

Hemp Tribal Research Initiative for Michigan (TRIM) 2020 CBD Hemp Cultivar Trial



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Introduction

The practice of growing hemp in Michigan ceased in the mid-20th century after decades of serving as an important crop for the Midwest region. The recently reborn hemp industry is seeing a dramatic increase in investment, but there is still substantial uncertainty regarding agronomic practices and potential markets, including such basic information as what cultivars should be grown. To address this lack of information, a replicated CBD hemp cultivar trial was conducted in the summer of 2020 at the University of Wisconsin Madison Arlington Research Station, Michael Fields Agricultural Institute (MFAI), Michigan State University – Upper Peninsula Research and Extension Center (MSU-UPREC) and Ziibimijwang Farm (Little Traverse Bay Bands of Odawa Indians). The main objective of the cultivar trial was to obtain data on how currently available 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. MSU – UPREC and Ziibimijwang Farm together evaluated 36 different hemp cultivars for plant height, uniformity, flowering time, biomass yield, and cannabinoid content in Michigan. The information synthesized from these trials will help refine and expand the knowledge base and increase the successful adaptation of hemp as a viable option for farmers and Native communities in the Midwest region.

Hemp producers and processors are required to follow tribal/state and federal regulations regarding hemp production and registration. Growers must register within their intended state/tribe for production and must adhere to 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/tribal lines and may be impacted by



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pending federal regulations. Please refer to the [Michigan Department of Agriculture and Rural Development hemp webpage](#) for rules and regulations regarding producing hemp in the state of Michigan.

2020 Growing Season and Soil

Temperature and precipitation were slightly above normal at MSU – UPREC in Chatham, Michigan (46.353274, -86.930878) (Table 1a). Temperatures were near normal, but precipitation was a few inches above normal, at Ziibimijwang Farm in Carp Lake, Michigan (45.695322, -84.813714) during the 2020 growing season (Table 1b). The trial at Chatham was planted on Eben very cobbly sandy loam soil following carrots. The soil type at Carp Lake was Emmet sandy loam, which was previously fallowed.

Table 1a. Average monthly weather data for Chatham, Michigan in 2020.

	Jun.	Jul.	Aug.	Sept.	Oct.
Average Temp (°F)	62.00	70.20	66.20	55.70	39.50
Total Precipitation (in)	4.60	6.89	3.44	3.03	4.29

Data retrieved from Enviro-weather formerly Michigan Automated Network (MAWN)

Table 1b. Average monthly weather data for Carp Lake, Michigan in 2020.

	Jun.	Jul.	Aug.	Sept.	Oct.
Average Temp (°F)	63.30	70.43	67.53	57.14	43.34
Total Precipitation (in)	3.60	4.56	2.25	4.83	5.91

Data retrieved from Enviro-weather formerly Michigan Automated Network (MAWN)

Experimental Location and Design

A total of thirty-six cultivars were evaluated between the two Michigan locations including five day-neutral (a.k.a. auto-flowering) cultivars and thirty-one photoperiod sensitive cultivars. The Chatham trial included all thirty-six cultivars, while Carp Lake included only sixteen. Both trials were established as randomized complete block designs with three replications. Plots consisted of five plants with 4 ft in-row and between-row spacing. Feminized seeds were sown in greenhouses at each location on May 4th (Carp Lake), 14th (Chatham photo-sensitive) and 27th (Chatham day-neutral). After hardening-off, seedlings were transplanted on June 11th (Chatham day-neutral), 17th (Chatham photo-sensitive) and 19th (Carp Lake). 1000 lbs/a 10-0-4 feather meal fertilizer (Morgan’s Safe Green Lawn) was incorporated with rotary tillage prior to transplanting at both locations. Weeds were controlled using black plastic mulch laid over raised beds and white clover (Chatham) or clean cultivation (Carp Lake) between beds. Drip irrigation supplied water to the plants as needed, and 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.

Trait Evaluation

Plant Height

Plant height was measured from the base of the plant to the tip of the tallest inflorescence. Plants were measured at harvest. The data was collected in inches and is reported in inches using the average of three plants per plot at Chatham, and one plant per plot at Carp Lake.



