

2021 University of Illinois Hemp Cultivar Trial Cannabinoid Production



Hemp has been legal to grow in Illinois since 2019, however, there is still substantial uncertainty regarding agronomic practices and markets, including such basic information as what varieties should be grown. To address this lack of information a replicated high cannabinoid cultivar trial was conducted by the University of Illinois at Urbana-Champaign in the summer of 2021 at Simple Livin' Farms in Morton, IL; this trial was part of a larger regional effort in collaboration with the Midwestern Hemp Database Team. The main objective of the cultivar trial was to obtain data on how high cannabinoid hemp cultivars perform in different upper midwestern locations. Farmers can use this data to help choose the best cultivars to plant, and breeders to decide on key traits in need of improvement. University of Illinois at Urbana-Champaign evaluated 18 different hemp cultivars for plant height, uniformity, flowering time, biomass yield, and cannabinoid content in this trial. As a result, the information synthesized from these trials will help refine and expand the existing knowledge base and increase the successful adaptation of hemp as a viable option for Midwestern farmers.

Hemp producers and processors are required to follow state and federal regulations regarding hemp production and registration. Growers must register within their intended state for production and must adhere to the most current or active rules and regulations. Regulations are subject to change from year to year with the development and approval of proposed program rules. It is important to note that these regulations may vary across state lines and may be impacted by pending federal regulations. In 2022, hemp production is licensed under the Illinois Department of Agriculture (IDOA). Illinois recently submitted a revised Hemp Plan to the USDA for approval based on the changes to the final rule. For current rules and regulations about hemp production, visit the [IDOA Industrial Hemp website](#).

2021 Growing Season

Weather data at Simple Livin' Farms in Morton, IL, indicated that June was slightly warmer than average and had more than average rainfall. September was warmer than average with less than average rainfall. October was also slightly warmer than average with higher than average rainfall compared to normal (Table 1). The total precipitation was the highest in October (9.68 inches). The lowest precipitation was in September (1.09 inches). The soil tests showed that the soil was a silt loam texture. Soil organic matter was around 2.7% and pH was 7.1. The previous crop was oats that were planted in the spring and terminated via mowing before transplanting.

2021 Monthly Weather Data for Morton, IL					
	June	July	Aug.	Sept.	Oct.
Max Average Temp (°F)	83.5	83.9	86.2	82.7	68.3
Average Temp (°F)	74.9	75.4	76.6	71.3	60.3
Min Average Temp (°F)	65.6	66.9	67.0	59.9	52.4
Total Precipitation (in)	5.44	4.07	3.87	1.09	9.68

Table 1. Data retrieved from National Centers for Environmental Information

Experimental Location and Design

The hemp cultivar trial was conducted at Simple Livin' Farms in Morton, IL. A total of 18 cultivars were evaluated including three day-neutral cultivars and 15 photo-period sensitive cultivars. The trial was established as a randomized complete block design with three replications. Day-neutral plots consisted of 15 plants per replication at 2 ft in-row spacing and 2 ft centers.

Photo-period sensitive plots consisted of five plants per replication with 6 ft in-row spacing and 6 ft centers. Photo period-sensitive feminized seeds were planted on May 10 in the greenhouse and transplanted on June 10. Day-neutral seeds were planted on May 10 in the greenhouse and transplanted on June 10. Before field transplanting, oats were mowed, and an auger was used to

prepare a place for each plant. Weeds were then managed by hand weeding and cultivation/mowing throughout the season, keeping the base of the plants free from competition. Plots were irrigated with water as needed during peak growing periods. In total 100 lbs. N was applied using Urea; 50 lbs. during the spring and 50 lbs. applied four weeks after transplanting.

Trait Evaluation

Plant Height

Plant height was measured from the base of the plant to the tip of the tallest inflorescence. Plants were measured when growth stopped at approximately week 5 of flowering. The data is reported in inches using an average of 15 plants.

Flowering Time

Flowering data was recorded every week after planting. A cultivar reached 50% flowering when half of the plants showed extruding stigma located at the terminal inflorescence or apical bud/cola (Figure 1). Flowering data are presented as the number of days after transplanting. Significant flowering windows were observed for some cultivars, while others flowered consistently across individual plants/plots within a cultivar (Figure 6).

