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NORTHWEST CROPS & SOILS PROGRAM



2020 Hemp Flower Variety Trial



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2020 HEMP FLOWER 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 re-emerging worldwide importance as medical providers and manufacturers seek hemp as a renewable and sustainable resource for a wide variety of consumer and industrial products. Hemp grown for all types of end-use (health supplement, fiber, and seed) contains less than 0.3% tetrahydrocannabinol (THC). Some hemp varieties intended to produce a health supplement contain relatively high concentrations of a compound called cannabidiol (CBD), potentially 10-15%. The compound CBD has purported benefits such as relief from inflammation, pain, anxiety, seizures, spasms, and other conditions. The CBD compound is the most concentrated in the female flower buds of the plant, however, it is also in the leaves and other plant parts as well.

To produce hemp for flower, the plant is generally grown intensively as a specialty crop and the flowers are cultivated for maximum growth. The various cannabinoids and terpenes concentrated in the flower buds are often extracted and incorporated into topical products (salves, lip balm, lotion) and food and is available in pill capsules, powder form, and more, which can be found in the market today. To help farmers succeed, agronomic research on hemp is needed in the United States. University of Vermont, in partnership with the [CASE Institute \(https://www.caseinstitute.org/\)](https://www.caseinstitute.org/), evaluated 27 different hemp varieties for their growth habit, pest tolerance, flower yields, and flower quality. Please note that there are 3 autoflower varieties, which are included for comparison with the full-term plants. They are not part of the statistical analysis, which is why they are not part of the full-term hemp cultivar count.

Participants of State Hemp Programs intending to grow 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 most current or active rules and regulations for production within a grower's given state. Regulations are subject to change from year to year with the development and approval of proposed program rules and it is important to note that regulations may vary across state lines and may be impacted by pending federal regulations. Please refer to this https://agriculture.vermont.gov/sites/agriculture/files/documents/PHARM/hemp/Vermont_Hemp_Rules_effective_05_21_20.pdf for a detailed outline of proposed rules in Vermont. Additional information regarding the Vermont Agency of Agriculture, Food and Markets (VAAFAM) Hemp Program can be found on the VAAFAM website here:

<https://agriculture.vermont.gov/public-health-agricultural-resource-management-division/hemp-program>.

MATERIALS AND METHODS

Companies selling hemp seed suitable for the CBD market were solicited to participate in the variety evaluation program. Six companies submitted twenty-seven unique hemp varieties for evaluation in the trial. The varieties were assessed for yield, quality and tolerance to pests at Borderview Research Farm in Alburgh, Vermont. The experimental design was a randomized complete block with 4 replicates. Plots

consisted of three plants spaced 5' apart in the row and between rows (Table 1). Treatments consisted of the 27 individual hemp flower varieties (Table 2).

Fertility amendments were based on soil test results received from the University of Vermont Agricultural and Environmental Testing Laboratory (Burlington, VT). On 5-Jun, all plots were fertilized with 180 lbs N ac⁻¹, 20 lbs P ac⁻¹, 72 lbs K ac⁻¹, using Kreher's (8-2-2) (Kreher's Family Farm; Clarency, NY), Pro-Booster (10-0-0) (North Country Organics; Bradford, VT), and sulfate of potash (0-0-52). Fertility amendments were based on soil test results (University of Vermont Agricultural and Environmental Testing Laboratory, Burlington, VT). All entries were transplanted into black plastic mulch with drip tape irrigation.

Table 1. Agronomic information for the hemp variety trial, Alburgh, VT, 2020.

Location	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam, 3-5% slope
Previous crop	Winter Canola
Plant spacing (ft)	5 x 5
Planting date	8-Jun, 25-Jun, 7-Jul
Fertilization	180 lbs N ac ⁻¹ , 20 lbs P ac ⁻¹ , 72 lbs K ac ⁻¹

The plant material received from the companies was comprised of seeds, unrooted cuttings (URC's), established seedlings, or rooted cuttings. Seed material was planted into deep 50-cell trays containing Fort Light potting mix (Vermont Compost Company, Montpelier, VT) on 12-May and placed in the UVM Greenhouses (Burlington, VT). Greenhouse temperatures were maintained at 70-75° F during the day and 68-72° F at night and received 18 hours of supplemental light at 400 W/m² from 1000W metal halide fixtures. Greenhouse pests, including thrips and fungus gnats, were managed with predatory mites, insects, and nematodes including *Amblyseius cucumeris*, *Orius insidiosus*, *Stratiolaelaps scimitus*, and *Steinernema feltiae*.

Table 2. 2020 Hemp varieties, source, material, and dominant cannabinoid.

Source	Cultivar	Material	Dominant cannabinoid
Front Range Biosciences	Angie	Seedling	CBD
Front Range Biosciences	Anna Lee	Rooted cutting	CBD
Northern Roots Nursery	Auto Ceiba	Seed	CBD
Northern Roots Nursery	Ceiba	Seed	CBD
American Hemp Ventures	Cherry Blossom	URC†	CBD
American Hemp Ventures	Early Bird 1	Seedling	CBD
American Hemp Ventures	Early Bird 2	Seedling	CBD
Front Range Biosciences	Early Pearly	Seedling	CBD
Davis Farms Oregon	Eighty-Eight	Seed	CBD
Oregon CBD	Elektra	Seed	CBD
45th Parallel Hemp	Honolulu Haze	Seed	CBD
Blue Forest Farm	Hot Blonde	Seed	CBD
Front Range Biosciences	Hybrid #5 Clones	Rooted cutting	CBD

Front Range Biosciences	Hybrid #5 Seedlings	Seedling	CBD
Front Range Biosciences	Hybrid #9 Clones	Rooted cutting	CBD
Oregon CBD	Lifter	Seed	CBD
The Hemp Mine	Lucky #7	URC	CBD
The Hemp Mine	Maine CBD 2	URC	CBD
Davis Farms Oregon	Painted Lady	Seed	CBD
Front Range Biosciences	Panakeia	Rooted cutting	CBG‡
Front Range Biosciences	Pure CBG	Rooted cutting	CBG
Blue Forest Farm	Queen Dream	Seed	CBD
The Hemp Mine	Southern Sunset	URC	CBD
Blue Forest Farm	Stormy	Seed	CBD
Oregon CBD	Suver Haze	Seed	CBD
Northern Roots Nursery	Suzy Q	Seed	CBD
Northern Roots Nursery	Suzy's Gift	Seed	CBD
American Hemp Ventures	T1	URC	CBD
Northern Roots Nursery	Tangie	Seed	CBD
Oregon CBD	White CBG	Seed	CBG

† URC, Unrooted Cutting

‡ CBG, Cannabigerol. CBG varieties were part of the full-term hemp (27 cultivar count) and are part of the stat analysis.

Unrooted cuttings that were received were allowed to soak in H₂O for 3-4 hours to increase turgidity before sticking. Cuttings were removed from H₂O soak, cut fresh at a 45-degree angle (approximately 1/4" below a node), and dipped up to 2" in Clonex Rooting Hormone Gel (Lansing, MI). Received cuttings were placed in pre-soaked peat rooting cubes and covered with propagation domes. For two to three weeks, cuttings were allowed to callus and begin root formation in greenhouse with a shade cloth covering over domes to reduce transpiration. After roots began to protrude from peat cubes and cuttings were fully rooted (approximately 2" roots emerging from callused stem), cuttings were transplanted into Fort Light potting mix (Vermont Compost Company) in trays of 1801 pots. Plant roots were allowed to fill out pots (approximately 1-2 weeks) prior to planting.

