

NORTHWEST CROPS & SOILS PROGRAM



2022 Hemp Flower Variety Trial



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2022 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) or cannabigerol (CBG), potentially 10-15% or higher. 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. The University of Vermont evaluated 22 full season hemp varieties for their growth habit, pest tolerance, flower yields, and flower quality. Please note that there are also 4 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 intending to grow hemp are required to follow state and federal regulations regarding hemp production and registration. Growers must either register with their intended state for production or adhere to federal 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. For the 2023 growing season, the Vermont Agency of Agriculture, Food and Markets Hemp program is no longer accepting registrations for growing or processing hemp in the state of Vermont.

Please refer to this <https://www.ams.usda.gov/rules-regulations/hemp> for detailed information on USDA hemp guidelines for production.

MATERIALS AND METHODS

Companies selling hemp seed suitable for the CBD market were solicited to participate in the variety evaluation program. Five companies submitted twenty-six full season hemp varieties for evaluation in the trial. The varieties were assessed for tolerance to pests, yield, and quality 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 22 individual hemp flower varieties (Table 2). In addition, 4 autoflower varieties are included in this study, but were planted at 2' in row spacing and not included in the statistical analysis.

Fertility amendments were based on soil test results received from the University of Vermont Agricultural and Environmental Testing Laboratory (Burlington, VT). On 6-Apr, all plots were fertilized with 57 lbs N ac⁻¹, 57 lbs P ac⁻¹, 57 lbs K ac⁻¹, using 19-19-19 fertilizer. All entries were transplanted into black plastic mulch with drip tape irrigation.

Table 1. Agronomic information for the hemp variety trial, Alburgh, VT, 2022.

Location	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Spring Grains
Plant spacing (ft)	5 x 5
Planting date	6-Jun, 14-Jun,
Fertilization	57 lbs N ac ⁻¹ , 57 lbs P ac ⁻¹ , 57 lbs K ac ⁻¹

The plant material received from the companies was comprised of seeds or rooted cuttings. Seed material was planted into deep 50-cell trays containing Fort Light potting mix (Vermont Compost Company, Montpelier, VT) on 10-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. 2022 Hemp varieties, source, material, and dominant cannabinoid.

Source	Cultivar	Material	Dominant cannabinoid
Hoku Seed Company	Death Eater	Seed	CBD
Hoku Seed Company	Sky Temple	Seed	CBD
Hoku Seed Company	Star Mind	Seed	CBD
Oregon CBD	Cakeberry Brulee	Seed	CBD
Oregon CBD	Elektra	Seed	CBD
Oregon CBD	Hawaiian Haze	Seed	CBD
Oregon CBD	Lifter	Seed	CBD
Oregon CBD	Lifter Seedless	Seed	CBD
Oregon CBD	Sour Brulee	Seed	CBD

Oregon CBD	Sour Candy Kush Seedless	Seed	CBD
Oregon CBD	Stem Cell	Seed	CBG‡
Oregon CBD	Stem Cell Seedless	Seed	CBG
Oregon CBD	Suver Haze	Seed	CBD
Oregon CBD	Suver Haze Seedless	Seed	CBD
Oregon CBD	Vitality Seedless	Seed	CBDV
Oregon CBD	White CBG Seedless	Seed	CBG
Oregon CBD	White CBG	Seed	CBG
Quick Plug	Abacus	Rooted Cutting	CBD
Quick Plug	Cherry Abacus	Rooted Cutting	CBD
Quick Plug	Rincon C	Rooted Cutting	CBD
University of Connecticut	Tsunami x Wife	Seed	CBD
University of Connecticut	Wife x Purple Star	Seed	CBD
Phylos	Phylos NBS-1	Seed	CBD -Autoflower
Quick Plug	QP 1010	Seed	CBD -Autoflower
Quick Plug	QP1148	Seed	CBD -Autoflower
Quick Plug	QP 1151	Seed	CBD -Autoflower

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

As a result of shipping delays or late entries, some varieties were required to be planted at different dates. Those entries started from seed were planted on 6-Jun, whereas those received as rooted cuttings were planted on 14-Jun (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 within each plot were recorded. High variation in growth rates, and plant structure 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. Variation in maturation rates was observed within the trial with up to a one-month span in harvest times ranging from the end of September through mid-late October, such as Lifter and White CBG maturing nearly one month before other later maturing varieties.

Table 3. Planting, flowering, and harvest dates for Hemp Flower Variety Trial, Alburgh, VT, 2022.

Variety	Planting week †	Flowering week	Harvest week
Abacus	24	32	41
Cakeberry Brulee	23	31-32 ‡	39
Cherry Abacus	24	32-34	40
Death Eater	23	32-35	40
Elektra	23	32-33	39
Hawaiian Haze	23	32-33	40
Lifter	23	31-33	38
Lifter Seedless	23	34-35	40
Rincon C	24	33	38

Sky Temple	23	31-34	41+ §
Sour Brulee	23	31-33	39
Sour Candy Kush Seedless	23	33	39
Star Mind	23	33-34	40
Stem Cell	23	33	40
Stem Cell Seedless	23	34	40
Suver Haze	23	33	40
Suver Haze Seedless	23	34	41
Tsunami x Wife	23	31	40
Vitality Seedless	23	34	41+
White CBG Seedless	23	31-32	40
White CBG	23	33	38
Wife x Purple Star	23	33	41

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

‡ Varieties with a range listed for flowering week exhibited per-plant 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.