Cannabinoid Composition

Approximately 3 inches of floral tissue was collected from the top third of 15 plants for each cultivar. Floral material was sent to ACT Laboratories (Morton, IL) for analysis of cannabinoid potency using high-performance liquid chromatography (HPLC). Flower samples were collected at three, five, and seven weeks after the cultivar reached 50% flowering. Total THC = $\Delta 9$ THC + (THCA*0.877), Total CBD = CBD + (CBDA*0.877), Total CBG = CBG + (CBGA*0.878). Cannabinoid data was not subject to statistical analysis.

Whole Plant Dry Yield and Biomass Yield

One representative plant per replication (three plants per cultivar total) was selected for drying and yield data. Hemp plants were harvested seven weeks after flowering by hand-cutting plants at the base and hanging whole plants in a ventilated barn for approximately three weeks. Whole-plant dry weight was taken for each plant. Next, each cultivar was

stripped to remove flower/bud and leaf matter from the stem. Flower bud and leaf material were then bagged and weighed to estimate floral biomass.

Statistical Analysis of Data

The tables on the following pages have been prepared with the entries listed in alphabetical order. Height, flowering, and yield data were analyzed in R with the program agricolae, with mean separation performed using the Fisher's Protected LSD (Least Significant Difference) test. All analyses used a mixed model with treatment as a fixed effect and replicate as a random effect with an alpha level of 0.05 to determine significance. Cultivars that are within the range of the value listed for LSD are not significantly different from each other at the 5 percent level of probability.

Results

Significant differences in plant height and cannabinoid composition were found for day-neutral cultivars (Table 4 and 5). Several significant differences in flowering date, plant height, whole plant dry weight yield, stripped biomass yield, and cannabinoid composition were found for photo period sensitive cultivars (Tables 3, 6, and 7).

Only a few "CBD" cultivars remained compliant for Total THC at week 5 after flowering and none remained compliant at week 7 (Figure 2); this aligns very closely with the 30 day testing period granted by the IDOA regulations. Both "CBG" cultivars remained compliant through week 7 (Figure 2). Most cultivars continue to accumulate cannabinoids (THC, CBD, and CBG) until harvest (Figures 2, 3, and 4). The ratio of CBD to THC ranged from 20:1 to 30:1 and remained stable throughout flowering periods for "CBD" cultivars (Figure 5).



Fig. 1. Flower initiation with an arrow pointing at the extruding stigmas.

Cultivar	Source	Planting Date	Av. Flowering (Day)	50% Flowering	Harvest Date
Dr. Chunk	Kayagene	6/08/2021	10.60 ^a	6/19/2021	8/07/2021
118 Early Harvest	7-Mile Farms, LLC	6/08/2021	10.00 ^a	6/18/2021	8/06/2021
Auto Blunami	Beacon Hemp	6/08/2021	10.30 ^a	6/18/2021	8/06/2021
Mean			10.30		
LSD (p=0.05)			1.30		

Table 2. Planting date, average days to flowering, 50% flowering, and harvest date for day-neutral cultivars. There is no significant difference between cultivars sharing the same letter assignment.

Cultivar	Source	Planting Date	Transplant Date	Av. Flowering (Day)	50% Flowering	Harvest Date
BaOx Hybrid	Arrowhead Seed Co.	5/10/2021	6/08/2021	62.3cd	08/09/2021	09/27/2021
Bubbatonic	Kayagene	5/10/2021	6/08/2021	52.3fg	07/30/2021	09/17/2021
Early Cherry	Beacon Hemp	5/10/2021	6/08/2021	55.3ef	08/02/2021	09/20/2021
Early Nueve	Beacon Hemp	5/10/2021	6/08/2021	39.6i	07/18/2021	09/05/2021
Early Remedy	Beacon Hemp	5/10/2021	6/08/2021	54.7ef	08/02/2021	09/20/2021
Panakeia	Tesoro Genetics	5/10/2020	6/08/2021	38.0i	07/16/2021	09/03/2021
Rogue	Arcadia	5/10/2021	6/08/2021	60.0de	08/07/2021	09/25/2021
Santiam	Arcadia	5/10/2021	6/08/2021	67.3abc	08/14/2021	10/02/2021
71x71	Industrial Hemp Genetics	5/10/2021	6/08/2021	70.7ab	08/18/2021	10/06/2021
Silver Lining	Eastern Plains Hemp	5/10/2021	6/08/2021	66.0bcd	08/13/2021	10/01/2021
Super Wife	Trilogene Seeds	5/10/2021	6/08/2021	64.3bcd	08/11/2021	09/29/2021
Suver Haze	Oregon CBD	5/10/2021	6/08/2021	54.7ef	08/02/2021	09/20/2021
Ultra Woman	Trilogene Seeds	5/10/2021	6/08/2021	73.0a	08/20/2021	10/08/2021
Umpqua	Arcadia	5/10/2021	6/08/2021	42.3hi	07/20/2021	09/07/2021
White CBG	Oregon CBD	5/10/2021	6/08/2021	47.3gh	07/25/2021	09/12/2021
Mean				56.5		
LSD (p=0.05)				6.6		