As a result of shipping delays, entries were required to be planted at different dates. Those entries started from seed were planted on 8-Jun, URC entries were planted on 25-Jun, and rooted/seedling entries were planted on 7-Jul (Table 3). Irrigation was applied through drip irrigation and the rate modified weekly based on rainfall. Each plot was monitored on a weekly basis for flowering date and variation amongst seedlings were recorded. High variation amongst seedlings generally also meant a range amongst flowering dates. Additionally, plants were harvested as they appeared ready using visual clues including trichome formation/maturity, pistil senescence, and swelling of bracts. Plants matured at different rates with some varieties such as Lifter and Tangie maturing nearly one month before other later maturing varieties.

Table 3. Planting, flowering, and harvest dates for Hemp Flower Variety Trial, Alburgh, VT, 2020.

Variety	Planting date	Harvest date	Planting week	Flowering week	Harvest week
Angie	25-Jun	6-Oct	26§	34	41
Anna Lee	25-Jun	20-Oct	26	36	43
Ceiba	8-Jun	24-Sep	24	32-34†	39

Cherry Blossom	7-Jul	20-Oct	28	36	43
Early Pearly	25-Jun	20-Oct	26	33	43‡
Eighty-Eight	8-Jun	12-Oct	24	36	42
Elektra	8-Jun	25-Sep	24	32	39
Honolulu Haze P.17	25-Jun	6-Oct	24	34-35	41
Hot Blonde	8-Jun	21-Oct	24	36	43
Hybrid #5 Clones	25-Jun	20-Oct	26	35	43
Hybrid #5 Seedlings	25-Jun	20-Oct	26	35	43+
Hybrid #9 Clones	25-Jun	21-Oct	26	36	43+
Lifter	8-Jun	24-Sep	24	32	39
Lucky #7	8-Jun	21-Oct	26	34	43
Maine CBD 2	25-Jun	12-Oct	26	32	42
Painted Lady	8-Jun	6-Oct	24	32-35	41
Panakeia	25-Jun	20-Oct	26	38	43‡
Pure CBG	25-Jun	21-Oct	26	36	43‡
Queen Dream	8-Jun	20-Oct	24	35-37	43‡
Southern Sunset	25-Jun	21-Oct	26	35	43‡
Stormy	8-Jun	21-Oct	24	35-36	43
Suver Haze	8-Jun	6-Oct	24	33	41
Suzy Q	8-Jun	6-Oct	24	32-33	41
Suzy's Gift	8-Jun	6-Oct	24	32-34	41
T1	7-Jul	20-Oct	28	36	43
Tangie	8-Jun	24-Sep	24	32-36	39
White CBG	8-Jun	6-Oct	24	34	41

†Varieties with a range listed for flowering week exhibited seedling variation in flowering dates so the entire period of flowering is listed.

‡Varieties with a “+” listed next to harvest date could have had an additional 1-2 weeks to fully mature.

§ Planting week, harvest week, and flowering week are the weeks of the year in which each respective event occurred .

Scouting took place weekly from 15-Sep until 9-Oct. One plant per plot was scouted for disease and insect pests. Three leaves per plant at low, medium, and high locations on each plant were counted for insect populations. Entire plant assessments were made for disease with total number of infected buds or stems counted and severity rated for gray mold (*Botrytis cinerea*), white mold (*Sclerotinia sclerotiorum*), and whole plant disease severity ratings provided for powdery mildew (*Glovinomyces spp.*), and Septoria leaf spot (*Septoria spp.*). Severity was rated on a 0-5 scale for gray mold and white mold, with a rating of 0 being least severe (no apparent infection) and a rating of 5 being most severe. Less severe cases were noted as single flower clusters showing degradation or infection for, most severe cases would be indicative of entire stems or colas showing severe disease infection. Whole plant powdery mildew infections were rated on a visual 0-10 scale indicating the percentage of the entire plant exhibiting infection, 0 having no infection, and 10 having 100% infection throughout the plant. Plants with no observable disease or abiotic damage for observed parameters were given a “0” rating for no disease or damage present.

Prior to harvest, plant height and width was measured from all harvested plants in each plot. From each plot, flower samples were taken from the top 8” of colas and sent to ProVerde Laboratories (Milford, MA) to be analyzed for cannabinoids and terpenes.

Plants were harvested by hand using bypass loppers or chainsaw depending on trunk diameter. The whole plant weight was recorded. Each harvested plant was broken down into smaller branched sections and larger “fan” or “sun” leaves were removed by hand, while smaller leaves were left attached since they subtend from the flower bract. Remaining stems were then bucked using the BuckmasterPro Bucker (Maple Ridge, BC, Canada) (Image 1) and remaining leaf material and buds were collected. Wet bud and leaf material was then run through the CenturionPro Gladiator Trimmer (Maple Ridge, BC, Canada) (Image 2). Wet bud weight and unmarketable bud weight were recorded. The flower buds were then dried at 80° F or ambient temperature with airflow until dry enough for storage without molding. A subsample of flower bud from each plot was dried in a small dehydrator and wet weights and dry weights were recorded in order to calculate the percent moisture of the flower buds. The percent moisture at harvest was used to calculate dry matter yields. Metrics were collected for each of the three harvested plants within each plot and a plot average was calculated.



Image 1. Triminitor BuckMaster Pro (Maple Ridge, BC, Canada).

Autoflower varieties are included for comparison with full season plants in the variety trial. Each was evaluated using similar metrics and received similar field preparation to those grown within the variety trial. Spacing for autoflower varieties was reduced to 2’ and were similarly planted into irrigated black plastic. Autoflower varieties ‘Auto Ceiba,’ ‘Early Bird 1,’ and ‘Early Bird 2’ are included for comparison, but were not included for statistical comparison due to unique growth habit.



Image 2. Centurion Pro Gladiator Trimmer (Maple Ridge, BC, Canada).

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within the trial were treated as random effects, and treatments were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p < 0.10$). Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. At the bottom of each table a p-value is presented for each variable that showed statistical significance ($p\text{-value} \leq 0.10$). In this case, the difference between two treatments within a column is equal to or greater than the least significant difference (LSD) value and you can be sure that for 9 out of 10 times, there is a real difference between the two treatments. In this example, variety 3 is significantly different from variety 1 but not from variety 2. Varieties with an asterisk are statistically similar to the top performer in bold. The difference between variety 3 and variety 2 is equal to 1.5, which is less than the LSD value of 2.0. This means that these varieties did not differ in yield. The difference between variety 3 and variety 1 is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these varieties were significantly different from one another.

Treatment	Yield
Variety 1	6.0
Variety 2	7.5*
Variety 3	9.0
LSD ($p\text{-value} \leq 0.10$)	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). The growing season was defined by hot and dry conditions throughout the summer months, punctuated by a handful of larger, infrequent rain events seen largely in August. June was especially dry during the transplant and establishment period for our hemp trials with below average precipitation in much of the growing season. Average temperatures during the growing period were 4.11 degrees higher than the 30-year average for the season with a 5.5% higher growing degree day accumulation for the year.

Table 4. Seasonal weather data collected in Alburgh, VT, 2020.

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	66.9	74.8	68.8	59.2	48.3
Departure from normal	1.08	4.17	0.01	-1.33	0.19
Precipitation (inches)	1.86	3.94	6.77	2.75	3.56
Departure from normal	-1.77	-0.28	2.86	-0.91	0.00
Growing Degree Days (Base 50°F)	516	751	584	336	126
Departure from normal	35	121	2	-24	-6

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Cultivars were scouted from 15-Sep through 9-Oct for pest pressure and abiotic injury (Table 5). Few insect pests were observed on hemp plants within the trial with aphids being the primary pest observed during the scouting period. Significant differences amongst varieties in aphid populations were observed with highest counts observed on Anna Lee with an average number of aphids leaf⁻¹ of 10.3, and statistically similar populations observed on Cherry Blossom, Hot Blonde, Hybrid #9 Clones, and T1 cultivars. While not quantified, large amounts of predatory insects were also observed on plants including green lacewings and various species of lady beetles.

