2023 Research Report - Cultivar Check Program

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Introduction

Hemp legalization has provided a unique opportunity to build an entirely new agriculture sector. Despite an overwhelming interest in hemp, there is still substantial uncertainty regarding agronomic best management practices and the cultivars to be grown for various products or markets. Without federal seed certification standards, substantial variation between and within cultivars has been observed in hemp. This variation often presents itself as non-uniformity among growth characterisitcs, flowering, and cannabinoid development. The Association of Seed Certifying Agencies (AOSCA) provides guidance via the development of lists promoting seed stock (cultivars, varieties, or hybrids) which are eligible or recommended for certification; however, AOSCA bases its recommendations on genetic purity and phenotypic uniformity without accounting for agronomic performance or regulatory compliance. To address these issues, The Midwestern Hemp Research Collaborative (MHRC), a joint effort of land grant universities, non-profits, private laboratories and growers was formed. The MHRC conducts collaborative hemp research and outreach and maintains the Midwestern Hemp Database (MHD). The MHD has become the largest public repository in the U.S. for information on hemp cultivar performance, utilizing a vast network of grower-cooperators via the Cultivar Check Program (CCP).

Cultivar Check Program Overview

Established via a Sustainable Agriculture Research and Education (SARE) Partnership Grant in 2021, the CCP operates as a series of participatory on-farm trials using an extensive grower-cooperator network across the Midwest. The main objective of these cultivar trials is to obtain data on how high cannabinoid hemp cultivars perform (cannabinoid development and agronomic performance) across the Midwest. Utilizing findings from the MHD, a list of cultivars is chosen annually to be further evaluated via the grower cooperator network. Those cultivars which meet an established set of criteria are categorized as "good potential," and help inform cultivar selections and harvest schedules. Criteria for the "good potential" cultivars will continue to evolve in accordance with regulation and results from the CCP. Previous criteria included expected flowering dates and cannabinoid production and can be found in Alberti et al., 2021. Cultivars that achieve "good potential" status are kept in the CCP for further evaluation while those that do not meet that criteria are cut to make room for new genetic material.

As of 2023, the updated criteria for "good potential" cultivars are as follows:

- Demonstrates compliance through (or following) week 5 of flower development
- Demonstrates an average overall performance rating of 3.5 or higher
- Has been evaluated in the CCP for at least two years with n>5 at each time point

Materials and Methods

Licensed hemp growers across the Midwest (Michigan, Illinois, Indiana, and Wisconsin) were recruited to participate in the Cultivar Check Program. Each grower received a subset of cultivars consisting of CBD Dominant (Chemotype 3) and/or CBG Dominant (Chemotype 4) cultivars. Seedlings were established in late April or early May in indoor/greenhouse settings, and were allowed to develop in a greenhouse/hoop house for 4-5 weeks prior to a "hardening-off " period. Following a one week hardening-off period ~15 healthy, representative seedlings from each cultivar were transplanted into the field in mid-June. Growers were responsible for submitting various management and performance data via an online survey using the SeedLinked® platform. The following traits were rated on a scale from 1 to 5 using a semi-quantitative guide to help cooperators with their ratings:

Seed Start and Transplant Date
- The dates at which the plants were started in the greenhouse/indoor environment and transplanted into the field, respectively.

Germination
- A visual rating of germinative capacity within a cultivar (1= poor, 5= excellent).

50% Flowering Date
- The date at which half of the plants of a given cultivar had visibly initiated terminal flowering

(extruding stigma at its apical (top) inflorescence (Figure 2).

Uniformity
- A visual rating of the uniformity of plants within a cultivar (1= not uniform, 5= very uniform)

Overall Performance
- A visual rating of the overall performance of plants within a cultivar (1= poor, 5= excellent)

In addition to agronomic performance data, growers were required to submit floral samples for cannabinoid analysis at three time points: 3 weeks, 5 weeks, and 7 weeks (~21 days, 35 days, and 49 days, respectively) after the 50% flowering date. Before submitting flower samples, growers submitted pictures of plants to establish flowering dates. Flowering was confirmed by one of the project collaborators and a sampling schedule was developed. For sampling, growers followed the USDA sampling guidelines, collecting 5-8 inches of floral tissue from the top third of 5 plants for each cultivar at each sampling time point (Figure 1). The 5 flowers were placed into one bag to generate one composite sample per cultivar at each time point. Floral material was sent to Rock River Laboratories (Watertown, WI) for analysis of cannabinoid potency using high-performance liquid chromatography (HPLC). Total THC = $\Delta 9$ THC + (THCA*0.877), Total CBD = CBD + (CBDA*0.877), and Total CBG = CBG + (CBGA*0.877) .

Figure 1. A plant which has reached terminal flowering, extruding stigma at the top inflorescence (Left, Photo Credit: Shelby Ellison). This figure illustrates proper sampling locations taken from hemp inflorescence located on the top 1/3 of the plant (Right, Photo Credit: USDA Hemp Sampling Guide).