Flowering Time

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



Figure 1. “Terminal flowering” showing female flower cluster and extruding stigmas at the shoot apices

Cannabinoid Composition

Approximately 3 inches of floral tissue was collected from the top third of 14-18 plants for each cultivar. Floral material was sent to Lake Superior State University (Sault Ste. Marie, MI) for analysis of cannabinoid potency using high-performance liquid chromatography (HPLC). Flower samples were collected 4-7 weeks after a cultivar reached 50% flowering, near the time of harvest. The latest flowering cultivars only flowered 4-5 weeks prior to harvest, which was necessitated by freezing temperatures.

Whole Plant Wet Weight and Biomass Yield

At Chatham, the three center plants from each plot were selected for drying and yield data, for a total of nine plants per cultivar. At Carp Lake, one representative plant per replication was selected for drying and yield data for a total of three plants per cultivar. Hemp plants were harvested after 4-7 weeks of flowering by hand-cutting plants at the base, weighing, and hanging whole plants in a dairy barn (Chatham and 1/2 Carp Lake) or high tunnel (1/2 Carp Lake) for approximately 6-8 weeks. Each plant was stripped to remove flower/bud and leaf matter from the stem using a rotary bucking machine from Capital Creations, LLC. Flower bud and leaf material was weighed; a grab sample was collected and oven dried to determine plant moisture. Stripped biomass yield data reported here is adjusted to a consistent 12% moisture.

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 Student–Newman–Keuls (SNK) method. All analyses used a mixed model with treatment as a fixed effect and replicates 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 five percent level of probability.

Results

Significant differences in flowering date, plant height, whole plant wet weight, stripped biomass yield and cannabinoid composition* were observed in our trials (Tables 2-6). Crop performance was negatively affected by cannabis aphid, European corn borer damage, white mold (*Sclerotinia sclerotiorum*) injury and lodging at both locations, which were not consistently rated. Differences existed between locations, and between cultivars to some extent, in transplant production practices,



timing of sampling and harvest, and in post-harvest handling/processing. These confounding factors, along with our limited experience growing CBD hemp, were important limitations in this research.

Day-neutral (auto-flowering) cultivars were generally high in CBD, while maintaining compliant THC levels. However, they yielded significantly less than photo-sensitive cultivars, making relay cropping or multiple rotations necessary. Extreme heterogeneity was observed within and between the photoperiod-sensitive cultivars on most of the parameters we evaluated. Cultivars clustered into 2-3 groups based on flowering date and maturity (Fig. 2). The latest flowering cultivars may not be appropriate for our high latitude environment. Some cultivars flowered consistently across plants/plots within a short number of days, while others flowered unevenly across a long period upwards of 50 days. Some cultivars were similarly heterogeneous in stature and architecture, making their agronomic performance highly unpredictable.

The Midwest Hemp Database project uses the following criteria to identify CBD hemp cultivars with “good potential” in our region:

- Flowering initiated prior to August 30th
- Average stripped floral yield above .5 lbs/plant
- Average Total THC for all samples below .39%
- Average Total CBD for all samples above 5%

Of the cultivars included in our trials, Buffalo Soldier, Hempres 3, Painted Lady, T1 and Trump T1 met those criteria most closely. Maverick was the one day-neutral cultivar that approached 0.50 lbs/plant in stripped biomass yield. However, all of the day-neutral cultivars showed potential advantages in predictability, high CBD concentration and regulatory compliance, and may therefore have their place in a purpose-built production system. **We encourage everyone to access the [Midwest Hemp Database](#) for the best information available on CBD hemp cultivar performance.**

**Cannabinoid data was not replicated at Chatham, but was at Carp Lake. Cultivar differences in CBD, THC and CBN were marginally significant (~P = 0.15) at Carp Lake.*

Table 2. Planting date, average days to flowering, 50% flowering and harvest date for day-neutral cultivars at Chatham, MI. Cultivars followed by the same letter are not significantly different.