Three main diseases were seen on plants including powdery mildew, gray mold, and white mold. Within this trial, the greatest severity of powdery mildew infection was seen in the White CBG cultivar at a 8.75 severity rating, indicating near entire plant surface coverage of fungal bodies. This was statistically similar to Elektra, Hybrid #5 Seedlings, Panakeia, Pure CBG, Suzy Q, and Suzy's Gift. Three out of seven of these cultivars being CBG dominate. Gray and white mold was present in lower levels throughout the trial in 2020 with little to no gray mold present on these cultivars overall. White mold was slightly more prominent throughout the study with highest observed incidence seen in the White CBG cultivar at 1.75 infected stems per plant, which was statistically similar to Early Pearly, Hybrid #5 Clones, Hybrid #5 Seedlings, Hybrid #9 Clones, Maine CBD2, Panakeia, Pure CBG, Stormy, Suzy's Gift, and T1. Greatest severity of infection was seen in Pure CBG for these cultivars.

Given early frost damage and windstorms during the 2020 growing season, plant and frost damage was also recorded with 0 indicating no damage from frost within plots and 5 indicating whole plant frost damage. Plants exhibiting broken branches, stems, or lodging were ranked on a 0-10 scale for structural plant damage (0=no damage and 10=100% damage). Those plants showing greatest amounts of lodging (i.e. completely toppled or high numbers of broken branches) included Panakeia with an 8.00 ranking for lodging. This

particular cultivar suffered from multiple broken branches, requiring staking to reach full maturity. Other cultivars such as Elektra and Lifter showed no lodging as a result of windstorms or growth habit. Frost damage was rated on a 0 to 5 scale, where some significant differences were also observed in frost susceptibility, with Panakeia showing the greatest amount of damage with a 2.25 rating and was statistically similar to Eighty-Eight and Pure CBG. The greatest extent of damage in this case was seen in brown, frosted leaf tips with no noticeable damage done to flower material.

Table 5. Biotic and abiotic cultivar susceptibility, Alburgh, VT, 2020.

Variety	Aphids # leaf ⁻¹	Powdery mildew severity 0-10†	Gray mold incidence # infected buds plant ⁻¹	Gray mold severity 0-5‡	White mold incidence # infected stems plant ⁻¹	White mold severity 0-5	Lodging 0-10	Frost damage 0-5
Angie	0.130	1.25	0.000	0.00	0.000	0.00	0.250	0.500
Anna Lee	10.3	3.50	0.000	0.00	0.000	0.00	3.00	1.00
Ceiba	1.13	4.00	0.000	0.00	0.000	0.00	1.25	0.00
Cherry Blossom	9.67*	1.75	0.130	0.380	0.000	0.00	1.00	1.00
Early Pearly	4.06	2.50	0.130	0.250	0.250*	0.750	1.75	1.25
Eighty-Eight	2.39	3.00	0.000	0.00	0.000	0.00	1.50	1.50*
Elektra	0.830	7.00*	0.000	0.00	0.000	0.00	0.00	0.00
Honolulu Haze	1.75	5.25	0.000	0.00	0.000	0.00	0.750	0.250
Hot Blonde	8.11*	3.25	0.000	0.00	0.000	0.00	0.750	0.750
Hybrid #5 Clones	1.25	5.25	0.380	0.630	0.500*	2.50*	1.25	1.25
Hybrid #5 Seedlings	1.81	7.75*	0.000	0.00	1.25*	1.25	0.750	1.00
Hybrid #9 Clones	7.53*	3.50	0.380	1.25*	0.250*	1.50	1.00	1.00
Lifter	0.830	4.75	0.000	0.00	0.000	0.00	0.00	0.00
Lucky Number 7	2.61	2.50	0.130	0.250	0.250	0.250	2.00	1.00
Maine CBD 2	3.43	1.25	0.000	0.00	0.750*	1.25	3.25	0.500
Painted Lady	2.33	2.25	0.000	0.00	0.000	0.00	1.50	0.500
Panakeia	0.310	6.25*	0.130	0.380	0.750*	1.00	8.00	2.25
Pure CBG	1.72	8.25*	0.380	2.25	1.50*	5.00	3.75	1.75*
Queen Dream	1.92	4.00	0.000	0.00	0.000	0.00	1.00	1.25
Southern Sunset	3.97	2.00	0.000	0.00	0.000	0.00	0.750	1.00
Stormy	4.58	3.75	0.000	0.00	1.50*	1.75	1.00	1.00
Suver Haze	3.32	3.25	0.000	0.00	0.000	0.00	0.500	0.250
Suzy Q	0.820	6.25*	0.000	0.00	0.000	0.00	1.25	0.500
Suzy's Gift	1.49	6.50*	0.000	0.00	0.250*	0.500	1.25	1.00
T1	8.31*	5.75	0.380	0.250	0.250*	2.00	0.750	1.00
Tangie	0.250	5.50	0.000	0.00	0.000	0.00	0.250	0.000
White CBG	0.00	8.75	0.250	1.00	1.75	2.00	0.500	0.250
LSD (0.10)¥	4.89	2.99	NS§	1.22	1.53	2.70	1.99	0.750
Trial mean	3.14	4.41	0.080	0.250	0.340	0.730	1.44	0.810

†Rating on a 0 to 5 scale; where 0 = no disease and 5 = severe.

‡Rating on a 0 to 10 scale; where 0 = no damage and 10 = severe damage.

*Treatments with an asterisk are not significantly different from the top performer in **bold**.

¥LSD – Least significant difference.

§NS – No significant difference between treatments.

Within the variety trial, Painted Lady was the tallest at 185 cm and was statistically similar in height to Eighty-Eight, Elektra, Lifter, Lucky Number 7, and Stormy (Table 6). Widest plants included the top performer Main CBD 2 at 163 cm and similarly wide varieties Lucky Number 7, Lifter, and Queen Dream. Lucky #7 and Maine CBD 2 had particularly long and sprawling growth habits as they matured compared

to Lifter and Painted Lady, which were much more upright and compact. Stormy had the highest whole plant biomass with plants reaching 33.2 lbs plant⁻¹. No other varieties were similar in size with some of the smallest plants weighing only 4.10 lbs plant⁻¹ and a trial average of 16.7 lbs plant⁻¹. Average heights for the trial were 138 cm and widths were 117 cm for whole plants. For each of the measured metrics, autoflower varieties ‘Auto Ceiba,’ ‘Early Bird 1,’ and ‘Early Bird 2’ are included for comparison. In this case, Auto Ceiba and Early Bird 1 had the potential to be planted at a 1’ plant spacing based on growth habit, whereas Early Bird 2 would have benefitted from greater plant spacing of 5’. Auto Ceiba and Early Bird 1 were more likely stressed due to hot weather during establishment or shipping methods as the Early Bird cultivar was received as started seedlings. Those that grew to full size were substantially larger and had growth habits more akin to full term varieties within the trial.

Table 6. Hemp whole plant weight, height, and width, Alburgh, VT, 2020.