Statistical Analysis of Data

The tables on the following pages have been prepared with the entries listed first by cannabinoid development/compliance categories (Table 1) and maturity group (Table 2), and then by alphabetical order. Cannabinoid development data were analyzed in R with the program agricolae, with mean separation performed using the Fisher's Protected LSD (Least Significant Difference) test. Cultivars were evaluated separately with all analyses using a mixed model with treatment (week) as a fixed effect and location/replication as a random effect with an alpha level of 0.05 to determine significance. Cultivars that were within the range of the value listed for LSD were not significantly different from each other at a five percent level of probability. Qualitative traits (germination, uniformity, vigor, disease resistance, and overall performance) are all presented as averages across all locations for that cultivar.

Results and Discussion

A complete list of the cultivars evaluated, the source of seed, years in the program, and number of sites evaluated, can be found in Table 2. Across the 2021, 2022, and 2023 growing seasons, a total of 36 grower-cooperators (58 site-years) evaluated 39 different hemp cultivars for agronomic performance and cannabinoid development (Figure 2). As a result, the information synthesized from these trials marks a significant increase in regional hemp knowledge and is an important step towards successful adaptation of hemp as a viable option for Midwestern farmers.
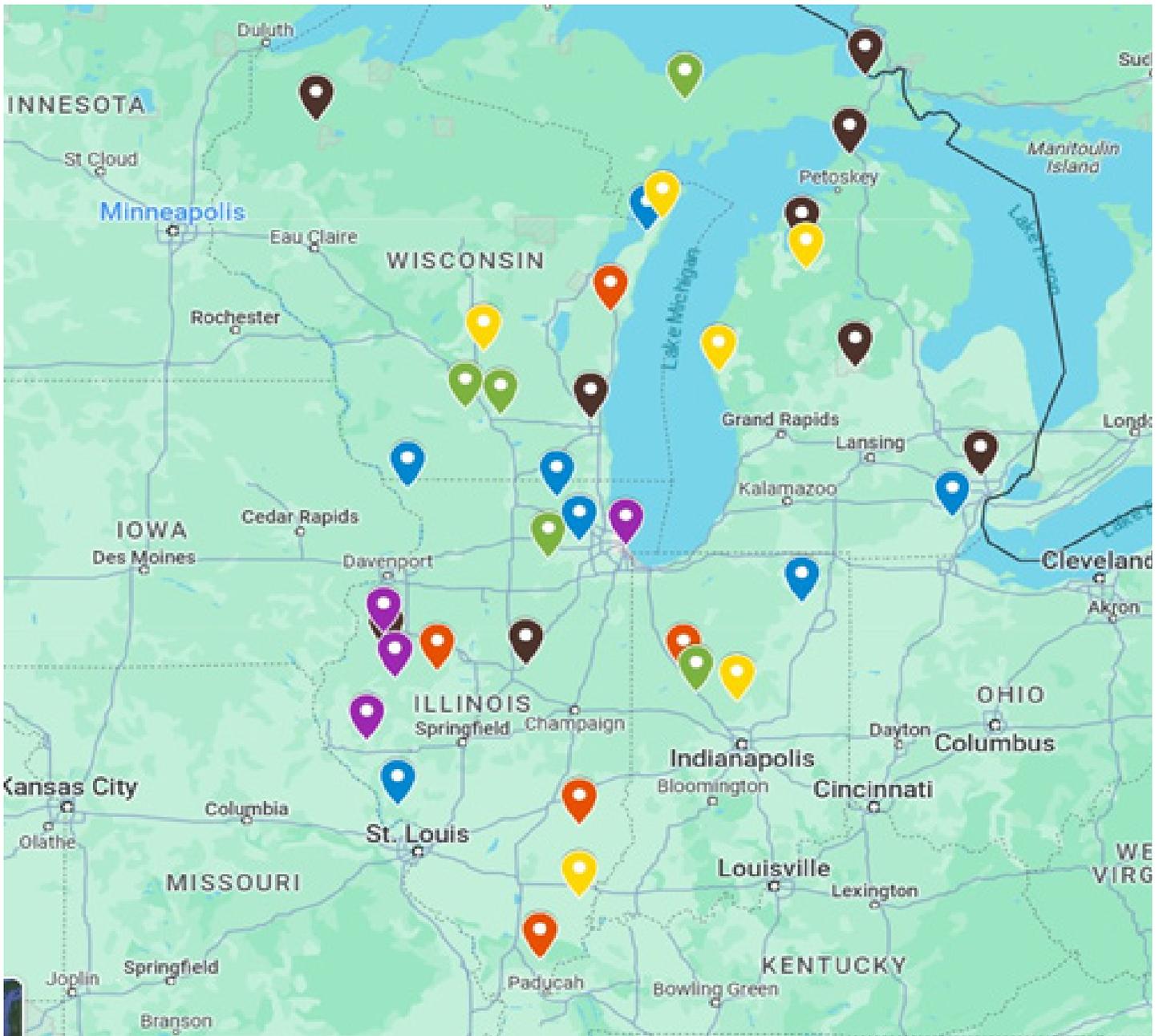
Figure. 2. Map showing geographic location of sites for MHD Cultivar Check Program. Yellow represents sites from 2021 only, black represents 2022 only, purple represents 2023 only, red represents sites from 2021 and 2022, blue represents sites from 2022 and 2023, and green represents sites from 2021, 2022, and 2023.

