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# **2024 Industrial Grain Hemp Variety Trial**



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## 2024 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 can be used for human and animal consumption or as a natural soil amendment. The fiber has high tensile strength and can be used to create cloth, rope, building materials, and bioplastics. 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 suitable cultivars for the region.

### MATERIALS AND METHODS

The trial was initiated at Borderview Research Farm in Alburgh, Vermont to evaluate yield potential of hemp grain varieties in the Northeast (Table 1). The experimental design was a randomized complete block with four replications. The seed bed was prepared with a Pottinger TerraDisc™. Twelve grain and dual-purpose hemp varieties (Table 2) were planted into 5 x 20' plots at a target rate of 680,000 live seeds ac<sup>-1</sup> on 20-May with a Great Plains NT60 Cone Seeder. The soil type was Benson rocky silt loam with 8-10% slopes, and the previous crop was soybean.

**Table 1. Agronomic information for the industrial hemp grain variety trial, Alburgh, VT, 2024.**

<b>Location</b>	<b>Borderview Research Farm Alburgh, VT</b>
<b>Soil type</b>	Benson rocky silt loam over shaly limestone, 8 to 10% slope
<b>Previous crop</b>	Soybeans
<b>Plot size (ft)</b>	5 x 20
<b>Planting date</b>	20-May
<b>Row spacing</b>	7"
<b>Replicates</b>	4
<b>Planting equipment</b>	Great Plains NT60 Cone Seeder
<b>Seeding rate (live seed m<sup>2</sup>)</b>	168
<b>Harvest date</b>	29-Aug, 10-Sep, 8-Oct

Seed was sourced from multiple companies displayed below in Tables 2 and 3. On 29-May, 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 29-Aug, 10-Sep and 8-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 were also determined for each variety.

**Table 2. Hemp grain varieties evaluated in the hemp trial, Alburgh, VT, 2024.**

Variety	Seed source	Days to maturity	Thousand kernel weight	Seed
			g	lb <sup>-1</sup>
Bialobrzkeski	International Hemp	110-115	15.0	2,9842
Carmenecta	International Hemp	130-150	18.4	24,652
Futura 83	KonopiUS Seeds	110-115	19.4	23,381
GVA-H-211135 Ursa Grande	Cornell University	130-150	30.1	15,070
GVA-H-22-1061 Ursa Alta	Cornell University	150-180	25.8	17,581
Henola	International Hemp	100-110	15.0	30,240
IH Williams (SSBeta)	IND Hemp	130-150	21.2	21,396
Jurassic	Verve Seeds	110-115	21.8	20,807
Mona 16	KonopiUS Seeds	110-115	18.8	24,128
Nashinoide 15	KonopiUS Seeds	100-110	17.5	25,920
Ostara 9	KonopiUS Seeds	100-110	14.8	30,649
X59	IND Hemp	100-110	13.8	32,870

**Table 3. Participating seed companies and contact information.**

Company	Contact Information
Cornell University	Larry Smart lbs33@cornell.edu
IND Hemp	Dalton Wittmer dalton.wittmer@indhemp.com
International Hemp	Eric Singular Eric@international-hemp.com
KonopiUS Seeds	Corbett Miteff <a href="mailto:mcmiteff@gmail.com">mcmiteff@gmail.com</a>
Verve Seeds	Jeff Kostuik jeff@verveseeds.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	<b>9.0</b>
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). May was warmer than average and provided excellent conditions for planting, germination, and emergence. June, July, and August all saw more precipitation than normal with 6.65, 6.67, and 5.78 in of rain, respectively. For the duration of the trial, every month experienced warmer than usual temperatures except for August, which produced an average temperature that was 1.45 degrees colder than data from previous years. Overall, from May to September there were 23.98 inches of precipitation and 2707 Growing Degree Days (GDDs) accumulated, which was 4.69 in of rain and 158 GDDs more than the 30 year average.

**Table 4. Seasonal weather data collected in Alburgh, VT, 2024.**

Alburgh, VT	May	June	July	August	Sept	Oct
Average temperature (°F)	61.9	68.5	73.7	69.2	64.7	52.1
Departure from normal	3.47	0.95	1.33	-1.45	2.02	1.81
<hr/>						
Precipitation (inches)	2.27	6.65	6.67	5.78	2.61	2.00
Departure from normal	-1.49	2.39	2.61	2.24	-1.06	-1.83
<hr/>						
Growing Degree Days (32-95°F)	388	548	732	595	444	628
Departure from normal	87	25	37	-47	56	60

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. Ursa Grande had the highest harvest populations at 9.5 plants ft<sup>-2</sup> or 412,780 plants ac<sup>-1</sup> but there was otherwise no significant statistical difference in populations amongst the varieties (Table 5). Ursa Grande also produced the tallest plants with an average height of 282 cm alongside the statistically similar Ursa Alta at 269 cm. Ostara 9 had the

largest average stem diameter in the trial at 12.5mm but, like in the case of populations, no statistically significant difference was observed in stem diameter between varieties.