Variety	Plant height	Plant width	Plant weight
	cm	cm	lbs plant ⁻¹
Angie	120	102	11.0
Anna Lee	122	111	11.3
Ceiba	146	134	18.9
Cherry Blossom	122	117	17.3
Early Pearly	68	74	4.10
Eighty-Eight	175*	133	23.0
Elektra	171*	140	22.5
Honolulu Haze P.17	159	109	15.8
Hot Blonde	165	118	21.5
Hybrid #5 Clones	65	62	5.0
Hybrid #5 Seedlings	108	96	9.2
Hybrid #9 Clones	94	80	5.7
Lifter	173*	142*	22.3
Lucky #7	172*	151*	26.0
Maine CBD 2	155	163	22.2
Painted Lady	185	119	16.0
Panakeia	125	92	9.3
Pure CBG	94	93	6.7
Queen Dream	155	143*	25.6
Southern Sunset	141	123	21.6
Stormy	167*	138	33.2
Suver Haze	167	136	20.6
Suzy Q	138	115	17.4
Suzy's Gift	147	115	19.4
T1	104	93	8.7
Tangie	147	122	15.5
White CBG	151	129	21.7
LSD (0.10)†	18.36	22.09	5.64
Auto Ceiba‡	29.3	29.9	0.441
Early Bird 1	43.8	46.5	0.638
Early Bird 2	162	140.3	14.3
Trial Mean	138	117	16.7

*Treatments with an asterisk are not significantly different from the top performer in **bold**.

†LSD – Least significant difference.

‡Autoflower varieties were not statistically analyzed with the full season varieties and are show for comparison.

Total bud weight, leaf weight, and stem weight were measured at harvest to further evaluate growth characteristics of each variety (Table 7). Stormy had the highest overall stem weight per plant by far with 12.30 lbs plant⁻¹ and was 37.2% of the whole plant weight. Interestingly, although Eighty-Eight and Southern Sunset had lower stem weight, the stems made up over 40% of the whole plant biomass. Lifter was a standalone top performer in the trial for flower weight at 9.4 lbs plant⁻¹ though it is also worth noting that other varieties produced large amounts of flower in excess of 7 lbs plant⁻¹ including Ceiba, Lucky Number 7, Stormy, and Suver Haze. Tangie had the highest percentage of flower material per plant at 44.6% and was statistically similar to Panakeia, Lifter, Ceiba, and Hybrid #5 Clones. Leaf weights were highest in Stormy at 13.6 lbs plant⁻¹ which was statistically similar to Queen Dream at 11.4 lbs plant⁻¹. Bud:stem ratios were also calculated with Panakeia having the highest ratio of flower to stem material at 2.3:1 alongside similar top performer Tangie at 2.01:1. Early Pearly had the highest ratio of leaf to stem material at 2.2:1 and was statistically similar to Hybrid #9 clones, Panakeia, and Pure CBG largely suggesting that stem material made up a very small fraction of plant material for Panakeia in particular. Pure CBG, Panakeia, and Hybrid #9 Clones were among the last varieties planted for the trial, which may have also had an impact on vegetative growth, reducing overall leaf weight.

The amount of total leaf or stem material can also greatly affect harvest time. While we were not able to record hand harvest times for each variety (as we switched to mechanical assisted harvest for later maturing varieties), a few were documented in 2019 and 2020. From 2019, VT Cherry was one of the smallest varieties which took approximately 45 minutes per plant to break down plants, remove fan leaves, and buck flowers from stems. In 2020, some smaller varieties with very little leaf material, such as Panakeia, took approximately 15 minutes to process plants. This variety had one of the lowest overall plant weights with the highest bud:stem ratio and was one of the last varieties to be planted, contributing to the size. Conversely, other much larger plants, such as Stormy, required approximately 3 hours to process and had the highest leaf weight within the trial. Growth habits varied greatly within the trial and each of these factors can greatly impact harvest time for individual plants. Some other larger, later harvested varieties may require additional time to trim and harvest by hand. Amount of time required to harvest plants will vary drastically depending not only on selected cultivars but also desired end-product and intricacy of trimming, however all are important factors to take into consideration when selecting a variety. Auto Ceiba had substantially larger proportions of flower compared to other leaf and stem material, yet plants as a whole were also much smaller compared to full term cultivars.

Table 7. Hemp plant wet weight growth metrics, Alburgh, VT, 2020.

Variety	Stem weight lbs plant ⁻¹	Stem weight %†	Flower weight lbs plant ⁻¹	Flower weight %	Leaf weight lbs plant ⁻¹	Leaf weight %	Bud:stem	Leaf:stem
Angie	2.88	25.8	3.88	36.3	4.24	37.9	1.46	1.5
Anna Lee	3.78	33.1	2.23	19.2	5.24	47.7	0.6	1.52
Ceiba	5.5	28.6	7.75	41.3*	5.6	30.0	1.47	1.06
Cherry Blossom	5.02	28.8	4.02	23.6	8.26	47.7*	0.82	1.67
Early Pearly	0.87	21.8	1.30	32.5	1.88	45.7*	1.51	2.2
Eighty-Eight	9.84	43.6	5.42	23.1	7.69	33.3	0.55	0.77
Elektra	7.29	33.0	6.89	32.8	8.32	34.2	0.99	1.05
Honolulu Haze P.17	4.78	29.0	4.90	33.7	6.07	37.3	1.24	1.33

Hot Blonde	7.63	35.9	4.12	19.4	9.71	44.7*	0.54	1.25
Hybrid #5 Clones	1.12	22.3	1.94	40.6*	1.9	37.1	1.87	1.66
Hybrid #5 Seedlings	2.28	25.1	3.09	33.3	3.78	41.6*	1.34	1.66
Hybrid #9 Clones	1.28	22.4	1.83	32.4	2.54	45.2*	1.46	2.05*
Lifter	7.15	32.0	9.40	42.1*	5.75	25.9	1.37	0.86
Lucky #7	8.7	34.4	7.32	28.6	9.98	37	0.84	1.14
Maine CBD 2	7.36	33.2	5.13	23.5	9.66	43.4*	0.72	1.33
Painted Lady	6.09	38.0	4.32	27.3	5.59	34.8	0.73	0.92
Panakeia	1.73	18.5	3.94	42.6*	3.66	38.9	2.3	2.11*
Pure CBG	1.54	23.6	2	29.4	3.17	47*	1.27	2.05*
Queen Dream	9.25	36.3	4.92	19.6	11.4*	44.1*	0.55	1.22
Southern Sunset	9.12	42.2*	2.48	11.6	9.95	46.1*	0.28	1.09
Stormy	12.3	37.2	7.28	22.2	13.6	40.6	0.6	1.09
Suver Haze	7.52	38.0	7.23	36.1	5.85	25.9	0.97	0.78
Suzy Q	4.75	26.4	5.98	36	6.63	37.6	1.41	1.45
Suzy's Gift	6.32	33.5	5.48	27.1	7.61	39.4	0.87	1.21
T1	2.39	28.8	2.6	30.2	3.71	41	1.06	1.47
Tangie	3.55	23.1	6.8	44.6	5.15	32.3	2.01*	1.47
White CBG	6.53	30.5	5.47	25.2	9.65	44.3*	0.85	1.49
LSD (0.10)	1.89	5.32	1.53	5.74	2.99	6.65	0.335	0.416
Auto Ceiba	0.035	7.84	0.361	81.9	0.046	10.3	10.3	1.31
Early Bird 1	0.450	70.0	0.090	14.3	0.095	15.2	0.200	0.211
Early Bird 2	4.60	32.6	4.70	32.1	5.00	35.3	1.02	0.986
Trial Mean	5.43	30.5	4.73	30.2	6.54	39.3	1.1	1.39

†Proportion of the whole plant biomass made up of stem, leaves, or flower material.

*Treatments with an asterisk are not significantly different from the top performer in **bold**.

‡LSD – Least significant difference at p=0.10.

