



## **Hemp Cultivar Trial – Wisconsin, 2020**

**Michael Fields Agricultural Institute  
East Troy, Wisconsin**

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### **Introduction:**

Michael Fields Agricultural Institute (MFAI) has been working with the CBD hemp crop since Wisconsin's pilot program launched in 2018. Our efforts to provide information to growers on this relatively new crop continued into 2020 when we undertook a cultivar trial in coordination with University of Wisconsin - Madison and Michigan State University. The main objective was to evaluate different cultivars that would best suit the Midwest region as well as generating information on agronomic practices for a successful crop. MFAI works in the certified organic space and the information generated can help farmers make decisions on the choice of hemp cultivars for their farm. In association with the Midwestern Hemp Database, an effort by the University of Illinois, we hope to also provide data that is useful to many other farmers who grow hemp in the Midwest. MFAI evaluated 44 cultivars and recorded various observations on plant height, flowering time, flowering duration, floral biomass at harvest and cannabinoid content over time. This information, along with that of the Land Grant Universities that partnered with MFAI will help to expand the knowledge base for hemp farmers in the Midwest. Farmers can use this data to help choose the best cultivars to plant, and breeders to decide on key traits in need of improvement.

In Wisconsin, the very beginning to the process of cultivation of hemp is to obtain a grower or processor license from DATCP, Wisconsin. This license is valid for one year and is to be renewed every year the grower plans to cultivate hemp. Hemp cultivation is guided by state and federal rules and regulations and a grower/processor is expected to always adhere to the changing rules and regulations. These also vary across state lines and the producer/processor is expected to be aware of and adhered to (all these state and federal rules). These may also be impacted by pending federal regulations. Please refer to the Wisconsin DATCP website for all rules and regulations regarding growing CBD Hemp in Wisconsin.

## Experimental Site

Our cultivar trial was conducted at the Research grounds of MFAI, East Troy, Wisconsin (42.783194, -88.422519 and 42.782724, -88.422661). The soil type was Fox loam (Fine-loamy over sandy Typic Argiudolls) with some Warsaw Silt Loam (Fine Loamy over sandy Typic Hapludalfs). Before transplanting hemp plants, a cover crop mixture of rye and white clover was planted into the prepared land on May 9<sup>th</sup>, 2020. In the trial, a total of 44 cultivars were tested in a Randomized Block Design with three replications. Out of the 44 cultivars, 26 were transplants from seedlings, 14 of them were clones and 4 were day-neutral (a.k.a. auto-flowering) cultivars. Each replication had 9 plants with a total of 27 plants for each cultivar. However, the day-neutral cultivars had 6 plants per replication and a total of 18 plants per cultivar. Feminized seeds were planted on May 12<sup>th</sup> and a few cultivars were resown on May 20<sup>th</sup> because of damage. After hardening off, transplanting of seedlings was carried out on June 17<sup>th</sup>, 2020. Clones were transplanted on June 18<sup>th</sup>, 2020. Feminized day-neutral cultivars were planted on June 11<sup>th</sup> and transplanted on June 25<sup>th</sup>, 2020. Spacing for all cultivars was 4 ft between rows and 3 ft between plants to enable intercultural operations, while the day-neutral cultivars were at 1 ft x 1 ft spacing. Irrigation was provided three times, when needed. Composted chicken manure was added at 1 lbs./plant 35 days after transplanting as rye provided great competition during the initial growth stages. fertility was supplemented with AgroThrive LF 2.5-2.5-1.5 fish emulsion applied in the irrigation water at a rate of 2 oz. per gallon, 3-4 times during the peak season. The cover crops and weeds were cut back every week by mowing close to the ground to keep off competition.

## Weather Data

The recorded weather data for East Troy, Wisconsin during the cropping season is thus: an average maximum temperature of 76.7 °F was recorded in July and a minimum temperature of 48.8 °F recorded in October. Highest rainfall of 4.25 inches was recorded in September, with a cropping season total of 17.52 inches.