Cannabinoid Development

Total THC and Total CBD were impacted by cultivar and sampling period (P < 0.05). Cannabinoid data is presented as averages across all locations at each time point. THC and CBD increase as flowering progresses, with cultivars exhibiting varying optimal harvest intervals for both compliance (THC) and profit potential (CBD) (Figure 3 and Table 1). Many, if not most, CBD dominant hemp cultivars currently on the market will go "hot" (Total THC >0.3%) if not monitored appropriately during flowering. To illustrate, 25 (66%) of the 38 cultivars in the check program exceeded the regulatory limit at some point during the flowering period (Table 1).

Data from the 2021, 2022, and 2023 growing seasons has been utilized to develop estimated compliance harvest/ sampling schedules based on 95% confidence intervals for Total THC (%) (Table 1). Cultivars are subsequently broken down into the following categories based on the findings:

- Compliant Prior to Week 3 (Red)

- Compliant Through Week 3 (Orange)

- Compliant Through Week 5 (Yellow)

- Compliant Through Week 7 (Green)

The ratio of CBD toTHC concentration (CBD:THC) is impacted by cultivar and sampling period (P<0.05). As such, cultivars were evaluated individually and CBD:THC is presented in terms of averages across all locations at each time point. CBD:THC of many of the hemp cultivars were unaffected by sample timing, remaining consistent throughout flowering (Figure 3 and Table 1). Similarly, CBD:THC was unaffected by grower location, remaining consistent across environments. This supports previous work by researchers from Cornell University showing that CBD:THC remains stable throughout flowering for uniform cultivars (Campbell et al., 2019; Toth et al., 2021). Total CBD (%) infrequently exceeds ~8% without exceeding the regulatory threshold of 0.3% Total THC, *resulting in a CBD:THC of ~27:1* (Alberti 2021). Considering this, cultivars with a stable CBD:THC throughout flowering will help to maximize profitability while maintaining compliance.

For each cultivar, cannabinoid development was impacted by sampling period and location/environment (P<0.05). As such, cannabinoid data is presented in the following manner for each cultivar: Total THC (%) and Total CBG (%) are presented in terms of averages across all locations at each time point. THC and CBG increased over time, with cultivars exhibiting varying optimal harvest intervals for both compliance (THC) and profit potential (CBG) (Figure 3 and Table 1). None of the three CBG dominant cultivars exceeded the THC threshold for compliant hemp by the week 7 sampling period. Similarly, across the entire MHD data set, average Total THC (%) of CBD dominant cultivars was 0.258 compared to 0.075 for CBG dominant cultivars (Source: MHD). CBG dominant cultivars may provide an alternative cropping option for those looking to reduce risk of non-compliance compared to production of CBD dominant cultivars.