At harvest, a composite subsample of flower material was collected from each plot and dried down to determine flower dry matter and calculate dry matter flower yields (Table 8, Figure 1). Lifter had the highest dry matter at harvest (24.1%) alongside Angie, Ceiba, Elektra, Honolulu Haze P17, Maine CBD 2, Painted Lady, Suver Haze, Suzy Q, Suzy's Gift, Tangie, and White CBG. The quantity of unmarketable flower was measured for each variety. Unmarketable flower included any flower that had suffered from disease, rot, soil contamination, or otherwise damaged flower material. Lucky Number 7 had the highest amount of unmarketable flower material at 1.46 lbs plant⁻¹ which was largely as a result of lower branches touching the ground and the more sprawling growth habit, resulting in flowers that had received some physical damage prior to harvest. Lifter had the least amount of unmarketable flower material with no unmarketable material. Lifter outperformed other varieties at 3940 lbs ac⁻¹ with significantly higher yields than other varieties. Other varieties with high average dry matter yields (above 2000 lbs ac⁻¹) included Ceiba, Suver Haze, Elektra, Tangie, Lucky Number 7, Suzy Q, Stormy, and Honolulu Haze P17. Average dry matter yields for the trial were 1691 lbs ac⁻¹ with the lowest observed yield at 463 lbs ac⁻¹ for Early Pearly. Yields, on a per acre basis, for autoflower varieties were comparable to other varieties grown within the trial. Higher plant density in this case appeared to compensate for lower per plant yields, however seed costs may be cost prohibitive when planting at 1' spacing. Early Bird 2 also had some comparably high yields and was harvested nearly one month prior to the latest maturing varieties within the trial.

Table 8. Hemp flower bud yield, Alburgh, VT, 2020.

Variety	Flower dry matter %	Dry matter flower yield† lbs plant ⁻¹	Unmarketable flower yield lbs plant ⁻¹	Dry matter flower yield lbs ac ⁻¹	Yield at 8% moisture lbs ac ⁻¹
Angie	23.1*	0.87	0.007	1524	1656
Anna Lee	19.0	0.41	0.043	718	781
Ceiba	22.2*	1.72	0.108	2998	3259
Cherry Blossom	16.8	0.68	0.128	1180	1282
Early Pearly	20.2	0.27	0.05	463	504
Eighty-Eight	19.0	0.99	0.037	1717	1866
Elektra	23.6*	1.60	0.370	2786	3028
Honolulu Haze	23.7*	1.16	0.019	2014	2189
Hot Blonde	18.3	0.73	0.122	1266	1376
Hybrid #5 Clones	17.2	0.33	0.247	580	631
Hybrid #5 Seedlings	16.2	0.49	0.149	858	932
Hybrid #9 Clones	17.1	0.31	0.272	538	585
Lifter	24.1	2.26	0.000	3940	4283
Lucky #7	18.9	1.38	1.458	2403	2612
Maine CBD 2	21.9*	1.11	0.296	1934	2102
Painted Lady	23.1*	1.00	0.000	1745	1896
Panakeia	16.4	0.63	0.645	1105	1201
Pure CBG	18.3	0.36	0.279	635	690
Queen Dream	19.1	0.92	0.042	1611	1751
Southern Sunset	16.3	0.40	0.005	702	763
Stormy	18.4	1.30	0.199	2266	2463
Suver Haze	23.2*	1.65	0.026	2877	3127
Suzy Q	22.4*	1.33	0.013	2318	2519
Suzy's Gift	22.0*	1.12	0.025	1959	2130
T1	19.9	0.49	0.093	861	936
Tangie	23.1*	1.54	0.174	2691	2925
White CBG	21.1*	1.14	0.702	1978	2150
LSD (0.10)‡	3.10	0.267	0.339	464.5	504.9
Auto Ceiba	24.4	0.088	0.000	3819	4125
Early Bird 1	28.2	0.025	0.000	1082	1169
Early Bird 2	22.9	1.11	0.000	1928	2082
Trial Mean	20.2	0.97	0.204	1691	1838

† Dry matter yield is reported at 0% moisture.

*Treatments with an asterisk are not significantly different from the top performer in **bold**.

‡LSD – Least significant difference at p=0.10.

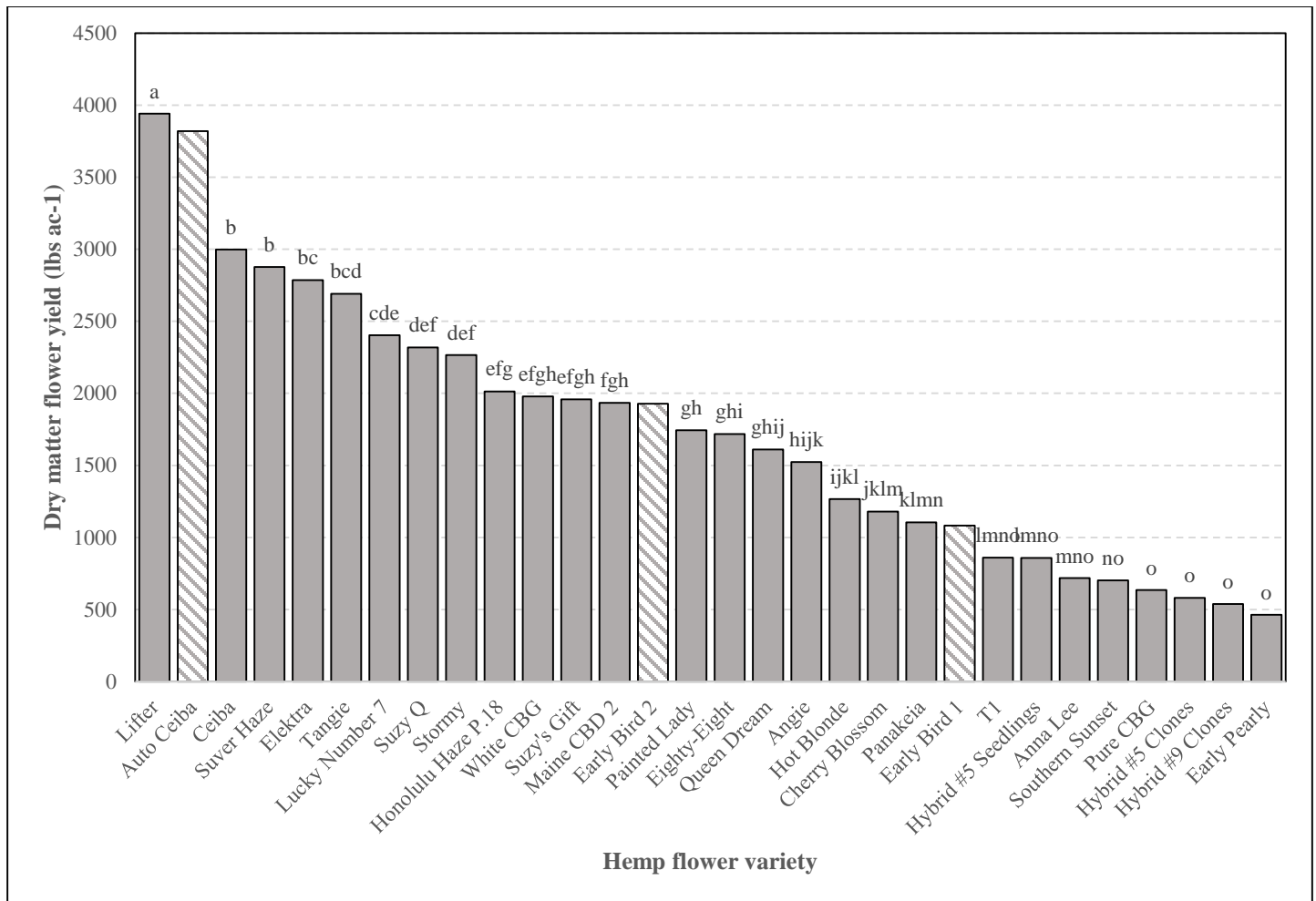


Figure 1. Dry matter flower yield of hemp varieties for the flower market, 2020. Similar letters indicate that these results are statistically similar. Autoflower varieties are included, and are denoted by striped bars.