Table 3. Planting date, average days to flowering, 50% flowering, and harvest date for photo period sensitive cultivars. There is no significant difference between cultivars sharing the same letter assignment. An asterisk indicates there were not enough viable plants to evaluate.

Cultivar	Source	Plant Height (in)	Dry Whole Plant Weight (lb)	Stripped Biomass (lb)
Dr. Chunk	Kayagene	17.8a	.38a	.29a
118 Early Harvest	7-Mile Farms, LLC	13.6b	.34a	.27a
Auto Blunami	Beacon Hemp	15.2ab	.39a	.33a
Mean		15.5	0.37	0.30
LSD (p=0.05)		3.09	.219	.188

Table 4. Plant height, dry whole plant weight, and stripped biomass for day-neutral cultivars. There is no significant difference between cultivars sharing the same letter assignment.

Cultivar	Source	CBD (%)	CBG (%)	THC (%)	CBD:THC
Dr. Chunk	Kayagene	12.36	0.22	0.49	25.5
118 Early Harvest	7-Mile Farms, LLC	9.35	0.27	0.35	26.8
Auto Blunami	Beacon Hemp	8.53	0.37	0.25	34.0

Table 5. Cannabinoid composition for day-neutral cultivars at 7 weeks after flowering. Red indicates cultivars with more than 0.3% THC.

Cultivar	Source	Plant Height (in)	Dry Whole Plant Weight (lb)	Stripped Biomass (lb)
BaOx Hybrid	Arrowhead Seed Co.	61.7a	1.58cde	0.80def
Bubbatonic	Kayagene	51.3bc	1.74cd	1.32bcd
Early Cherry	Beacon Hemp	38.7de	3.48a	2.39a
Early Nueve	Beacon Hemp	31.5e	0.85de	0.58ef
Early Remedy	Beacon Hemp	34.3de	1.57cde	1.11cde
Panakeia	Tesoro Genetics	32.7de	1.33de	0.53ef
Rogue	Arcadia	40.0de	1.26de	0.79def
Santiam	Arcadia	38.3de	1.45de	0.99cdef
71x71	Industrial Hemp Genetics	42.3cd	2.45bc	1.56bc
Silver Lining	Eastern Plains Hemp	62.7a	2.84ab	1.88ab
Super Wife	Trilogene Seeds	50.3bc	0.87de	0.58ef
Suver Haze	Oregon CBD	55.0ab	1.59cde	1.02cde
Ultra Woman	Trilogene Seeds	51.3bc	1.41de	0.86def
Umpqua	Arcadia	36.7de	0.65e	0.31f
White CBG	Oregon CBD	39.7de	1.34de	0.99cdef
Mean		44.3	1.63	1.05
LSD (p=0.05)		10.3	.96	.68

Table 5. Table 6. Plant height, dry whole plant weight, and stripped biomass for photo period sensitive cultivars. There is no significant difference between cultivars sharing the same letter assignment.