| Cultivar	Seed Provider	Years Evaluated	Weeks After Flowering	Total CBD (%) Avg.	Total CBG (%) Avg.	CBD:THC Avg.	CBG:THC Avg.	**Total THC (%) CI @95%**	# of Samples Total	# of Samples <.3% THC
Ultra Woman	Trilogene Seed Co.	2022	3	6.21	-	23.48	-	**.197 - .354**	7	5
			5	6.38	-	25.46	-	**.165 - .335**	6	5
			7	8.23	-	25.83	-	**.196 - .436**	3	2
Abacus	Arrowhead Seed Co.	2022	3	5.82b	-	21.84	-	**.207 - .322**	9	8
			5	9.16a	-	23.28	-	**.334 - .456**	8	1
			7	11.21a	-	24.56	-	**.380 - .536**	5	0
Berry Blossom	High Grade Hemp Seed	2023	3	3.04	-	20.02	-	**.101 - .210**	3	3
			5	5.42	-	22.54	-	**.140 - .351**	2	1
			7	8.29	-	24.98	-	**.271 - .401**	2	1
Boxwine	Arrowhead Seed Co.	2022	3	4.31	-	19.86b	-	**.168 - .269**	8	8
			5	7.48	-	25.29a	-	**.236 - .364**	5	3
			7	7.21	-	23.96a	-	**.198 - .401**	2	1
Early Spectrum	Beacon Hemp	2023	3	3.44b	-	19.76b	-	**.114 - .224**	11	11
			5	6.47a	-	22.33a	-	**.230 - .341**	11	7
			7	7.68a	-	24.30a	-	**.261 - .372**	11	7
Hawaiian Haze	Oregon CBD	2022/2023	3	4.99c	-	20.52b	-	**.217 - .259**	16	13
			5	7.53b	-	22.13a	-	**.314 - .358**	15	5
			7	7.65a	-	22.91a	-	**.311 - .352**	17	11
Lifter	Oregon CBD	2022/2023	3	5.61c	-	20.92c	-	**.246 - .284**	15	11
			5	8.37b	-	22.03b	-	**.355 - .392**	16	5
			7	10.41a	-	24.06a	-	**.413 - .453**	14	3
Pineapple Kush	East Fork Cultivars	2023	3	4.65b	-	21.03	-	**.136 - .309**	12	9
			5	6.18ab	-	21.87	-	**.191 - .371**	11	7
			7	7.97a	-	22.71	-	**.262 - .435**	12	6
Sour Pineapple	East Fork Cultivars	2023	3	3.83b	-	19.22	-	**.113 - .272**	10	9
			5	5.638ab	-	22.88	-	**.167 - .335**	9	6
			7	7.39a	-	22.29	-	**.249 - .419**	9	4
Suver Haze	Oregon CBD	2021/2022/2023	3	5.59c	-	23.43	-	**.199 - .264**	34	29
			5	8.63b	-	28.58	-	**.309 - .375**	32	14
			7	11.12a	-	24.96	-	**.413 - .484**	28	8
BaOX Hybrid	Arrowhead Seed Co.	2021/2022	3	3.49c	-	26.00	-	**.064 - .144**	17	17
			5	5.16b	-	28.69	-	**.111 - .206**	12	12
			7	8.13a	-	29.33	-	**.246 - .331**	15	10
Cherry Blossom	Blue Forest Farms	2022/2023	3	5.18c	-	21.20b	-	**.231 - .253**	3	3
			5	6.70b	-	22.30ab	-	**.290 - .312**	13	10
			7	8.44a	-	23.50a	-	**.352 - .374**	13	8
Cherry Blossom	Old Country Hemp	2023	3	3.11c	-	15.42	-	**.082 - .245**	3	3
			5	6.33b	-	26.61	-	**.155 - .312**	2	1
			7	8.49a	-	24.10	-	**.245 - .444**	13	6
Early Cherry	Beacon Hemp	2023	3	3.59c	-	20.74	-	**.134 - .198**	6	6
			5	5.08b	-	21.14	-	**.211 - .275**	6	5
			7	6.99a	-	23.37	-	**.266 - .330**	6	4
Early Nueve	Beacon Hemp	2021/2022	3	5.01c	-	21.94b	-	**.189 - .258**	19	18
			5	6.78b	-	26.15a	-	**.229 - .304**	18	13
			7	10.01a	-	26.41a	-	**.354 - .433**	16	5
Early Remedy	Beacon Hemp	2023	3	4.36b	-	20.86b	-	**.156 - .259**	12	12
			5	5.71b	-	22.74ab	-	**.197 - .306**	11	10
			7	7.41a	-	23.62a	-	**.266 - .374**	11	5
Hot Blonde	Blue Forest Farms	2023	3	3.59b	-	20.27	-	**.137 .218**	5	5
			5	5.57a	-	23.13	-	**.204 - .284**	5	4
			7	7.31a	--	21.62	-	**.293 - .382**	4	1
Hybrid #5	Front Range Biosciences	2021	3	3.29c	-	26.78	-	**.010 - .150**	18	17
			5	5.17b	-	29.82	-	**.080 - .190**	16	16
			7	9.62a	-	28.26	-	**.270 - .380**	16	8
Legendary Platinum	High Alpine Genetics	2023	3	4.69	-	22.06b	-	**.145 - .277**	10	8
			5	5.99	-	26.73a	-	**.192 - .340**	8	5
			7	6.23	--	21.96b	-	**.210 - .358**	8	4
Oregon Sweetgum	East Fork Cultivars	2023	3	3.24b	-	18.02b	-	**.122 - .224**	9	8
			5	5.29a	-	24.93a	-	**.168 - .277**	8	7
			7	7.15a	-	22.89ab	-	**.257 - .365**	8	3
Queen Dream	Blue Forest Farms	2022/2023	3	4.29c	-	21.31	-	**.174 - .226**	18	18
			5	6.04b	-	23.42	-	**.228 - .284**	16	12
			7	7.57a	-	26.05	-	**.282 - .338**	16	8
Silver Lining	Eastern Plains Hemp	2021	3	3.32c	-	24.66	-	**.050 - .146**	13	13
			5	5.46b	-	29.26	-	**.119 - .219**	12	11
			7	10.43a	-	27.46	-	**.320 - .412**	12	3
Super Wife	Trilogene Seed Co.	2022/2023	3	3.26c	-	20.09b	-	**.129 - .189**	10	10
			5	6.43b	-	24.42a	-	**.215 - .300**	5	4
			7	7.98a	-	23.33a	-	**.303 - .389**	5	1
T1 (Trump)	Old Country Hemp	2023	3	2.59b	-	22.29	-	**.059 - 205**	5	5
			5	3.49b	-	20.50	-	**.060 - .290**	2	2
			7	7.54a	-	24.91	-	**.209 - .397**	3	1

Table 1. Table showing cannabinoid concentrations Total THC (%), Total CBD (%), and Total CBG (%) over time from cultivars entered into the MHD Cultivar Check Program. Colors used to indicate Total THC(%) compliance for various harvest windows using a 95% confidence interval include Red (non-compliance prior to week 3), Orange (compliance through week 3), Yellow (compliance through week 5), and Green (compliance through week 7). There is no significant difference between cultivars sharing the same letter assignment. In cases where letters are missing, the values are not significantly different.