**Table 5. Harvest metrics by variety for industrial grain hemp, Alburgh, VT, 2024.**

Variety	Population plants ft <sup>-2</sup>	Population plants ac <sup>-1</sup>	Average height cm	Average stem diameter mm	Male plants %	Female plants %	Monoecious plants %
Bialobrzieski	8.20	356124	193	8.60	3.50*	42.1	42.3*
Carmenecta	5.80	250905	247	9.90	34.6	58.7*	0.00
Futura 83	7.60	331843	228	8.90	<b>0.00</b>	46.6	<b>50.7</b>
GVA-H-211135 Ursa Grande	<b>9.50</b>	<b>412780</b>	<b>282</b>	10.3	42.4	46.7	0.00
GVA-H-22-1061 Ursa Alta	7.50	327796	269*†	9.70	38.2	58.1	0.00
Henola	6.90	299468	124	9.60	7.40*	<b>77.5</b>	15.1
IH Williams (SSBeta)	6.80	295421	233	10.4	33.3	61.8*	0.00
Jurassic	5.90	258999	195	7.50	26.7	60.8*	10.4
Mona 16	8.80	384452	184	9.30	13.9*	54.8	21.3
Nashinoide 15	7.00	303515	200	10.0	2.20*	72.6*	14.1
Ostara 9	7.40	323749	166	<b>12.5</b>	7.60*	76.2*	9.60
X59	5.70	246858	105	8.40	28.0	72.0*	0.00
<b>LSD (p=0.10)‡</b>	<b>NS§</b>	<b>NS</b>	<b>26.7</b>	<b>NS</b>	<b>15.4</b>	<b>19.3</b>	<b>15.5</b>
<b>Trial mean</b>	<b>7.26</b>	<b>315,992</b>	<b>202</b>	<b>9.60</b>	<b>19.8</b>	<b>60.6</b>	<b>13.6</b>

†Treatments marked with an asterisk did not perform statistically different than the top performing treatment shown in **bold** (p=0.10).

‡LSD; least significant at the p=0.10 level.

§NS – There was no statistical difference between treatments in a particular column (p=0.10).

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 generally 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 from a variety of biotic and abiotic factors such as weather events or lack of nutrients, and 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 was the variety in the trial with the least number of male plants (Table 5). Male plants, while necessary for hempseed production, are disadvantageous in large percentages for grain crops because they bear no seed. Statistically similar low male counts were observed for Bialobrzieski, Henola, Nashinoide 15, Ostara 9,

and Mona 16. The variety with the greatest percentage of female plants was Henola, followed by Ostara 9, Nashinoide 15, IH Williams, Jurassic, and Carmenecta. Futura 83 and Bialobrzkeski had the highest percentages of monoecious plants at 50.7% and 42.3% respectively.

**Table 6. Harvest yields and grain moisture by variety for industrial grain hemp, Alburgh, VT, 2024.**

Variety	Harvest date	Grain moisture %	Thousand kernel weight g	Seeds lb <sup>-1</sup>	Yield at 10% moisture lbs ac <sup>-1</sup>
Bialobrzkeski	10-Sep	20.1	15.9	28637	697
Carmenecta	8-Oct	19.1	21.0	21624	1839
Futura 83	10-Sep	25.8	19.6	23122	<b>3356</b>
GVA-H-211135 Ursa Grande	8-Oct	36.8*†	<b>26.0</b>	17459	3125*
GVA-H-22-1061 Ursa Alta	8-Oct	28.2	16.8	28804	160
Henola	29-Aug	24.9	13.7	<b>33242</b>	2818*
IH Williams (SSBeta)	8-Oct	26.6	19.5	23338	2770*
Jurassic	10-Sep	<b>42.2</b>	20.6	22093	2261
Mona 16	10-Sep	17.1	20.6	22097	1381
Nashinoide 15	29-Aug	19.8	17.2	26578	1163
Ostara 9	29-Aug	22.0	16.0	28597	1436
X59	29-Aug	22.2	18.4	24751	3300*
<b>LSD (0.10)‡</b>		<b>10.9</b>	<b>2.12</b>	<b>3634</b>	<b>989</b>
<b>Trial mean</b>		<b>25.4</b>	<b>18.8</b>	<b>25029</b>	<b>2025</b>

†Treatments marked with an asterisk did not perform statistically different than the top performing treatment shown in **bold**.