Cultivar	Source	CBD (%)	CBG (%)	THC (%)	CBD:THC
BaOx Hybrid	Arrowhead Seed Co.	9.91	0.64	0.45	21.8
Bubbatonic	Kayagene	8.60	.23	0.33	26.5
Early Cherry	Beacon Hemp	11.61	.56	0.43	27.1
Early Nueve	Beacon Hemp	12.63	.25	0.58	21.6
Early Remedy	Beacon Hemp	10.19	.51	0.44	23.0
Panakeia	Tesoro Genetics	0.00	10.28	0.00	-
Rogue	Arcadia	5.88	.59	0.33	2.1
Santiam	Arcadia	9.33	.00	0.48	19.6
71x71	Industrial Hemp Genetics	9.28	.14	0.39	24.0
Silver Lining	Eastern Plains Hemp	12.77	.60	0.55	23.4
Super Wife	Trilogene Seeds	8.87	.21	0.33	26.9
Suver Haze	Oregon CBD	12.14	.35	0.55	23.8
Ultra Woman	Trilogene Seeds	11.95	.27	0.53	22.4
Umpqua	Arcadia	7.81	.23	0.27	28.9
White CBG	Oregon CBD	0.00	13.4	0.00	-

Table 4. Cannabinoid composition for photo period sensitive cultivars at 5 weeks after flowering. Green indicates cultivars with more than 8% CBD, blue indicates cultivars with more than 4% CBG, and red indicates cultivars with more than 0.3% THC.

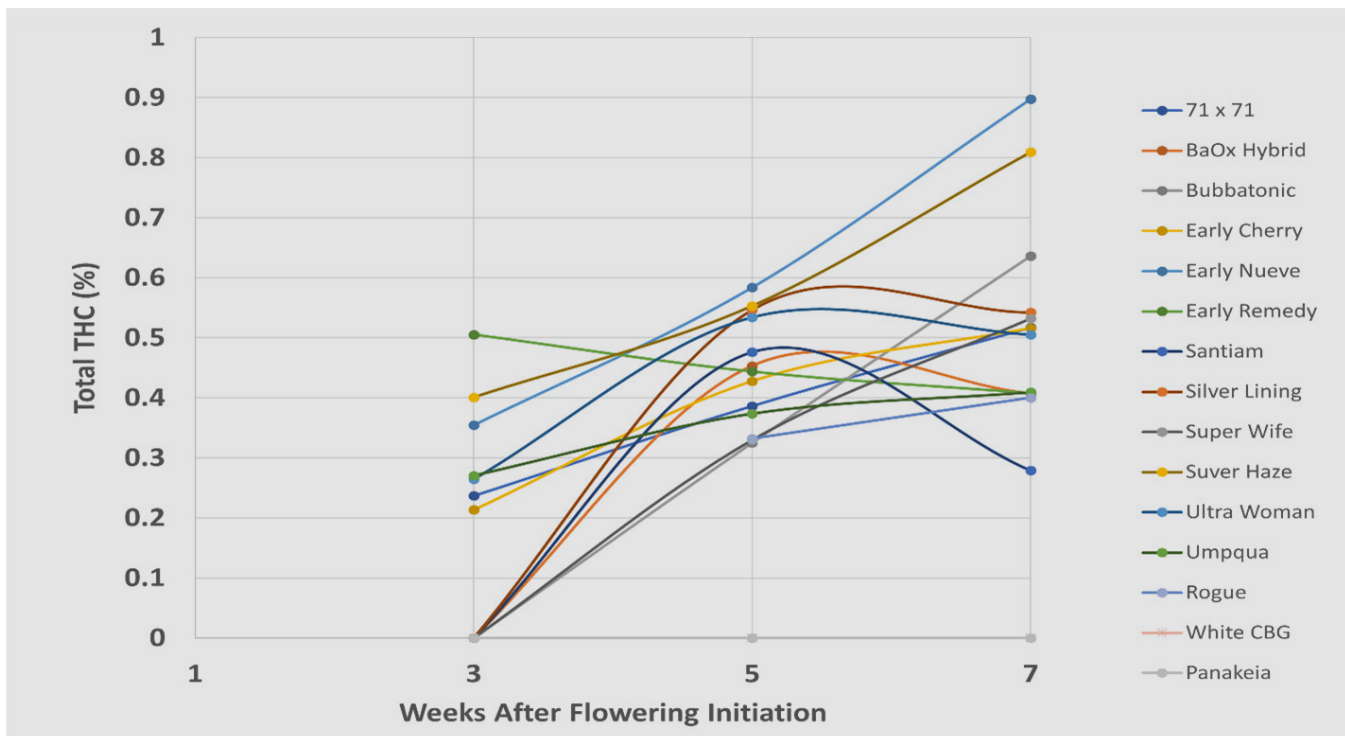


Fig. 2. Total THC (%) for “CBG” and “CBD” cultivars at 3, 5, and 7 weeks after flowering.