Each cultivar within the trial was also analyzed for cannabinoid content and terpenes (Table 9, Figure 2). Results for cannabinoids are on a dry matter basis (0% moisture). These results represent three replications of the study. Autoflower varieties are included with these results for comparison. Peak, dominant cannabinoid concentration for each variety ranged from 5.40% to 15.0%. Within the study, Suver Haze had the highest total concentrations of CBD at 15.0%, whereas White CBG had the highest total CBG at 12.6%. Each variety within the trial would be compliant with Vermont State regulations for THC limits for both total THC and D9-THC with lowest observed values seen in all CBG varieties as well as those varieties with lower total CBD such as Eighty-Eight, T1, Lucky #7, and Maine CBD2 to name a few. No varieties exceeded action limits for D9-THC with the highest value observed for Hybrid #5 Clones at 0.121%. Highest total THC was seen in Suver Haze at 0.502%, closely followed by Lifter at 0.495% total THC. Some varieties within this trial may not be compliant with other state regulations and limits for THC. It is important to consult individual state regulations and recognize that varieties may perform differently in other growing regions.

Table 9. Total flower bud cannabinoids, cannabidiol, cannabigerol and tetrahydrocannabinol content, Alburgh, VT, 2020.

Variety	D9-THC %	THCA %	CBD %	CBDA %	CBG %	CBGA %	Total THC ‡ %	Total CBG ? %	Total CBD † %	CBD:THC
Angie	0.035	0.284	0.437	9.22	0.009	0.208	0.283	0.192	8.52	30.1*
Anna Lee	0.083*	0.266	0.924	10.6	0.024	0.260	0.316	0.252	10.2	32.1*
Ceiba	0.070	0.393	0.686	12.5	0.030	0.350	0.415*	0.337	11.7	28.1
Cherry Blossom	0.072	0.307	0.837	11.5	0.032	0.205	0.342	0.212	10.9	31.9*
Early Pearly	0.072	0.243	0.749	8.71	0.007	0.117	0.286	0.11	8.38	29.3
Eighty-Eight	0.012	0.159	0.444	5.99	0.004	0.143	0.152	0.13	5.70	36.0
Elektra	0.085*	0.383	0.847	12.7	0.040	0.343	0.422*	0.341	12.0	28.3
Honolulu Haze	0.075	0.431*	0.755	14.1*	0.010	0.291	0.453*	0.266	13.1*	29.0
Hot Blonde	0.062	0.266	0.601	9.38	0.003	0.230	0.296	0.204	8.82	29.9*
Hybrid #5 Clone	0.121	0.296	1.38	11.1	0.007	0.242	0.38	0.219	11.1	29.2
Hybrid #5 Seedling	0.078	0.290	0.913	11.1	0.027	0.263	0.332	0.257	10.7	32.4*
Hybrid #9 Clone	0.087*	0.253	0.963	10.2	0.023	0.148	0.308	0.153	9.91	31.9*
Lifter	0.079*	0.475*	0.782	15.2*	0.053	0.355	0.495*	0.364	14.1*	28.5
Lucky #7	0.014	0.193	0.391	6.55	0.002	0.060	0.184	0.055	6.14	33.1*
Maine CBD	0.031	0.233	0.433	8.36	0.000	0.136	0.235	0.119	7.77	33.2*
Painted Lady	0.049	0.214	0.472	7.74	0.005	0.187	0.237	0.169	7.26	30.6*
Panakeia	0.007	0.037	0.036	0.490	0.300	8.99	0.04	8.19	0.460	10.0
Pure CBG	0.006	0.011	0.000	0.000	0.366	5.74	0.016	5.4	0.000	0.00
Queen Dream	0.073	0.287	0.794	10.4	0.005	0.217	0.325	0.195	9.95	30.6*
Southern Sunset	0.072	0.212	0.772	8.45	0.018	0.278	0.258	0.262	8.18	31.5*
Stormy	0.049	0.264	0.502	9.02	0.005	0.164	0.28	0.149	8.42	29.9*
Suver Haze	0.063	0.500	0.768	16.2	0.030	0.336	0.502	0.325	15.0	30.0
Suzy Q	0.044	0.434*	0.524	13.7*	0.059	0.287	0.425*	0.311	12.6*	29.7*
Suzy's Gift	0.021	0.321	0.401	10.3	0.033	0.235	0.302	0.239	9.42	31.7*
T1	0.031	0.204	0.425	7.13	0.003	0.176	0.211	0.158	6.68	31.7*
Tangie	0.110*	0.419*	1.07*	13.9*	0.075	0.295	0.478*	0.333	13.3	27.9
White CBG	0.081*	0.074	0.015	0.040	0.572	13.8	0.146	12.6	0.050	0.300
Trial mean	0.059	0.276	0.627	9.43	0.065	1.26	0.301	1.17	8.90	27.7
LSD (0.10)	0.043	0.106	0.358	3.23	0.068	0.955	0.097	0.813	2.83	6.30
Auto Ceiba	0.09	0.33	0.86	11.1	0.036	0.38	0.21	0.25	5.47	26.0
Early Bird 1	0.08	0.3	0.72	9.19	0.027	0.27	0.35	0.26	8.77	25.1
Early Bird 2	0.06	0.34	0.48	10.4	0.033	0.38	0.36	0.37	9.6	26.7

*Treatments with an asterisk are not significantly different from the top performer in **bold**.

LSD – Least significant difference at p=0.10.

† Total potential CBD = (0.877 x CBDA) + CBD.

‡ Total potential THC = (0.877 x THCA) + Δ-9 THC.