**Table 1.** Average monthly weather data for East Troy, Wisconsin in 2020.

	Jun.	Jul.	Aug.	Sept.	Oct.
Average Temp (°F)	69.8	76.7	73.4	63.7	48.8
*Total Precipitation (in)	2.05	3.10	3.90	4.25	4.22

(Temperature data retrieved from National Weather Service, NOAA, 2020, Milwaukee)

\* Data collected at MFAI field site at East Troy, Wisconsin, 2020)

## Trait Evaluation

### *Plant Height*

Plant height was measured from the base of the plant to the tip of the tallest inflorescence at 35, 60, 90 days after planting and at harvest. Plants were measured when growth stopped at approximately week 5 of flowering. The data was collected from 5 tagged plants for each replication, both in the seedling transplants and the clonal transplants. Plant height was recorded for all the plants of the day-neutral cultivars.

### *Flowering Time*

The plots were scouted every week and flowering data was recorded every week once the plants showed indication of flowering. All nine plants in a plot were rated for flowering. A plant was considered to be flowering when clusters of female flowers were observed at the shoot apices (terminal flowering – Fig. 1). Flowering data is presented as the average number of days after transplanting that terminal flowering occurred in 50% of the plants. Significant flowering intervals were observed for some cultivars, while others flowered consistently across individual plants/plots within a cultivar. Flowering data is presented as number of days after transplanting for clones and seedlings.



### *Cannabinoid Composition*

Flower samples were collected at seven weeks after the cultivar reached 50% flowering for testing of Cannabinoid and Total THC. Approximately 3 inches of floral tissue was collected from the top third of 15 plants for each cultivar. Floral material was sent to Rock River Laboratory (Watertown, WI) for analysis of cannabinoid potency using high-performance liquid chromatography (HPLC).

### *Whole Plant Biomass and Dry Matter Yield*

At maturity, seven weeks after achieving 50% flowering, the plants were cut at the base by hand. One plant was harvested in each replication, for a total of three plants for a cultivar, and the wet weight was recorded. The whole plants were air dried in a barn with air circulation for approximately 5 weeks. Once dried, the whole plant dry weight was recorded. They were then stripped to remove the flowers/bud and the leaf matter from the stem, which was bagged and weighed separately to give the floral yield for the cultivar.

### *Statistical Analysis of Data*

The entries in the table of results have been entered as planted in the field, for ease of observation, and does not indicate a hierarchy of value. The data were analyzed using the DMRT with a significance level of 0.05.

## Results & Discussion

Significant differences in flowering date, plant height, whole plant dry weight yield, stripped biomass yield, and cannabinoid composition were found for day-neutral (auto) flowers (Table 2 & 5), clonally propagated cultivars (Table 3 & 6) and seed propagated cultivars (Table 4 & 7).

**Table 2.** Planting date, average days to flowering, 50% flowering and harvest date for day-neutral cultivars.

Cultivar	Source	Planting Date	Av. days to flowering	50% Flowering	Harvest Date
199ENO	Beacon Hemp	6/25/2020	<b>26</b>	7/23/2020	9/14/2020
Maverick	Kayagene	6/25/2020	<b>27</b>	7/23/2020	9/14/2020
Pipeline	Kayagene	6/25/2020	<b>26</b>	7/23/2020	9/14/2020
Socati	Boring Hemp	6/25/2020	<b>27</b>	7/23/2020	9/14/2020

**Table 3.** Planting date, average days to flowering, 50% flowering and harvest date for cultivars produced by clonal propagation (clones).