‡LSD; least significant at the p=0.10 level.

According to the USDA National Hemp Report, the average yield for grain hemp in the US in 2023 was estimated at 779 lbs ac<sup>-1</sup>. All of the varieties in our trial surpassed the national average with the exception of two; Bialobrzkeski and Ursa Alta. Grain yield hinges on harvest timing, and grain must be harvested when the majority of the seed is mature in order to turn the highest profit. It is important to note that Ursa Alta was harvested on 8-Oct prior to reaching maturity, even after growing for 141 days. Given that our farm is situated on the 49<sup>th</sup> parallel, Ursa Alta is not well-suited for grain production at our latitude and would be a better fit for a more southerly location. It is likely that Bialobrzkeski was also harvested shy of its ideal harvest window for maximizing grain yield. Futura 83 produced the highest grain yield at 3,356 lbs ac<sup>-1</sup> and was statistically similar to Ursa Grande, Henola, and IH Williams (Table 6). Futura 83 was also the highest yielder in both of our 2022 and 2023 hemp grain trials (Figure 1). Yields from our variety trials across 2021-2024 have ranged from 160-3356 lbs ac<sup>-1</sup> with those trialed across each year represented below. Numerous varieties have been evaluated in the trial for multiple years, while others were new to the trial this year, so yield information may only represent a single season.

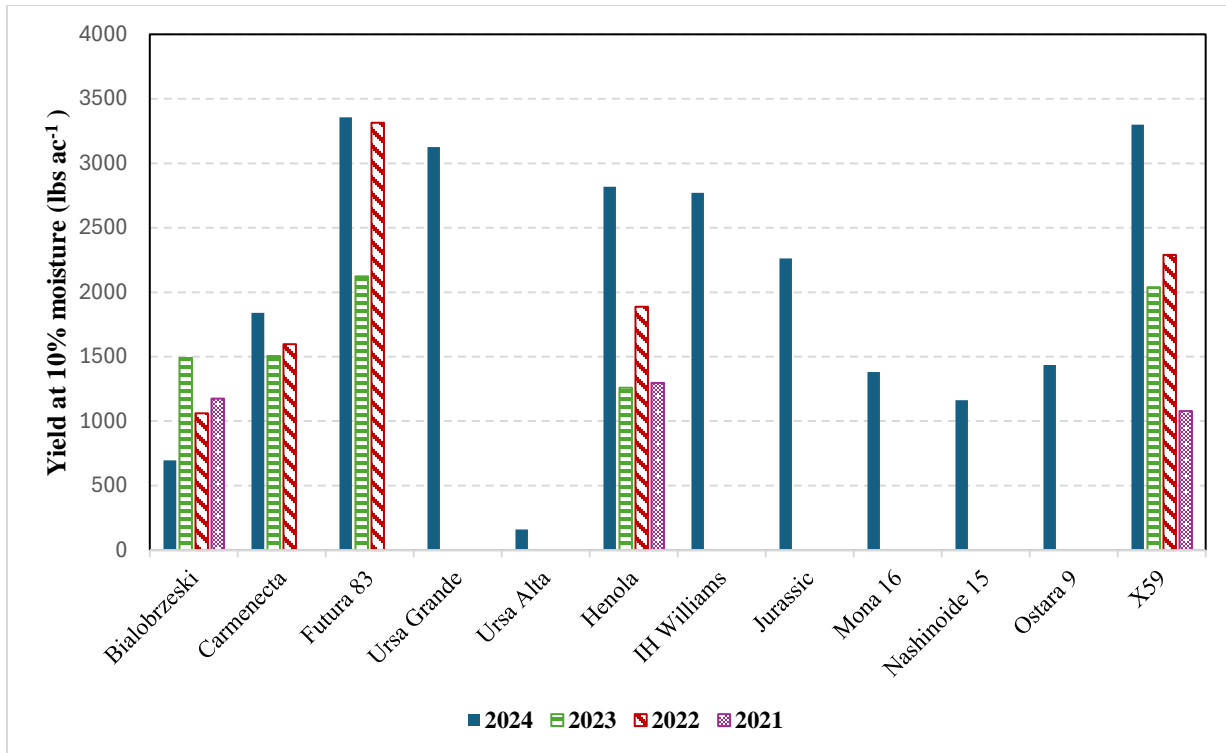


Figure 1. Hemp variety grain yields from 2021, 2022, 2023, and 2024. Alburgh, VT.