? Total potential CBG = (0.877 x CBGA) + CBG

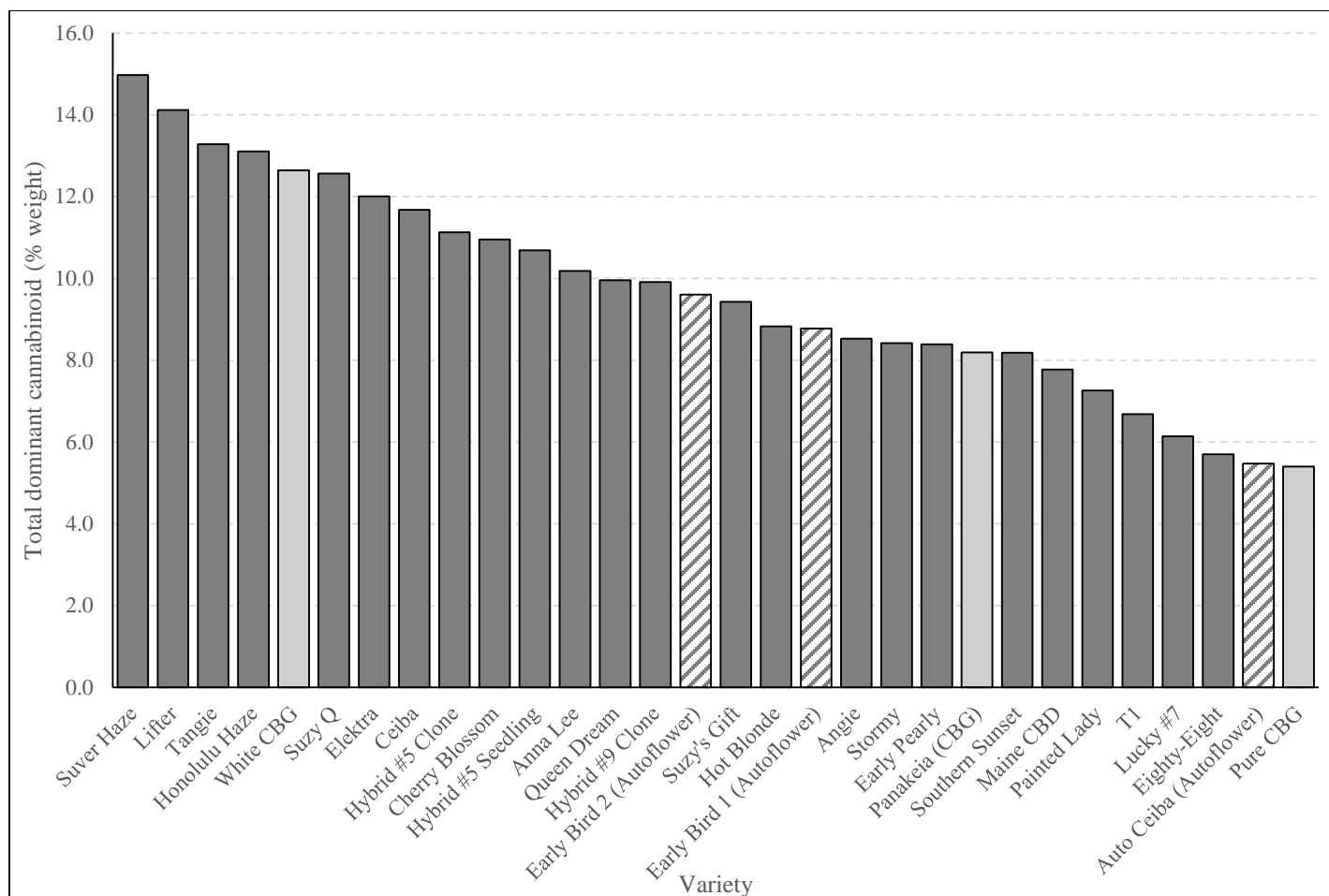


Figure 2. Dominant hemp flower cannabinoid concentrations, 2020.

CBG varieties are denoted by light gray bars, whereas autoflower varieties are denoted by striped bars for comparison with other CBD dominant varieties.

The cannabis plant contains a wide array of non-cannabinoids that contribute to aromatic profiles and may potentially have similar health benefits to some cannabinoids. Terpenes make up one group of many types of compounds found in hemp. Terpene profiles were determined in one replicate for each variety (Table 10). Results are included for 23 analyzed, unique terpenes, which have distinct chemical compositions and associated aromas that contribute to individual plant characteristics. Some terpenes may have medicinal uses as anti-irritants, anti-inflammatories, anti-microbials, or pain relievers, however the medicinal effects of many known compounds remains to be unseen. As highly volatile compounds, many of these terpenes can be subject to high levels of loss as a result of various harvest, drying, processing, or storage methods. Each of these factors should be carefully considered when evaluating and determining your growing practices, as well as desired end-product.

Table 10. Total flower bud terpene profiles, Alburgh, VT, 2020†.

Variety	Alpha-bisabolol	Alpha-humulene	Alpha-ocimene	Alpha-phellandrene	Alpha-pinene	Alpha-terpinene	Beta-caryophyllene	Beta-myrcene	Beta-pinene	Camphene	Caryophyllene-Oxide
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Angie	35.6	209	0.680	16.7	7.94	48.4	524	27.6	11.1	0.720	67.6
Anna Lee	176	170	0.460	0.00	8.88	0.790	398	147	10.1	0.880	48.3
Ceiba	322	339	0.720	22.8	15.6	60.8	1060	36.6	16.0	1.05	54.2
Cherry Blossom	227	302	0.260	0.00	34.0	1.34	869	107	15.4	0.890	41.3
Early Pearly	143	342	0.470	0.00	7.50	0.540	784	83.9	7.23	0.700	111
Eighty-Eight	247	444	0.230	0.00	41.7	1.86	1370	104	19.8	1.23	114
Elektra	311	312	0.180	72.6	1.55	1040	0.00	117	32.0	1.45	56.8
Honolulu Haze	269	271	1.09	0.00	8.17	2.31	1140	145	13.0	2.11	134
Hot Blonde	285	117	0.120	0.00	243	2.17	344	240	99.5	4.20	43.1
Hybrid #5 Clone	475	250	0.300	0.00	70.8	1.05	836	227	32.2	1.70	65.2
Hybrid #9 Clone	683	1170	0.570	0.00	9.47	1.38	2350	92.4	9.75	1.15	188
Hybrid#5 Seedling	230	105	0.530	0.00	8.59	1.37	273	137	8.96	0.840	41.0
Lifter	256	554	0.270	62.2	2.02	1410	0.00	170	32.3	1.87	65.2
Lucky #7	178	156	0.260	6.22	76.7	16.4	442	116	28.9	1.20	25.0
Maine CBD2	22.8	221	22.3	11.0	42.8	27.2	720	42.0	14.4	0.780	102
Painted Lady	704	638	0.470	0.00	8.27	1.89	2160	85.7	7.69	1.24	105
Panakeia	65.7	46.7	0.260	0.00	2.91	0.980	157	10.2	2.05	0.27	28.1
Pure CBG	264	111	0.150	0.00	2.20	0.280	351	8.38	1.38	0.00	30.7
Queen Dream	170	51.6	0.130	0.00	40.3	1.06	155	61.6	13.7	0.590	47.3
Southern Sunset	247.0	208	0.563	0.00	51.5	2.48	434	165	21.8	1.07	54.5
Stormy	87.5	202	0.200	0.00	4.81	0.710	364	41.4	4.62	0.540	85.2
Suver Haze	30.5	396	0.510	4.96	2.23	1260	0.00	43.0	5.42	1.040	74.4
Suzy Q	500	710	0.310	0.00	6.38	0.860	1870	44.5	10.4	1.460	97.0
Suzy's Gift	248	220	0.270	0.00	27.1	1.39	636	74.4	12.9	1.270	40.4
T1	327	187	0.000	0.00	39.0	0.610	660	122	17.6	0.950	178
Tangie	257	257	0.220	0.00	71.0	2.41	502	190	36.3	2.220	44.4
White CBG	651	267	0.470	6.49	2.47	868	0.00	25.8	4.67	1.710	56.7
Auto Ceiba	283.5	139	0.790	6.23	6.77	17.1	381	6.26	8.04	0.780	63.0
Early Bird 1	41.4	99.0	0.770	0.00	5.95	0.00	295	11.0	2.12	0.00	0.00
Early Bird 2	164	216	0.290	0.00	39.0	0.840	513	86.5	17.6	0.00	0.720

†The above data represents only one replicate, hence no statistical analysis was run on terpene profiles.

Table 10 continued. Total flower bud terpene profiles, Alburgh, VT, 2020†.