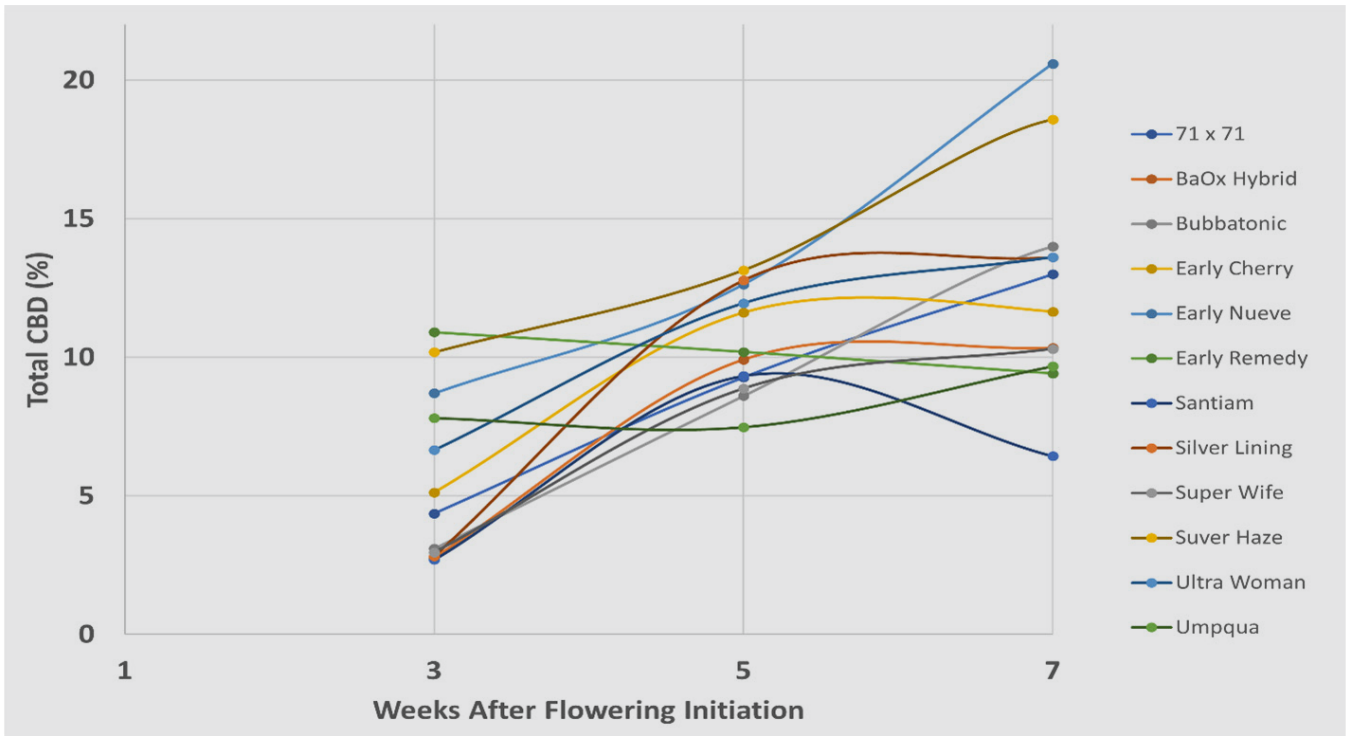


Fig. 3. Total CBD (%) for “CBD” cultivars at 3, 5, and 7 weeks after flowering.