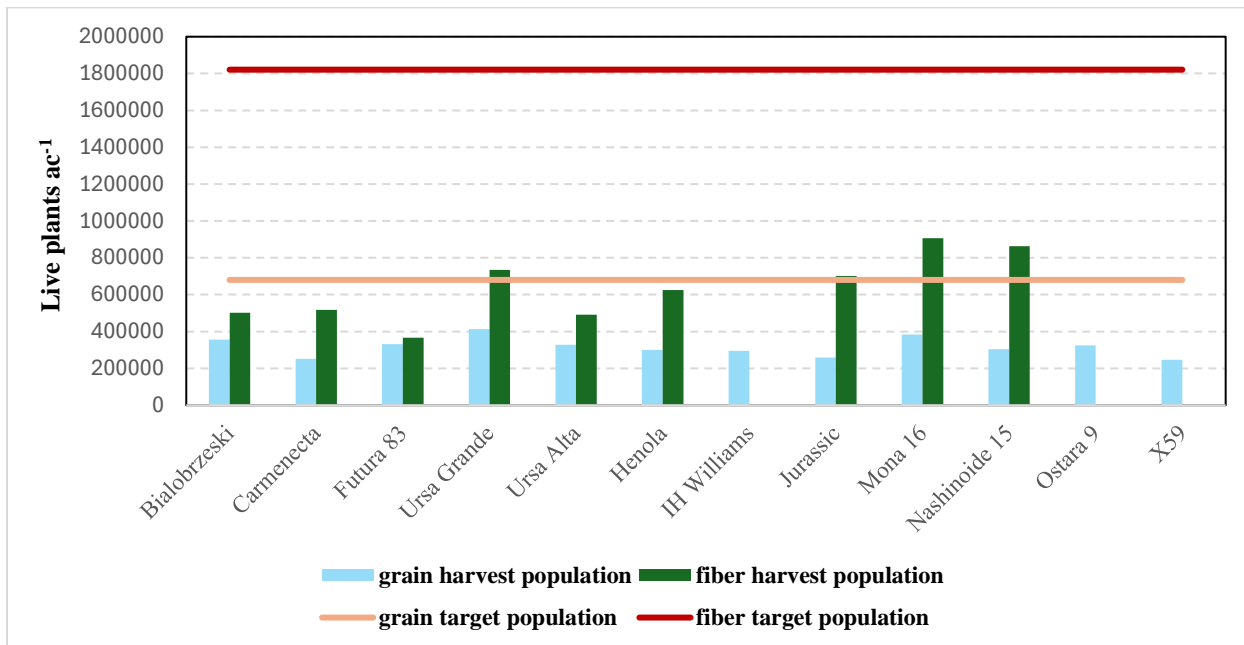


Figure 2. Harvest populations and target populations of varieties grown in the 2024 hemp fiber and grain variety trials, Alburgh, VT. Solid top line is fiber target population.

Figure 2 shows the harvest populations of each variety in the 2024 hemp grain variety trial alongside the harvest populations of those also trialed in the fiber trial. It also includes the target populations of the grain and fiber trials, represented by lines at the 680,000 and 1,821,500 marks, respectively. The graph illustrates

that while some varieties in the fiber trial surpassed the target population of the grain trial, no variety met the targets within its designated trial. There are currently no definitive explanations for the recurring gap between harvest populations and target populations in the hemp trials, although some hypotheses have been formed. In 2025, some of our additional research will evaluate different remedies to reduce the presence of seed borne pathogens which may be causing a reduction in seed vigor.

## DISCUSSION

As in past years, the timing of grain maturity differed widely amongst varieties with harvest spanning from 29-Aug to 8-Oct. This is especially important to take into consideration when selecting grain varieties for your region. Those varieties harvested at the end of August and beginning of September are likely best suited for 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 experiences, the trial was outfitted with both an air cannon and a laser to reduce bird predation as the seeds matured. In addition to bird predation, the timing of harvest is also critical to produce a successful crop. Some shattering will be observed once grain is approaching ideal maturity as plants are indeterminate and will continue to develop. However, waiting too long can result in complete shattering or loss due to predation. The period for the 12 harvested varieties ranged over a month showing that many would be suitable for production in Vermont. However, Ursa Alta was not maturing fast enough to beat the frost in our climate. While this variety had large seed and was entered into the grain trial, it is best suited to fiber production. 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 2023 and 2024 trials and will be further evaluated in 2025. 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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