Variety	Cis-beta-ocimene ppm	D-limonene ppm	Delta-3-carene ppm	Eucalyptol ppm	Gamma-terpinene ppm	Guaiol ppm	L-fenchone ppm	Linalool ppm	P-cymene ppm	Sabinene ppm	Terpinolene ppm	Trans-nerolidol ppm
Angie	27.5	14.4	1.67	3.97	0.00	12.4	6.93	17.6	3.50	92.1	68.9	40.5
Anna Lee	11.6	26.6	0.590	1.95	1.05	3.31	0.00	7.69	0.700	0.00	0.52	0.00
Ceiba	39.2	22.2	2.54	16.3	69.8	270	12.2	27.3	0.00	75.2	148	0.00
Cherry Blossom	4.93	16.0	1.14	0.54	1.58	1.38	3.89	1.62	0.670	0.00	0.75	0.00
Early Pearly	8.04	22.2	0.510	0.00	0.640	1.86	3.50	0.60	0.580	0.00	0.520	53.6
Eighty-Eight	5.60	12.6	0.00	0.680	2.40	364	3.24	0.91	0.00	0.00	2.87	0.00
Elektra	3.41	15.4	0.00	0.700	1.47	196	7.58	32.6	0.00	0.00	2.80	48.1
Honolulu Haze	17.7	36.8	0.00	1.44	2.42	341	22.1	138	0.00	1.62	12.0	28.5
Hot Blonde	4.93	22.7	0.00	1.58	3.13	136	8.02	4.11	0.00	0.00	3.68	0.00
Hybrid #5 Clone	4.71	30.8	1.14	0.610	1.13	3.36	4.19	2.34	0.980	0.00	0.640	0.00
Hybrid #9 Clone	10.6	26.8	0.940	1.62	2.13	0.00	4.89	16.2	0.850	0.00	0.970	76.6
Hybrid#5 Seedling	14.2	23.5	0.930	2.33	1.90	200	2.55	1.03	0.620	0.00	0.670	0.00
Lifter	7.23	26.5	0.00	0.00	2.08	0.00	9.52	155	0.00	0.00	16.8	0.00
Lucky #7	12.1	9.86	0.00	1.62	23.3	137	2.13	0.00	0.00	27.5	14.3	0.00
Maine CBD2	16.0	5.12	1.17	7.33	36.5	10.4	1.54	5.17	3.03	51.4	55.1	0.00
Painted Lady	17.2	21.0	0.00	1.01	2.29	300	10.3	11.4	0.00	1.95	4.61	54.8
Panakeia	1.07	4.03	0.00	1.22	0.970	227	0.00	2.02	0.160	0.00	0.390	0.00
Pure CBG	0.680	2.58	0.00	0.44	0.350	353	0.330	0.00	0.00	0.00	0.800	0.00
Queen Dream	2.10	7.73	0.610	1.89	1.18	61.5	1.26	0.91	0.500	0.00	0.440	16.5
Southern Sunset	19.3	16.4	0.00	8.86	3.01	378	1.83	2.18	0.00	0.00	1.29	0.00
Stormy	4.99	12.0	0.550	0.00	1.09	181	1.65	1.09	0.490	0.00	0.550	0.00
Suver Haze	10.8	15.9	0.00	1.48	2.38	4.99	10.7	90.2	0.00	2.44	14.9	0.00
Suzy Q	4.59	59.9	0.00	0.870	1.02	725	7.95	25.9	0.00	0.550	9.43	127
Suzy's Gift	5.99	21.6	0.00	1.62	2.15	287	7.80	4.73	0.00	1.19	3.89	0.00
T1	2.57	16.0	0.640	0.440	0.720	2.76	2.44	2.07	0.600	0.00	0.460	18.3
Tangie	5.55	31.2	0.00	4.11	2.02	2.37	7.56	58.8	0.00	0.00	5.37	0.00
White CBG	4.82	12.6	0.00	0.00	2.18	271	2.10	0.00	0.00	1.70	2.80	29.1
Auto Ceiba	15.8	9.06	0.533	1.55	20.5	333	0.00	2.33	1.42	24.7	22.0	33.2
Early Bird 1	19.0	0.00	6.73	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00
Early Bird 2	42.4	0.00	6.04	0.00	0.00	0.00	10.3	0.00	0.00	0.00	0.00	0.92

†The above data represents only one replicate, hence no statistical analysis was run on terpene profiles.

DISCUSSION

Many of the varieties within the trial appeared to perform well in our Northeast climate, however others appeared as if they would have benefit from additional time in the field as they did not reach full maturity. Varieties including Early Pearly, Hybrid #5 Seedlings, Hybrid #9 Clones, Panakeia, T1, and Pure CBG all could have benefit from an additional week of growth and higher yields could potentially have been obtained if planted earlier as challenges arose from shipping delays earlier on in the season. On the other hand, varieties including Queen Dream and Southern Sunset were in for some of the earlier planting dates, yet did not appear to reach full maturity. Additionally, there were some stark differences in growth habits and quality across the board. Based on growth habit alone, there is potential to adjust plant spacing of any given variety to optimize per acre yields, while also maintaining adequate spacing for air flow and thus disease control. This year there was noticeably more disease pressure present within the trial when comparing to past years. Differences in disease resistance was particularly noticeable across cultivars as some had severe infection, whereas others appeared to have little to no instances of the disease present on flowers and leaves. Some disease issues could potentially be mitigated by cultural practices such as adequate plant spacing and selecting varieties with disease tolerance or resistance. Various growth characteristics, such as sprawling versus upright growth habits, can be especially important when looking at the potential for high disease pressure leading up to harvest when we may experience wet conditions conducive for major pathogen growth and potential crop losses. Few species of arthropod pests were found on hemp plants this year with aphids being most prevalent. In addition to problems associated with feeding damage, there is also potential for sooty mold growth on leaves as a result of high aphid populations, reducing quality of flower. Other pests may begin to develop as a greater concern, such as stem borers, which were seen in greater populations in other parts of the region.

While varieties were able to be harvested in a timely matter, weather constraints in the region dictated harvest of some later maturing varieties as we faced colder temperatures in the latter part of October. As a result, a handful of varieties could have likely benefitted from an additional week or two to fully mature and develop a higher quality flower. These varieties likely are not suited to the Northeastern climate. Varieties such as Lifter and Tangie stood out for their higher yields and earlier maturation, which finished 4 weeks prior to some of the latest maturing varieties. Similarly, varieties that were able to be harvested by mid-October would also prove beneficial in this region with potential for losing crops to frost. Some frost damage was observed on plants within the trial, though in this case it was minimal. Some of the lowest yielding varieties in the trial may have also been a result of the later planting date, which was nearly 1 month after the initial planting, however there could be potential for increasing planting density to compensate for smaller plant sizing. These plants also would take a significantly shorter amount of time to harvest compared to some larger varieties that were planted in the first week of June.

Within this trial, all cultivars tested were compliant in accordance with Vermont State Regulations for THC limits, having a D9-THC below 0.3% and total potential THC below 1.0%. Highest values of total potential CBD were seen in Suver Haze, Lifter, Tangie, and Honolulu Haze to name a few, however these may not be compliant depending on your state when looking at total potential THC values. As regulations may differ from state to state, it is important to refer to your own state specific regulations to ensure you are selecting compliant cultivars for your area. Lower total potential CBD cultivars also appeared to produce lower total THC and may be safer options to produce a compliant crop. Similarly, CBG varieties tested within this

study were among the lowest values for total THC and may serve as a good alternative depending on market and desired product. Terpene profiles and concentrations of hemp may also become increasingly important as new markets are developed for the crops. While many of these compounds contribute to the vast array of aromatics and can exhibit distinct aroma profiles across cultivars, many of these compounds may also be important for their purported health benefits and synergistic effects with other compounds when consumed in hemp and hemp related products. The twenty-seven varieties within our research trial, and building on past year's variety trials, only begins to scratch the surface of the multitude of hemp cultivars that are now commercially available. With such wide scale variations in growth habits, yield, and quality of various cultivars, it will be increasingly important to continue research and evaluation of those available cultivars to provide region specific information to optimize farmer yields within the Northeast.

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