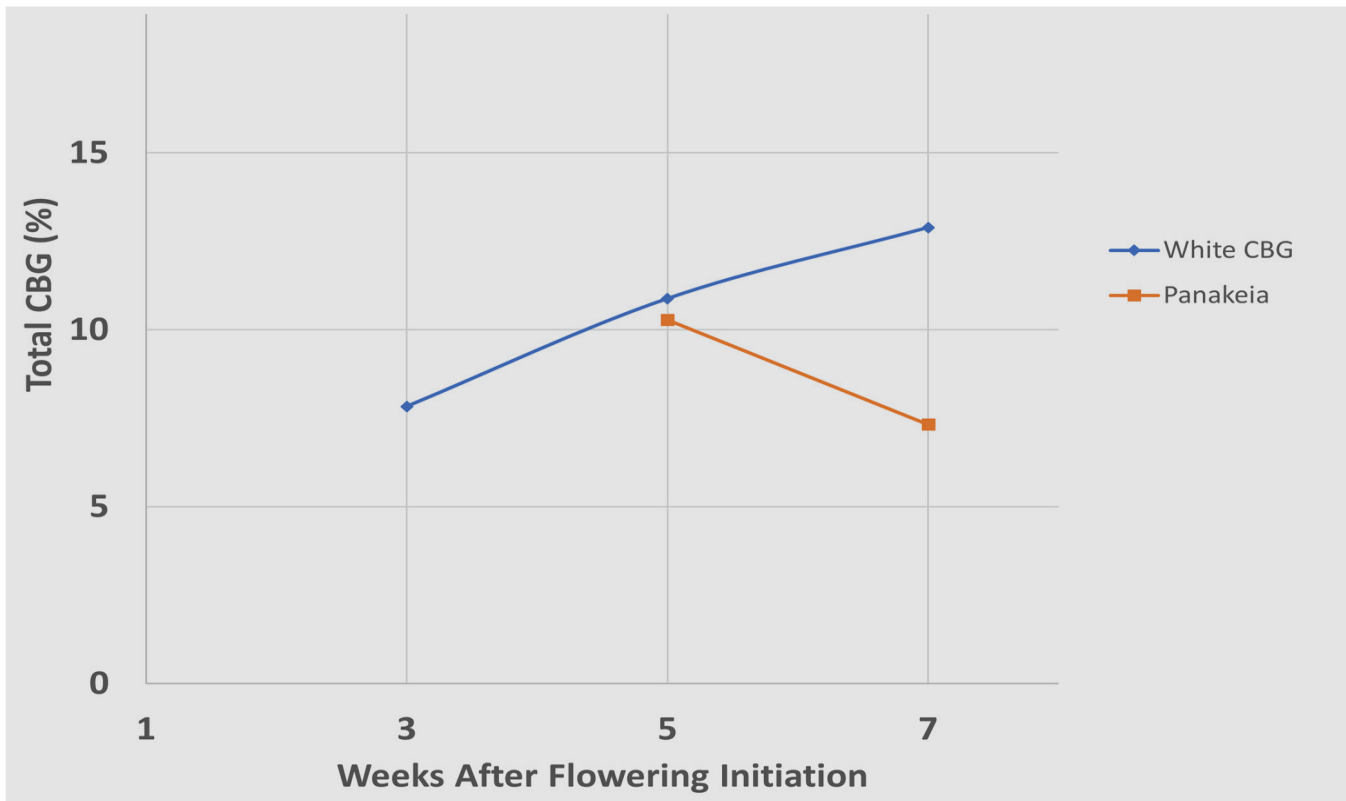


Fig. 4. Total CBG (%) for “CBG” cultivars at 3, 5, and 7 weeks after flowering. Week 3 samples of “Panakeia” have been eliminated due to sampling error.