Cultivar	Source	Planting Date	Avg. Flowering (days)	Avg. Flowering Date	Harvest Date
Auto Tune	Beacon Hemp	6/11/2020	27.00 a	7/8/2020	8/24/2020
Autopilot 1.0	Specialty Seed	6/11/2020	15.00 c	6/26/2020	8/24/2020
Maverick	Kayagene	6/11/2020	26.33 a	7/7/2020	8/24/2020
Pipeline	Kayagene	6/11/2020	20.00 b	7/1/2020	8/24/2020
Socati	Boring Hemp	6/11/2020	21.67 b	7/2/2020	8/24/2020
Mean		6/11/2020	22.00	7/2/2020	8/24/2020
LSD (p=0.05)			5.33		



Table 3. Planting date, average days to flowering, 50% flowering and harvest date for photoperiod-sensitive cultivars at Chatham, MI. Cultivars followed by the same letter are not significantly different.

Cultivar	Source	Planting Date	Avg. Flowering (days)	Avg. Flowering Date	Harvest Date
Early Spectrum	Beacon Hemp	6/17/2020	66.00 fg	8/22/2020	10/1/2020
Early Nueve	Beacon Hemp	6/17/2020	54.50 g	8/10/2020	10/1/2020
Aquawoman	Trilogene Seeds	6/11/2020	92.33 abc	9/11/2020	10/1/2020
BaOx Hybrid	Infinite Tree	6/17/2020	82.00 b-f	9/7/2020	10/13/2020
Buffalo Soldier	KifCure	6/17/2020	55.17 g	8/11/2020	10/1/2020
Cherry Blossom	Green Life Inc./Key to Life	6/11/2020	88.00 a-d	9/7/2020	10/9/2020
Cherry Wine	Bucu Farm & Greenhouse	6/11/2020	86.25 bcd	9/5/2020	10/1/2020
Cherry Wine	Green Life Inc./Key to Life	6/11/2020	98.00 ab	9/17/2020	10/14/2020
Cherry Wine S1	Eastern Plains Hemp	6/17/2020	86.33 bcd	9/11/2020	10/13/2020
CWSI x EPG	Eastern Plains Hemp	6/17/2020	71.00 def	8/27/2020	10/1/2020
Eighty Eight	Davis Farms of Oregon	6/11/2020	85.67 bcd	9/4/2020	10/1/2020
EPG	Eastern Plains Hemp	6/17/2020	72.00 def	8/28/2020	10/1/2020
FL71	Sunrise Genetics	6/17/2020	81.17 b-f	9/6/2020	10/13/2020
Florence	Infinite Tree	6/17/2020	84.33 bcd	9/9/2020	10/13/2020
Hempres 3	Seedified	6/17/2020	67.33 efg	8/23/2020	10/1/2020
Hot Blonde	Blue Forest Farms	6/11/2020	94.00 abc	9/13/2020	10/9/2020
Mountain Mango	Cheyenne Mountain	6/11/2020	104.83 a	9/23/2020	10/14/2020
Otto II	KifCure	6/17/2020	92.00 abc	9/17/2020	10/14/2020
Otto II Stout	Colorado Hemp Genetics	6/11/2020	98.25 ab	9/17/2020	10/1/2020



Painted Lady	Davis Farms of Oregon	6/11/2020	79.83 b-f	8/29/2020	10/1/2020
Prairie Wine	Eastern Plains Hemp	6/17/2020	77.33 c-f	9/2/2020	10/1/2020
Queen Dream	Blue Forest Farms	6/11/2020	96.33 ab	9/15/2020	10/14/2020
Quick Kush	Cheyenne Mountain	6/11/2020	89.00 a-d	9/8/2020	10/9/2020
Ruby #1	Green Lynx Farms	6/17/2020	84.67 bcd	9/9/2020	10/14/2020
Silver Lining	Eastern Plains Hemp	6/17/2020	83.00 b-e	9/8/2020	10/13/2020
Stormy Daniels	Blue Forest Farms	6/11/2020	90.67 abc	9/9/2020	10/5/2020
T1	Green Lynx Farms	6/17/2020	76.17 c-f	9/1/2020	10/1/2020
Trump T1	Green Life Inc./Key to Life	6/11/2020	89.00 a-d	9/7/2020	10/9/2020
Mean		6/14/2020	82.82	9/5/2020	10/7/2020
LSD (p=0.05)			18.50		

Table 4. Plant height, wet whole plant weight, striped biomass and cannabinoid composition for day-neutral cultivars at Chatham, MI. Green indicates cultivars with more than 8% CBD and red indicates cultivars with more than 0.36% THC (Michigan regulatory threshold with uncertainty).