Cultivar	Source	Planting Date	Av. days to flowering	50% Flowering	Harvest Date
SB1	Sunrise Genetics	6/18/2020	40.0	8/4/2020	09/21/2020
FL 71	Sunrise Genetics	6/18/2020	70.33	8/24/2020	10/16/2020
FL70	Sunrise Genetics	6/18/2020	68.0	8/24/2020	10/17/2020
FL58	Sunrise Genetics	6/18/2020	68.0	8/24/2020	10/18/2020
FL80	Sunrise Genetics	6/18/2020	70.0	8/31/2020	10/23/2020
FL49	Sunrise Genetics	6/18/2020	68.0	8/24/2020	10/16/2020
CJ2	Sunrise Genetics	6/18/2020	46.7	8/11/2020	10/02/2020
Pure CBD	PureGene	6/18/2020	72.7	8/31/2020	10/23/2020
Pure CBG	PureGene	6/18/2020	75.0	8/31/2020	10/24/2020
Anna Lee	Front Range Biosciences	6/23/2020	72.7	8/31/2020	10/23/2020
Panakeia	Front Range Biosciences	6/23/2020	35.0	7/23/2020	9/14/2020
Hybrid #9	Front Range Biosciences	6/23/2020	63.0	8/24/2020	10/16/2020
Hybrid #5	Front Range Biosciences	6/23/2020	58.3	8/18/2020	10/08/2020
Pure CBG (FRB)	Front Range Biosciences	6/23/2020	63.0	8/24/2020	10/16/2020
Mean			62.2		
LSD (p=0.05)			4.7		

**Table 4.** Planting date, average days to flowering, 50% flowering and harvest date for cultivars produced by seed propagation (seedlings).

Cultivar	Source	Planting Date	Transplant Date	Av. Days to flowering	50% Flowering	Harvest Date
The Grand	Boring Hemp	5/12/2020	6/17/2020	76.0	08/31/2020	10/23/2020
Hempress 3	Seedified	5/12/2020	6/17/2020	71.7	08/24/2020	10/16/2020
Hot Blonde	Blue Forest Farms		6/17/2020	78.7	08/31/2020	10/23/2020
T1	Green Lynx Farms	5/12/2020	6/17/2020	69.0	08/24/2020	10/16/2020
Painted Lady	KifCure	5/12/2020	6/17/2020	71.3	08/24/2020	10/17/2020
Eighty Eight	KifCure	5/12/2020	6/17/2020	71.3	08/24/2020	10/18/2020
Silver Lining	Eastern Plains Hemp	5/12/2020	6/17/2020	73.7	08/24/2020	10/19/2020
Early Spectrum (198 MUY)	Beacon Hemp	5/12/2020	6/17/2020	59.7	08/18/2020	10/08/2020
Queen Dream	Blue Forest Farms	5/12/2020	6/17/2020	76.0	08/31/2020	10/23/2020
Early Nueve (202 EVY)	Beacon Hemp	5/12/2020	6/17/2020	46.3	08/04/2020	09/25/2020
Cherry Wine S1	Eastern Plains Hemp	5/12/2020	6/17/2020	73.7	08/24/2020	10/16/2020
Fl 71	Sunrise Geentics	5/12/2020	6/17/2020	46.0	08/31/2020	10/23/2020
Prairie Wine	Eastern Plains Hemp	5/12/2020	6/17/2020	66.7	08/24/2020	10/16/2020
Ruby 1	Green Lynx Farms	5/12/2020	6/17/2020	71.3	08/24/2020	10/17/2020
BaOx Hybrid	Infinite Tree	5/12/2020	6/17/2020	69.0	08/24/2020	10/18/2020
Buffalo Soldier	KifCure	5/12/2020	6/17/2020	59.7	08/24/2020	10/08/2020
EPG	Eastern Plains Hemp	5/12/2020	6/17/2020	66.7	08/24/2020	10/16/2020
CWS1 x EPG	Eastern Plains Hemp	5/12/2020	6/17/2020	71.3	08/24/2020	10/17/2020
Florence	Infinite Tree	5/12/2020	6/17/2020	73.7	08/24/2020	10/18/2020
C2 (Stellar Cherry)	Boring Hemp	5/12/2020	6/17/2020	74.3	08/31/2020	10/23/2020
OTTO II	KifCure	5/12/2020	6/17/2020	74.3	08/31/2020	10/24/2020

Stormy	Blue Forest Farms	5/12/2020	6/17/2020	84.0	08/31/2020	10/25/2020
Angie*	Front Range Biosciences	unknown	6/23/2020	51.3	08/18/2020	10/08/2020
Pure CBD Lite*	PureGene	unknown	6/23/2020	58.3	08/11/2020	10/02/2020
Pure CBG*	PureGene	unknown	6/23/2020	63.0	08/24/2020	10/16/2020
Hybrid #5*	Front Range Biosciences	unknown	6/23/2020	67.8	08/24/2020	10/16/2020
Mean				69.0		
LSD (p=0.05)				9.5		

\*Indicates cultivars sent as seedling liners and planted 6 days later.

