was also the top performer in our 2022 fiber trials in terms of height, vigor, bast fiber ratio, and dry matter yield. Other varieties with noteworthy yields included Orion 33, X59, NWG 2463, NWG 4114, and Henola. According to the USDA, the average yield for grain hemp in the US in 2021 was estimated at 530 lbs ac⁻¹. All of the varieties in our trial surpassed that national average, and our trial average was nearly three times that of the national average. The lowest yields in the trial belonged to variety Canda, which may have been a result of poor germination.

DISCUSSION

In 2022, timing of grain maturity differed widely amongst the varieties with harvest spanning from 9-Sep to 20-Oct. This is especially important to take into consideration when selecting grain varieties for production based on your region. Those varieties harvested in the beginning of September would be more well suited for production in more northern climates and would have the opportunity to fully mature, whereas those harvested late into October would be better suited for more southern regions. Based on past experience, the trial was outfitted with both an air cannon and a laser to reduce bird predation in the later months of the season as the seeds set. Two varieties worth mentioning here are Italian varieties Carmenecta and Enectarol. They were the tallest varieties in the trial and also took the longest to mature, growing well into October before their harvest date of 20-Oct. Even still, at harvest they were among the wettest of grains, which suggests that in a milder climate, they could have continued maturing, producing seed, and drying down deep into the fall. They also produced the heaviest seeds with the largest thousand kernel weights of 22.6 and 20.8 g respectively.

Yields averaged 1481 lbs ac⁻¹ at 10% moisture, which was greater than our 2021 trial average of 1180 lbs ac⁻¹ at 10% moisture, and nearly three times the 2021 national average of 530 lbs ac⁻¹ as purported by the USDA. Futura 83 was the top performer from this year's trial in terms of grain yield, though unfortunately oil was not able to be pressed from any of the harvested grain due to mechanical malfunction. In the event that one is pressing oil from the seed, grain hemp should be harvested 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 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. A wide number of new or more accessible varieties yielded well in our 2022 trial and will likely be evaluated in future years to further determine suitability in our climate. 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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