Cultivar	Source	Plant Height (in)	Wet Whole Plant Weight (lb)	Stripped Biomass (lb)	CBD (%)	THC (%)	CBN (%)	CBD:THC Ratio
Auto Tune	Beacon Hemp	18.96	1.31	0.24	8.88	0.24	<0.05	37.00
Autopilot 1.0	Specialty Seed	15.78	0.63	0.19	11.75	0.30	<0.05	39.17
Maverick	Kayagene	21.06	1.51	0.32	11.04	0.25	<0.05	44.16
Pipeline	Kayagene	17.72	1.00	0.18	6.88	0.17	<0.05	40.47
Socati	Boring Hemp	21.00	1.15	0.22	11.42	0.31	<0.05	36.84
Mean		18.90	1.12	0.23	9.99	0.25	NA	39.53
LSD (p=0.05)		ns	ns	ns				



Table 5. Plant height, wet whole plant weight, striped biomass and cannabinoid composition for photo-sensitive cultivars at Chatham, MI. Cultivars followed by the same letter are not significantly different. Green indicates cultivars with more than 8% CBD and red indicates cultivars with more than 0.36% THC (Michigan regulatory threshold with uncertainty).

Cultivar	Source	Plant Height (in)	Wet Whole Plant Weight (lb)	Stripped Biomass (lb)	CBD (%)	THC (%)	CBN (%)	CBD:THC Ratio
Early Spectrum	Beacon Hemp	61.00 a-e	14.32 a	1.97 a	18.00	0.65	0.18	27.69
Early Nueve	Beacon Hemp	59.00 b-e	11.81 ab	1.79 ab	17.99	0.61	0.18	29.49
Aquawoman	Trilogene Seeds	67.00 a-e	14.21 a	2.10 a	11.95	0.29	0.12	41.21
BaOx Hybrid	Infinite Tree	61.67 a-e	9.79 ab	1.44 ab	14.39	0.37	0.14	38.89
Buffalo Soldier	KifCure	58.22 cde	10.49 ab	1.39 ab	12.69	0.33	0.09	38.45
Cherry Blossom	Green Life Inc./Key to Life	66.78 a-e	11.92 ab	1.74 ab	14.68	0.52	0.12	28.23
Cherry Wine	Bucu Farm & Greenhouse	72.50 abc	14.45 a	1.94 a	11.42	0.36	0.15	31.72
Cherry Wine	Green Life Inc./Key to Life	63.22 a-e	12.60 ab	1.61 ab	10.19	0.33	0.13	30.88
Cherry Wine S1	Eastern Plains Hemp	53.00 ef	8.29 ab	1.30 ab	10.11	0.35	0.09	28.89
CWSI x EPG	Eastern Plains Hemp	61.44 a-e	11.35 ab	1.50 ab	18.96	0.70	0.21	27.09
Eighty Eight	Davis Farms of Oregon	75.50 ab	12.25 ab	1.43 ab	5.97	0.23	0.06	25.96
EPG	Eastern Plains Hemp	59.44 b-e	12.69 ab	1.70 ab	20.99	0.72	0.41	29.15
FL71	Sunrise Genetics	45.11 f	5.41 b	0.83 b	7.35	0.22	0.09	33.41
Florence	Infinite Tree	73.55 abc	12.06 ab	1.64 ab	7.64	0.28	0.08	27.29
Hempres 3	Seedified	68.67 a-e	16.41 a	2.11 a	10.73	0.36	0.22	29.81
Hot Blonde	Blue Forest Farms	61.44 a-e	11.21 ab	1.59 ab	12.59	0.36	0.11	34.97
Mountain Mango	Cheyenne Mountain	66.33 a-e	12.64 ab	1.54 ab	3.24	0.07	<0.05	46.29