**Table 5.** Plant height, dry whole plant weight and cannabinoid composition for day-neutral cultivars.

Cultivar	Source	Plant height		CBG (%)	THC (%)	CBD:THC ratio
		(cm)	CBD (%)			
Auto Tune (199ENO)*	Beacon Hemp	9.7	4.54	0.44	0.17	23.6
Maverick*	Kayagene	18.0	4.71	0.28	0.17	28.3
Pipeline*	Kayagene	12.0	3.53	0.30	0.15	23.3
Socati*	Boring Hemp	16.7	4.79	0.26	0.20	24.3

\*The stripped plant biomass was <0.01 kg per plant and was not accounted.

**Table 6.** Plant height, dry whole plant weight, striped biomass and cannabinoid composition for clonally propagated (clone) cultivars

Cultivar	Source	Plant Height (cm)	Dry Whole Plant		CBD (%)	CBG (%)	THC (%)	CBD:THC Ratio
			Weight (kg/plt)	Stripped Biomass (kg/plt)				
SB1	Sunrise Genetics	51.8 <sup>fg</sup>	0.04 <sup>ef</sup>	0.03 <sup>f</sup>	7.53	0.29	0.31	24.6
FL 71	Sunrise Genetics	70.2 <sup>a-d</sup>	0.14 <sup>bc</sup>	0.11 <sup>bc</sup>	5.18	1.42	0.19	28.0
FL70	Sunrise Genetics	83.7 <sup>a</sup>	0.15 <sup>bc</sup>	0.11 <sup>bc</sup>	10.02	0.28	0.32	31.4
FL58	Sunrise Genetics	63.9 <sup>b-f</sup>	0.13 <sup>bc</sup>	0.10 <sup>bc</sup>	8.84	0.42	0.32	27.2
FL80	Sunrise Genetics	78.0 <sup>ab</sup>	0.12 <sup>b-d</sup>	0.10 <sup>b-d</sup>	10.51	0.28	0.39	26.9
FL49	Sunrise Genetics	76.3 <sup>a-c</sup>	0.15 <sup>bc</sup>	0.11 <sup>bc</sup>	10.33	0.21	0.35	29.9

CJ2	Sunrise Genetics	66.1 <sup>b-e</sup>	0.06 <sup>d-f</sup>	0.04 <sup>ef</sup>	9.93	0.54	0.10	24.7
Pure CBD	PureGene	58.1 <sup>d-g</sup>	0.16 <sup>b</sup>	0.13 <sup>b</sup>	11.46	0.64	0.41*	28.2
Pure CBG	PureGene	61.7 <sup>d-f</sup>	0.23 <sup>a</sup>	0.20 <sup>a</sup>	0.38	2.27	0.19	0.00
Anna Lee	Front Range Biosciences	68.7 <sup>b-d</sup>	0.09 <sup>c-f</sup>	0.07 <sup>c-f</sup>	7.04	0.34	0.08 <sup>1</sup>	82.7 <sup>2</sup>
Panakeia	Front Range Biosciences	63.0 <sup>c-f</sup>	0.03 <sup>f</sup>	0.02 <sup>f</sup>	0.03	7.57	0.0	0.00
Hybrid #9	Front Range Biosciences	54.4 <sup>e-g</sup>	0.05 <sup>d-f</sup>	0.05 <sup>d-f</sup>	7.48	0.30	0.24	31.6
Hybrid #5	Front Range Biosciences	45.6 <sup>g</sup>	0.03 <sup>ef</sup>	0.02 <sup>f</sup>	8.18	0.31	0.30	27.3
Pure CBG (FRB)	Front Range Biosciences	50.3 <sup>fg</sup>	0.10 <sup>b-e</sup>	0.09 <sup>b-e</sup>	0.06	4.07	0.04	0.00
Mean		63.7	0.1	0.08				
LSD (p=0.05)		10.1	0.07	0.05				

(\*Cultivar recorded THC >0.39 at harvest)

<sup>1</sup>showed very low THC values at harvest after exposure to several frost events

<sup>2</sup>CBD:THC ratio very high due to several frost events

**Table 7.** Plant height, dry whole plant weight, striped biomass and cannabinoid composition for seed propagated (seedling) cultivars.