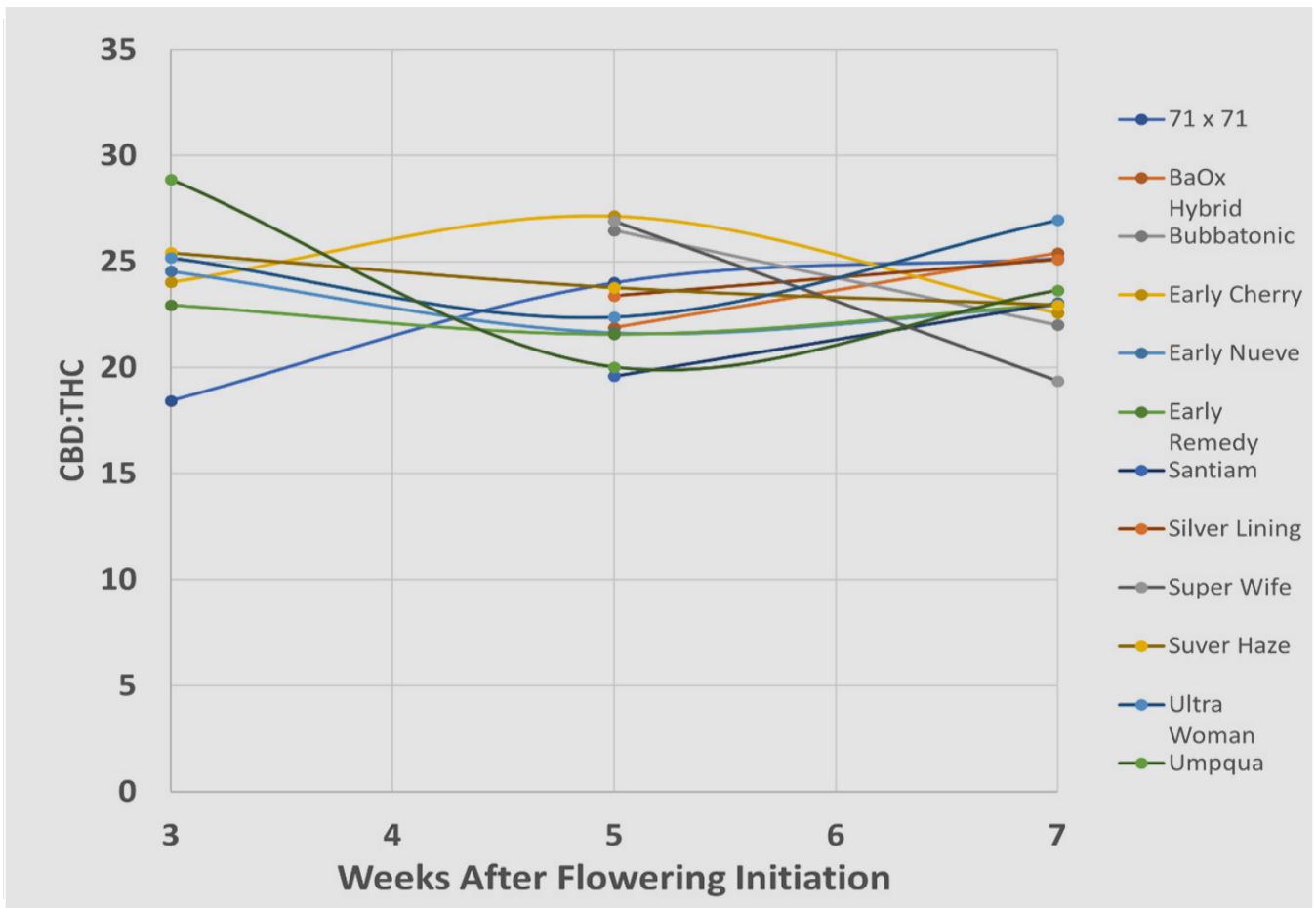


Fig. 5. Total CBD/THC ratio for “CBD” cultivars at 3, 5, and 7 weeks after flowering. Week 3 samples for several varieties (“BaOx Hybrid,” “Bubbatonic,” “Santiam,” “Silver Lining,” and “Super Wife”) are not included in this data set due to Total THC being below the limit of quantification (LOQ).