Cultivar	Seed Provider	Years Evaluated	Weeks After Flowering	Total CBD (%) Avg.	Total CBG (%) Avg.	CBD:THC Avg.	CBG:THC Avg.	Total THC (%) CI @95%	# of Samples Total	# of Samples <.3% THC
Buffalo Soldier	KifCure	2021	3	-	4.82b	-	297.08a	.000 - .000	14	14
			5	-	6.05b	-	320.59a	.000 - .040	14	14
			7	-	9.43a	-	119.06b	.050 - .110	11	11
Cherry Wine	Cheyenne Mountain Seed Co.	2022/2023	3	4.03c	-	20.78	-	.194 - .222	15	14
			5	6.14b	-	24.41	-	.238 - .268	14	12
			7	6.61a	-	24.32	-	.253 - .286	11	8
Florence	Arrowhead Seed Co.	2021/2022	3	3.16c	-	21.43b	-	.099 - .153	19	19
			5	4.66b	-	27.29a	-	.156 - .206	21	19
			7	6.88a	-	28.46a	-	.226 - .279	19	15
Matterhorn CBG	High Grade Hemp Seed	2023	3	-	2.26	-	56.58	.015 - .048	9	9
			5	-	3.81	-	46.04	.060 - .105	11	11
			7	-	3.91	-	55.13	.048 - .095	10	10
Merlot	High Grade Hemp Seed	2023	3	4.09	-	20.80	-	.141 - .245	3	3
			5	5.05	-	22.35	-	.180 - .270	4	4
			7	7.08	-	26.04	-	.211 - .315	3	3
Mountain Mango	Cheyenne Mountain Seed Co.	2022/2023	3	2.79	-	19.66	-	.174 - .226	9	9
			5	4.55	-	23.30	-	.228 - .284	12	11
			7	4.04	-	21.15	-	.282 - .338	6	6
Old Northwest	Cedar Field Farm	2023	3	4.95	-	20.45b	-	.171 .278	7	5
			5	4.13	-	19.88b	-	.134 - .276	4	4
			7	6.41	-	26.44a	-	.209 - .324	6	4
Oregon Guava	East Fork Cultivars	2023	3	3.56b	-	21.21	-	.094 - .243	9	8
			5	5.36ab	-	23.15	-	.158 - .315	8	6
			7	5.92a	-	28.27	-	.178 -.318	10	7
Quick Kush	Cheyenne Mountain Seed Co.	2022/2023	3	4.05c	-	21.25b	-	.185 - .194	14	13
			5	5.59b	-	22.9ab	-	.244 - .257	14	10
			7	7.09a	-	24.58a	-	.283 - .293	10	5
Rosado	Cedar Field Farm	2023	3	3.16	-	21.52b	-	.076 - .219	10	9
			5	4.49	-	23.8b	-	.099 - .285	6	5
			7	5.51	-	29.07a	-	.109 - .294	6	5
StemCell CBG	Oregon CBD	2022/2023	3	-	4.29b	-	47.67	.073 - .101	23	23
			5	-	5.50a	-	55.00	.084 - .113	21	21
			7	-	6.65a	-	47.50	.121 - .152	18	17
Superwoman	Trilogene Seed Co.	2023	3	2.57b	-	18.78	-	.089 - .189	4	4
			5	4.81ab	-	24.72	-	.141 - .252	3	3
			7	7.50a	-	29.58	-	.187 - .323	2	2
Sweet Wife	Trilogene Seed Co.	2022/2023	3	2.47c	-	20.35b	-	.116 - .137	6	6
			5	4.49b	-	22.42b	-	.187 - .212	4	4
			7	6.53a	-	30.40a	-	.200 - .228	3	3
White CBG	Oregon CBD	2021/2022/2023	3	-	5.01b	-	76.97ab	.043 - .088	27	27
			5	-	7.40a	-	69.02a	.085 - .132	25	25
			7	-	8.28a	-	59.12b	.117 - .164	25	24

Table 1 (Continued). Table showing cannabinoid concentrations Total THC (%), Total CBD (%), and Total CBG (%) over time from cultivars entered into the MHD Cultivar Check Program. Colors used to indicate Total THC(%) compliance for various harvest windows using a 95% confidence interval include Red (non-compliance prior to week 3), Orange (compliance through week 3), Yellow (compliance through week 5), and Green (compliance through week 7). There is no significant difference between cultivars sharing the same letter assignment. In cases where letters are missing, the values are not significantly different.