Cultivar	Source	Plant Height (cm)	Dry Whole Plant Weight (kg/plt)	Stripped Biomass (kg/plt)	CBD (%)	CBG (%)	THC (%)	CBD:THC Ratio
The Grand	Boring Hemp	78.4 <sup>h-m</sup>	0.11 <sup>g-l</sup>	0.09 <sup>e-k</sup>	8.45	0.12	0.28	29.7
Hempres 3	Seedified	81.4 <sup>g-k</sup>	0.24 <sup>a-e</sup>	0.21 <sup>a-b</sup>	5.78	1.45	0.24	24.3
Hot Blonde	Blue Forest Farms	75.6 <sup>j-m</sup>	0.10 <sup>h-l</sup>	0.09 <sup>g-k</sup>	7.53	0.17	0.11 <sup>1</sup>	69.8 <sup>2</sup>
T1	Green Lynx Farms	116.0 <sup>ab</sup>	0.26 <sup>a-c</sup>	0.19 <sup>a-c</sup>	6.24	0.29	0.20	31.0
Painted Lady	KifCure	108.0 <sup>bc</sup>	0.30 <sup>a</sup>	0.24 <sup>a</sup>	6.81	0.35	0.24	28.3
Eighty Eight	KifCure	103.7 <sup>b-d</sup>	0.21 <sup>b-f</sup>	0.16 <sup>b-e</sup>	4.61	0.27	0.17	27.5





Hybrid #5*	Front Range Biosciences	56.5 <sup>n</sup>	0.06 <sup>kl</sup>	0.05 <sup>jk</sup>	6.44	0.24	0.20	31.7
Mean		87.3	0.17	0.12				
LSD (p=0.05)		12.5	0.09	0.07				

\*Indicates cultivars sent as seedling liners and planted 6 days later.

<sup>1</sup>showed very low THC values at harvest after exposure to several frost events

<sup>2</sup>CBD:THC ratio very high due to several frost events

Though a cover crop mixture of rye and white clover was sown in May, rye established well compared to white clover early in the season. CBD hemp seedlings and clones were transplanted



into such a field. Though it controlled broadleaved weeds early in the season, the crab grass also established along with the rye and became a very dominant competition to the crop. The cover crop had to be mowed regularly to the ground level every 8 to 10 days throughout the crop duration. The hemp plants almost did not show any growth for the first 30 to 35 days after transplanting. Additional labor had to be engaged to remove the rye and crab grass from around the root zone of the CBD hemp crop to reduce the competition, and the plants were also provided with 1 lb./plant of composted and pelleted chicken manure (4-3-2 NPK). This then brought about a rejuvenation in the plants. However, a very valuable time of 4 weeks was lost due to the intense competition. White clover started to establish and grow well during the early fall when the seasonal temperature got cooler. The plants did not benefit from the white clover planted as a cover crop during the 2020 season.

The Midwestern Database uses certain criteria such as: 1) Flowering initiated before Aug 30<sup>th</sup>; 2) average stripped floral yield of 0.5 lbs/plant; 3) Total THC for samples below 0.39; 4) total CBD for samples above 5% for determining the cultivars as ‘good potential’ ones. Using the same criteria, an effort was made to recognize the ‘good potential’ cultivars in the trial. However, due to the initial lag in growth, most of the cultivars grown in this organic trial did not produce dry floral yield higher than 0.5 lbs/ plant. The list of good potential cultivars listed here are the ones that have ranked higher in terms of yield in this trial, have satisfied the other criteria of the Midwest Database, and those that did not have high heterogeneity in the field during the growing season. All the cultivars grown from the seeds and transplanted were THC compliant.