Otto II	KifCure	62.67 a-e	10.35 ab	1.48 ab	6.30	0.24	0.09	26.25
Otto II Stout	Colorado Hemp Genetics	55.00 def	11.99 ab	1.47 ab	4.18	0.09	<0.05	46.44
Painted Lady	Davis Farms of Oregon	76.67 a	9.88 ab	1.18 ab	9.13	0.21	0.09	43.48
Prairie Wine	Eastern Plains Hemp	60.67 a-e	10.57 ab	1.64 ab	10.50	0.29	0.17	36.21
Queen Dream	Blue Forest Farms	66.11 a-e	12.48 ab	1.88 ab	12.02	0.31	0.13	38.77
Quick Kush	Cheyenne Mountain	70.11 a-d	12.72 ab	1.65 ab	12.58	0.43	0.10	29.26
Ruby #1	Green Lynx Farms	60.67 a-e	9.72 ab	1.76 ab	13.29	0.40	0.14	33.23
Silver Lining	Eastern Plains Hemp	72.67 abc	10.67 ab	1.62 ab	12.02	0.40	0.14	30.05
Stormy	Blue Forest Farms	63.78 a-e	11.76 ab	1.62 ab	11.94	0.41	0.09	29.12
T1	Green Lynx Farms	66.33 a-e	12.19 ab	1.68 ab	12.16	0.37	0.12	32.86
Trump T1	Green Life Inc./Key to Life	57.89 cde	12.50 ab	1.86 ab	10.55	0.26	0.11	40.58
Mean		63.66	11.63	1.62	11.56	0.36	0.14	33.42
LSD (p=0.05)		18.45	11.00	1.28				