Agronomic Performance

Flowering data are presented as the Julian Calendar Date at which a cultivar was deemed to be flowering. Results of the ANOVA show that flowering date was significantly impacted by cultivar and location ($P > 0.05$). Across all cultivars, the mean 50% flowering date was day 226 or August 15th (Table 2). Cultivars were subsequently grouped into maturity groups (early and late) based on mean expected flowering day. Agronomic performance ratings (germination, uniformity, overall performance etc.) are given as averages across all environments for each cultivar. These ratings will not be analyzed for statistical significance given the subjective nature of the qualitative ratings and are meant to guide future research trials and cultivar selections only. University station trials may be more useful/accurate sources of information for yield metrics and will not be discussed here (Ellison et al., 2021; DeDecker et al., 2021).
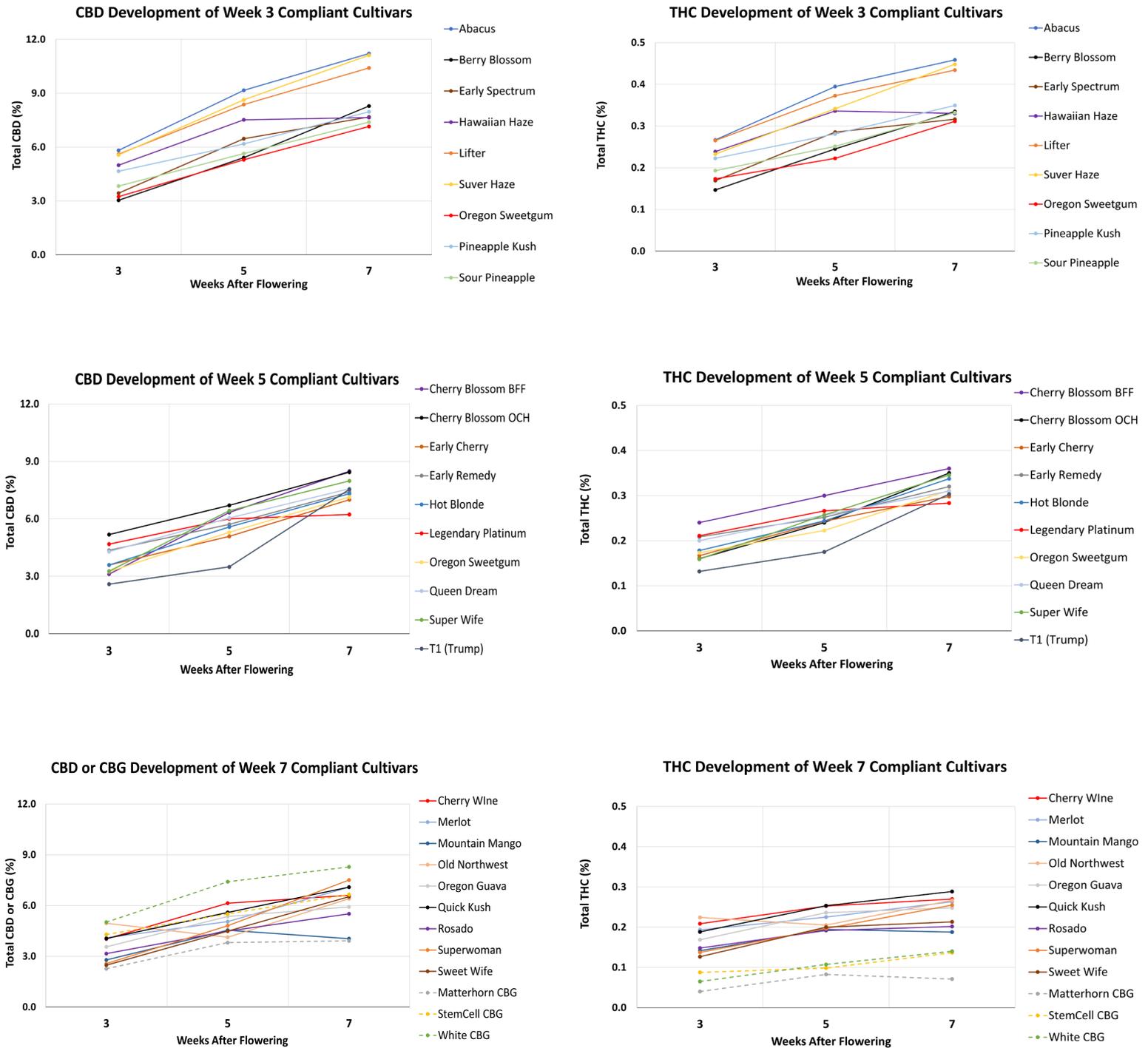
Figure 3. Total THC (%), Total CBD (%), and Total CBG (%) accumulation at 3, 5, and 7 weeks after flowering from cultivars within the Cultivar Check Program. Only cultivars which are still actively being evaluated via the CCP are being illustrated. Data is presented in terms of averages across all locations at each time point. Solid lines represent CBD dominant cultivars while dotted lines signify CBG-dominant cultivars.