The day-neutral cultivars did not perform well in this trial at MFAI. They were very small, and the yield was very low. Hence, they have been discounted from this experiment. The data provided with respect to the day-neutral cultivars is just to serve as a reference for the Cannabinoid profile accumulation.

With regard to the cultivars raised as clones, the dry floral yield per plant was low with all clones compared to the seedling transplants. However, the cannabinoid content was high in the clones. The FL series 71, 70, 49, 80 and 58 all performed on par with respect to yield and also recorded higher than 8% CBD, except FL 71. The cultivar Pure CBD from PureGene had higher floral



yield and CBD (11.46%) but tested high in THC when harvested at 7 weeks after 50% flowering. Among the CBG clones, Panakeia recorded the highest CBG content (7.57%) followed by the Pure CBG cultivar from Front Range Biosciences (4.07%). These are considered ‘good potential’ based on the criteria above.

Among the cultivars raised as transplants from seeds, the good potential cultivars from the trial were: Painted Lady, Hempress, T1, BaOx Hybrid, Stormy and Florence. Hempress showed a high degree of heterogeneity with auto flowering plants, and low survival rate to maturity. Stormy recorded the highest CBD (7.15%) among the cultivars listed here followed by Painted Lady (6.81%). Eighty Eight, Silver Lining, Queen Dream, Ruby 1, Prairie Wine and EPG also closely followed in terms of dry floral yield. Among these, the highest CBD was recorded with Silver Lining (8.19%). Most of these cultivars also recorded CBD higher than 7%. The highest CBD from this trail was recorded with The Grand (8.45%) and C2 (Stellar Cherry) (8.34%). However, their dry floral yield was lower than the cultivars reported earlier. Early Nueve (202 EVY) and Early Spectrum (198 MUY) were the cultivars that were ready for harvest early in the harvesting season, and escaped the frost in October. Another observation in the trial has been that when the crop flowered late which extended harvesting into late October, exposing the crop to several frost events, the THC values showed a reduction in some cultivars while CBD levels almost held steady. The frost events also degraded the quality of the flower, making it fit only for extraction.

### **Acknowledgement:**

I gratefully acknowledge the support of our Executive Director Perry Brown, my MFAI colleagues Nicole Tauges, Allison Pratt-Szeliga, Sara Krizan. I also thank Scott Fleming and Gustav Parkhurst for weekly sampling, Rock River Lab for cannabinoid testing, employees of Lotfol Greenhouse, Andrea Clemens, the Midwestern Hemp Research Team of Dr. Shelby Ellison, Asst. Professor, University of Wisconsin – Madison; Dr. James DeDecker, Director, Upper Peninsula Research and Extension Center, Michigan State University; Phillip Alberti,

Commercial Agriculture Educator, University of Illinois – Extension and Marguerite Bolt, Hemp Extension Specialist, Purdue University. I thank the seed companies for supplying the seeds and clones of different cultivars for this trial.

**Important Disclaimer:**

This is neither an endorsement nor a promotion of these cultivars or seed companies. This resource is intended to increase the knowledge on cultivar performance and to provide additional information to growers in their production endeavors. Performance of these cultivars may not be similar in another field, and varies with the resources available and the prevalent weather conditions.

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**Reports from the Midwest Hemp Research Group:**

Midwestern Hemp Database Report

[https://extension.illinois.edu/sites/default/files/2.26.21mhd\\_fact\\_sheet.pdf](https://extension.illinois.edu/sites/default/files/2.26.21mhd_fact_sheet.pdf)

Michigan State University Hemp Variety Trials

<https://www.canr.msu.edu/uprc/uploads/Grain%20Hemp%20Report%202020%20Final.pdf>  
(grain/fiber)

<https://www.canr.msu.edu/uprc/uploads/files/2020%20CBD%20Hemp%20Report.pdf> (CBD)

UW Madison Hemp Variety Trial

<https://fyi.extension.wisc.edu/hemp/files/2021/02/2020-UW-Madison-Hemp-Cultivar-Trial-Factsheet.pdf>

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