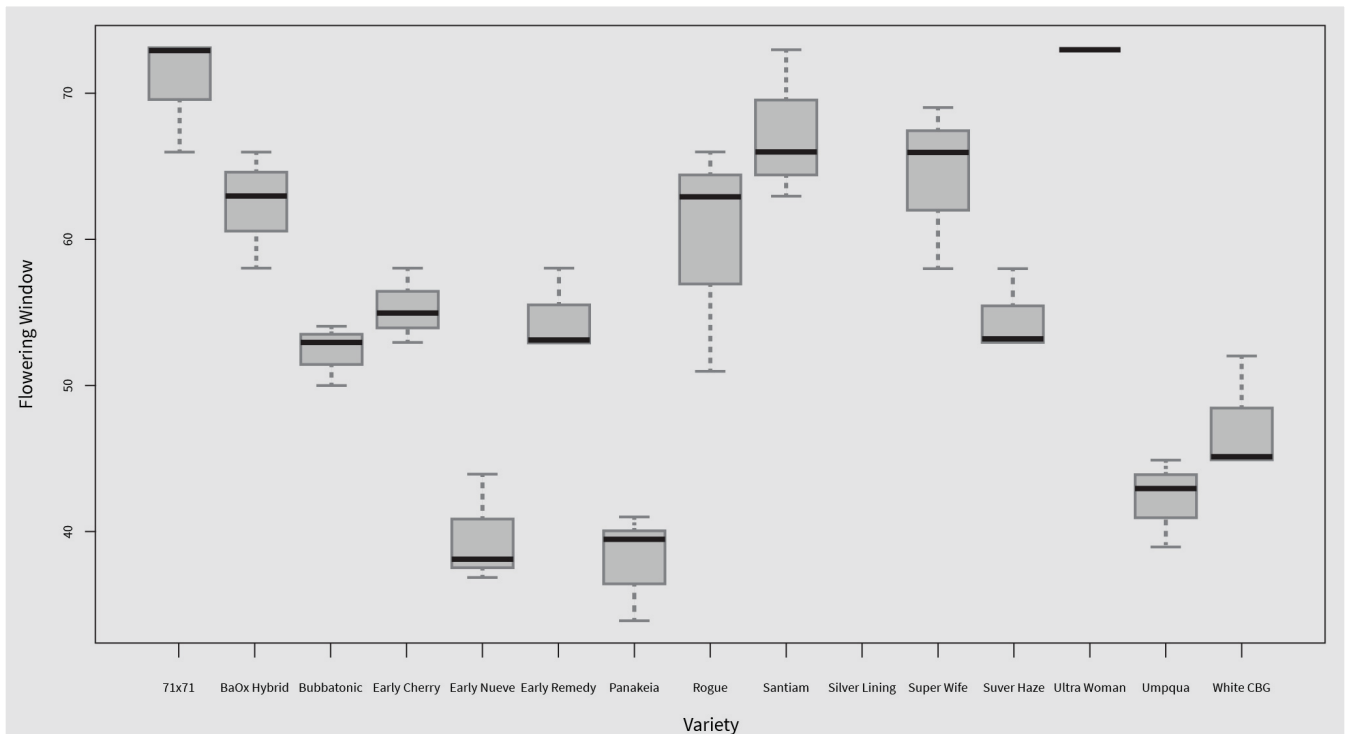


Fig. 6. Flowering Window for all “CBD” and “CBG” cultivars at Morton, IL.

Recommendations

Data from this trial only represents variety performance at one location, in one year. To better understand variety agronomic performance growers are encouraged to access university variety trials for more accurate regional information. See Additional Information.

Similarly, growers are encouraged to access the [Midwestern Hemp Database](#) and [Cultivar Check Program Report](#) for the best information available on high cannabinoid hemp cultivar performance across environments and years in the Midwest. The Midwest Hemp Database project uses the following criteria to identify CBD hemp cultivars with “good potential” in our region:

- Flowering initiated before August 30
- Average stripped floral yield above 1 lb/plant
- Average CBD:THC ratio above 25:1

Acknowledgments

This research was funded by the Sustainable Agriculture Research and Education (SARE) Partnership Grant with support from participating companies.

We gratefully acknowledge the physical, emotional, and intellectual assistance of the following individuals in conducting this trial: Paul Grethey, Chad Huette, Mason Grenier, Al Diehl, Dustin Sawyer, Scott Fleming, Esther Shekinah, James DeDecker, Shelby Ellison, and Marguerite Bolt.

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Phillip Alberti, Commercial Agriculture Educator. 2022. “2021 University of Illinois Hemp Cultivar Trial: Cannabinoid Production.” University of Illinois Extension.

Additional Information

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University of Illinois Extension, Cultivar Check Report, extension.illinois.edu/sites/default/files/2021_research_update_-_cultivar_check_program.pdf

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Michigan State University Upper Peninsula Research and Extension Center, Hemp Cultivar Trial Results, www.canr.msu.edu/uprc/specialty-crops

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Updated March 2022

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