Maturity Group	Cultivar	Origin	Julian Calendar Flowering Date (Avg.)	Average Flowering Date	Germination	Uniformity	Overall Performance	# of Site Years
Early	Sour Pineapple	East Fork Cultivars	210d	July 28th	3.8	3.2	3.5	6
	T1 (Trump)	Old Country Hemp	213d	July 31st	4.5	3.3	4.0	5
	Early Cherry	Beacon Hemp	213d	July 31st	2.5	3.8	3.2	7
	Pineapple Kush	East Fork Cultivars	214d	August 1st	3.2	3.0	3.6	7
	Legendary Platinum	High Alpine Genetics	215d	August 2nd	3.8	4.9	5.0	4
	Sweet Wife	Trilogene Seed Co.	216d	August 3rd	3.5	3.7	4.0	6
	Matterhorn CBG*	High Grade Hemp Seed	216d	August 3rd	2.8	3.3	2.8	6
	Early Remedy	Beacon Hemp	216d	August 3rd	3.1	4.0	4.3	8
	Early Spectrum	Beacon Hemp	218d	August 5th	2.5	3.7	3.9	7
	Old Northwest	Cedar Field Farm	219d	August 6th	2.4	3.3	3.5	4
	White CBG*	Oregon CBD	220d	August 7th	3.2	4.3	4.1	18
	StemCell CBG*	Oregon CBD	222d	August 9th	3.3	3.8	3.9	12
	Superwoman	Trilogene Seed Co.	222d	August 9th	3.3	3.8	3.3	4
	Quick Kush	Cheyenne Mountain Seed Co.	222d	August 9th	4.2	3.2	4.0	13
	Lifter	Oregon CBD	222d	August 9th	3.0	4.3	4.2	14
	Oregon Sweetgum	East Fork Cultivars	223cd	August 10th	3.4	3.3	3.4	5
	Suver Haze	Oregon CBD	223cd	August 10th	3.4	4.4	4.4	20
	Early Nueve^	Beacon Hemp	223cd	August 10th	4.4	3.4	2.7	12
	Rosado	Cedar Field Farm	223cd	August 10th	2.7	4.0	3.7	3
	Hawaiian Haze	Oregon CBD	225cd	August 12th	3.7	3.8	4.0	14
	Super Wife	Trilogene Seed Co.	225cd	August 12th	4.3	4.2	4.0	8
Late	Buffalo Soldier*^	KifCure	226bcd	August 13th	4.4	4.0	3.2	6
	Hybrid 5^	Front Range Biosciences	226bcd	August 13th	4.1	3.4	2.4	8
	Oregon Guava	East Fork Cultivars	228abcd	August 15th	3.4	3.9	4.0	6
	Hot Blonde	Blue Forest Farms	229abcd	August 16th	2.2	3.5	3.5	6
	Merlot	High Grade Hemp Seed	230abcd	August 17th	4.3	3.3	3.7	4
	Silver Lining^	Eastern Plains Hemp	231abcd	August 18th	4.0	4.7	3.7	7
	Berry Blossom	High Grade Hemp Seed	232abcd	August 19th	4.7	2.8	3.0	4
	BaOX Hybrid	Arrowhead Seed Co.	233abcd	August 20th	4.6	4.0	3.0	10
	Cherry Blossom	Old Country Hemp	233abcd	August 20th	4.6	4.7	3.3	6
	Cherry Blossom	Blue Forest Farms	234abcd	August 21st	3.6	4.0	4.2	15
	Abacus	Arrowhead Seed Co.	237ab	August 24th	3.2	3.3	4.6	6
	Queen Dream	Blue Forest Farms	238ab	August 25th	4.0	4.0	3.8	17
	Florence^	Arrowhead Seed Co.	240ab	August 27th	4.0	3.4	3.4	12
	Ultra Woman^	Trilogene Seed Co.	241ab	August 28th	5.0	-	-	4
	Mountain Mango	Cheyenne Mountain Seed Co.	242a	August 29th	2.6	2.8	3.0	12
	Cherry Wine	Cheyenne Mountain Seed Co.	242a	August 29th	3.1	3.4	3.5	11
	Boxwine^	Arrowhead Seed Co.	245a	September 1st	4.0	-	-	3

Table 2. Average flowering day number, Average flowering day, Germination, Uniformity, and Overall Grower Ratings for cultivars entered into the Cultivar Check Program. Colors used to indicate Total THC(%) compliance for various harvest windows using a 95% confidence interval include Red (non-compliance prior to week 3), Orange (compliance through week 3), Yellow (compliance through week 5), and Green (compliance through week 7).

*Indicates CBG- dominant cultivars.