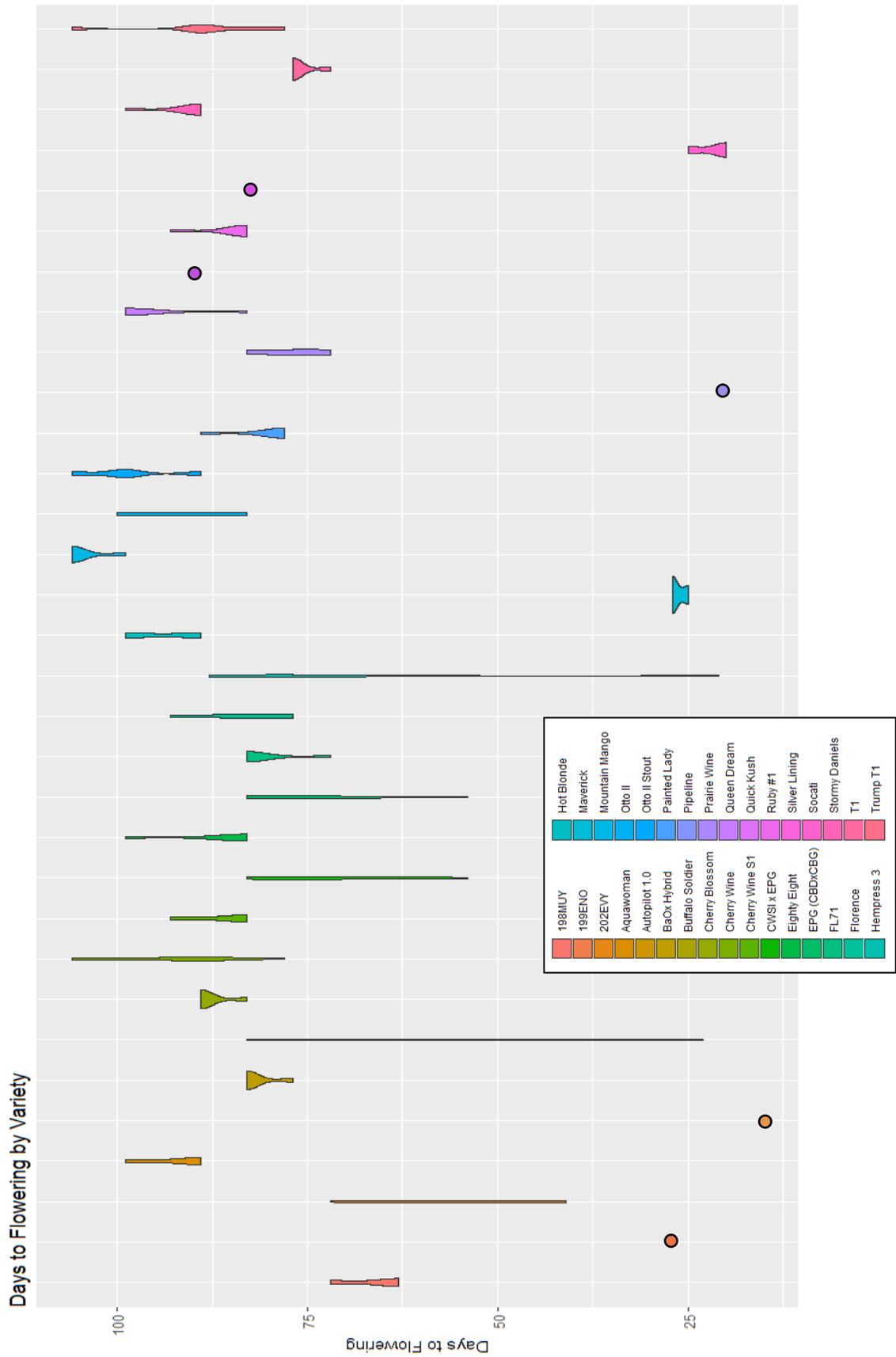


Table 6. Plant height, wet whole plant weight, striped biomass and cannabinoid composition for photo-sensitive cultivars at Carp Lake, MI. Cultivars followed by the same letter are not significantly different. Green indicates cultivars with more than 8% CBD and red indicates cultivars with more than 0.36% THC (Michigan regulatory threshold with uncertainty).

Cultivar	Source	Plant Height (in)	Whole Plant Weight (wet lb)	Stripped Biomass (lb)	CBD (%)	THC (%)	CBN (%)	CBD:THC Ratio
Aquawoman	Trilogene Seeds	64.33 ab	10.32	1.43	12.21	0.45	0.16	27.13
Cherry Blossom	Green Life Inc./Key to Life	58.00 ab	14.47	2.12	13.61	0.46	0.14	29.59
Cherry Wine	Bucu Farm & Greenhouse	69.33 a	18.75	2.82	9.54	0.31	0.10	30.44
Cherry Wine	Green Life Inc./Key to Life	57.00 ab	16.16	2.33	10.62	0.34	0.13	31.55
Eighty Eight	Davis Farms of Oregon	66.33 ab	14.52	1.89	8.08	0.29	0.07	27.53
Hot Blonde	Blue Forest Farms	49.33 b	11.86	1.73	7.09	0.25	0.09	28.35
Mountain Mango	Cheyenne Mountain	63.00 ab	14.86	2.15	7.19	0.20	0.07	36.56
Otto II Stout	Colorado Hemp Genetics	53.67 ab	10.43	1.30	5.91	0.15	0.07	38.52
Painted Lady	Davis Farms of Oregon	63.33 ab	14.53	2.09	9.23	0.25	0.10	36.91
Queen Dream	Blue Forest Farms	63.67 ab	13.91	2.14	8.19	0.31	0.07	26.71
Quick Kush	Cheyenne Mountain	62.33 ab	19.25	2.52	10.40	0.35	0.05	29.71
Sangria S1	Trilogene Seeds	60.67 ab	15.08	2.17	10.51	0.34	0.15	31.22
Stormy	Blue Forest Farms	60.67 ab	11.78	1.85	10.76	0.33	0.13	32.94
Superwoman	Trilogene Seeds	71.33 a	15.20	2.36	10.32	0.31	0.12	33.64
Trump T1	Green Life Inc./Key to Life	59.33 ab	13.31	1.92	11.04	0.33	0.10	33.81
Mean		61.49	14.30	2.05	9.65	0.31	0.10	31.64
LSD (p=0.05)		20.21	ns	ns				



Figure 2. Distribution of days to flowering (DTF) for each of the 36 cultivars.



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