^Indicates cultivars which are no longer being evaluated by the CCP due to poor performance or cultivars which are no longer availabile/discontinued

Discussion/Recommendations

Growers will want to consider the following factors when making variety selections in their region:

- Seed Quality (Germination, Uniformity, etc.)
- Maturity Group (Photoperiod)
- Agronomic Performance (Yield and Quality)
- Cannabinoid Development (Compliance Potential)

Seed certification standards in the hemp industry are still being developed. Growers are encouraged to develop relationships with seed providers and to look to university published resources to guide their selections. Seed providers should provide seed testing data (germination, dormancy, noxious weed presence, etc.) but growers may also wish to look to local seed certifying agencies (such as crop improvement centers or departments of agriculture) to find cultivars which have either been certified or are in the process of becoming so. AOSCA provides an updated list of cultivars eligible for certification, which can be found on their website (AOSCA.org)

Growers will want to consider maturity group when making variety selections. For example, growers in northern latitudes may want to plant earlier maturing cultivars to maximize the shorter growing season compared to their southern counterparts. It should be noted that some cultivars exhibit heterogeneity across and within cultivars which can make agronomic performance and cannabinoid development less predictable. Due to the non-uniformity of the flowering process, unstable/non-uniform cultivars could reach maturity at different points in the growing season, which could have adverse impacts on testing and harvesting strategies at the field level. As such, growers may want to consider uniformity of growth and development of plants within a cultivar when making selections to avoid compliance concerns.

Importantly, cultivars with a history of certification or compliance may not be agronomically suited to a region while some cultivars with a history of high performance may not be reliably compliant. To better understand cultivar agronomic performance in a similar region, growers are encouraged to access local university cultivar trials for the most accurate regional information. Similarly, growers are encouraged to access the MHD for the best information available regarding compliance potential of evaluated cultivars. Using the information from both of these sources will allow growers to make informed decisions.

As cannabinoids do not begin to develop rapidly until flowering has initiated, growers are encouraged to delay sampling until after terminal flowering to eliminate unnecessary testing costs. Compliance with state, federal, or tribal regulations is determined by showing that each hemp lot produces Total THC <0.3%. Under the current final rule, no more than 30 days prior to the anticipated harvest of cannabis plants, a "sampling agent" must collect samples for compliance testing. If producers do not harvest within 30 days of sampling, the lot must be retested prior to harvest, and the plants will likely have a higher THC level at harvest than the initial sample. Growers will want to consider their cultivar's cannabinoid development following flower initation in conjunction with this 30-day window from sampling to harvest to maximize profitability while maintaining compliance. Lastly, there is currently a great deal of variation across sampling, sample handling, laboratory sample preparation and analytical methods. This disparity between current field and laboratory procedures makes cannabinoid results difficult to compare. As such, using USDA/state approved sampling methods and submitting samples to an approved, accredited laboratory is recommended.

Limitation of Liability

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Acknowledgments

Additional Information/References

Alberti, P., et al. 2023. Cultivar Check Program 2022 Research Report. University of Wisconsin Extension Publication. https://cropsandsoils.extension.wisc.edu/files/2023/08/2022-Research-Report-Cultivar-Check-Program.pdf

Alberti, P., et al. 2022. Cultivar Check Program 2021 Research Report. University of Illinois Extension Publication. https://extension.illinois.edu/sites/default/files/2021_research_update_-_cultivar_check_program.pdf

Alberti, P., et al. 2022. Midwestern Hemp Database 2021 Research Report. University of Illinois Extension Publication. https://extension.illinois.edu/sites/default/files/mhd_2021_research_report.pdf

Alberti, P., et al. 2021. "Midwestern Hemp Database 2020 Research Report." https://extension.illinois.edu/sites/default/files/4.7.21mhd_2020_report_0.pdf

Campbell, B.J., et al. 2019. "Genotype Environment Interactions of Industrial Hemp Cultivars Highlight Diverse Responses to Environmental Factors." Agrosystems, Geosciences & Environment, 2:1, 1–11., https://doi.org/10.2134/age2018.11.0057

DeDecker, J., et al. 2021. "Hemp Tribal Research Initiative for Michigan (TRIM) 2020 CBD Hemp Cultivar Trial.." https://www.canr.msu.edu/uprc/uploads/files/2020%20CBD%20Hemp%20Report.pdf

Ellison, S., et al. 2021. "2020 UW Madison– Wisconsin Hemp Cultivar Trial." https://cropsandsoils.extension.wisc.edu/files/2023/08/2020-UW-Madison-Wisconsin-Hemp-Cultivar-Trial.pdf

Shekinah, E., 2021. "2021 MFAI- Wisconsin Hemp Cultivar Trial." https://static1.squarespace.com/static/5ffe234190a9e60c8cb479b7/t/63bc792a6758866ed2fba62c/1673296220366/2021+MFAI+Hemp+Cultivar+Report

Shekinah, E., 2020. "2020 MFAI- Wisconsin Hemp Cultivar Trial." https://static1.squarespace.com/static/5ffe234190a9e60c8cb479b7/t/622f7206e4935149af9fb8cb/1647276959369/CBD+Hemp+Cultivar+Trial++Report+-2020+-+MFAI+site+.pdf

Toth, J.A., et al. 2021. "Limited Effect of Environmental Stress on Cannabinoid Profiles in High Cannabidiol Hemp (Cannabis Sativa L.)." GCB Bioenergy, 13:10, 1666–1674., https://doi. org/10.1111/gcbb.12880