Scouting took place weekly from 7-Sep until 21-Sep leading up to harvest to capture insect and disease pests that have the potential to impact flower quality as plants matured. 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 and feeding damage. 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 0-10 scale for gray mold and white mold, with a rating of 0 being least severe (no apparent infection) and a rating of 10 being most severe. Less severe cases were noted as single flower clusters showing degradation or infection and most severe cases would be indicative of entire stems or colas showing severe disease infection and tissue degradation. Whole plant powdery mildew and leaf spot infections were rated on a visual 0-100 scale indicating the percentage of the entire plant exhibiting infection, 0 having no infection, and 100 having 100% infection throughout the plant, affecting the entirety of the leaf surface.

Prior to harvest, plant height and width were measured from all harvested plants in each plot. From each plot, composite flower samples were taken from harvested floral material and sent to Bia Diagnostic Laboratories (Colchester, VT) to be analyzed for cannabinoids and terpenes.

Plants were harvested by hand using bypass loppers or chainsaw depending on trunk diameter. 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,



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

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.

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 'QP 1010,' 'QP 1148,' 'QP 1151, and 'Phylos NBS-1' 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.

Treatment	Yield
Variety 1	6.0
Variety 2	7.5*
Variety 3	9.0
LSD (p-value ≤ 0.10)	2.0

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.

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 saw cooler overall temperatures with well above average precipitation, especially during the establishment period of the hemp plants in the month of June and during harvest and maturation periods in October. As a result, growing conditions accumulated below average Growing Degree Days (GDDs) and temperatures that were an average of 3.67 degrees cooler than the 30-year average.

Table 4. Seasonal weather data collected in Alburgh, VT, 2022.

Alburgh, VT	June	July	August	Sept	Oct
Average temperature (°F)	65.3	71.9	70.5	60.7	51.5
Departure from normal	-2.18	-0.54	-0.2	-1.99	1.24
Precipitation (inches)	8.19	3	4.94	4.4	2.56
Departure from normal	3.93	-1.06	1.4	0.73	-1.27
Growing Degree Days (50-86°F)	459	674	630	343	184
Departure from normal	-64	-20	-11	-44	46

Historical averages are for 30 years of data provided by the NOAA (1991-2020) for Burlington, VT.

Cultivars were scouted from 7-Sep through 21-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. Additionally, low levels of flea beetles were observed during the scouting period and throughout the season. Significant differences amongst varieties were observed for aphids, and leaf damage as a result of flea beetles. Lowest observed values were seen for White CBG with an average of 0.08 aphids leaf⁻¹, and was statistically similar to the majority of the other varieties within the trial, excluding Cherry Abacus, Elektra, and Wife x Purple Star, which were among those varieties with highest observed aphid pressure. Similarly, there was low observable leaf chewing damage from flea beetles and other chewing insects. Overall, the lowest observable damage was noted in Cherry Abacus and Hawaiian Haze showing 1.25% leaf damage each when compared to other varieties. Conversely, Stem Cell showed highest observed leaf damage from chewing at 6.88% leaf damage. Similar to past years, insect pests did not seem to be highly impactful on hemp varieties within the trial. Akin to past years, large amounts of predatory insects were also observed on plants including green lacewings and various species of lady beetles, however, these populations were not quantified.

Four main diseases were observed including Septoria leaf spot, powdery mildew, gray mold, and white mold. While Septoria leaf spot was the predominant leaf spot disease, others were noted including bipolaris leaf spot, cercospora leaf spot, and perhaps others not identified. As a result, these were grouped into a generic “leaf spot” category for scouting purposes. This year, powdery mildew pressure was much lower than in past years with the many of the varieties showing little to no presence of powdery mildew on leaves. Abacus, Rincon C, and Vitality Seedless all showed no powdery mildew leaf infection throughout the scouting period. Those varieties that were most impacted by powdery mildew included White CBG Seedless at 20.0% whole plant infection, Stem Cell Seedless, and Suver Haze (at 12.5% each). Leaf spot remained highly prevalent throughout the trial with most susceptible varieties including White CBG at 77.5% alongside Abacus and Cakeberry Brulee at 68.8 and 61.3% respectively. The CBDV variety, Vitality Seedless, showed little to no disease damage or incidence across the board, whereas a number of earlier maturing CBD varieties, as well as the CBG varieties, were more greatly impacted by the various observed diseases. White and gray mold were largely not observed during the scouting period, with greater impacts observed throughout the harvest period as plants matured and experienced physical damage leading up to harvest. These impacts are recorded through the unmarketable flower metric collected at harvest.

Table 5. Disease and arthropod pest incidence and severity on hemp varieties, Alburgh, VT, 2022.

Variety	Aphids	Chewing damage	Powdery mildew	Leaf spot	Gray mold incidence	Gray mold severity	White mold incidence	White mold severity
	# leaf ¹	%	%	%	# infected stems plant ⁻¹	0-10	# infected stems plant ⁻¹	0-10 [†]
Abacus	0.92* ‡	3.13*	0.00	68.8	1.00	0.75	0.00	0.00
Cakeberry Brulee	0.38*	1.88*	2.50*	61.3	0.00	0.00	0.00	0.00
Cherry Abacus	2.25	1.25	2.50*	35.0	0.00	0.00	0.00	0.00
Death Eater	0.50*	6.25	2.50*	20.0*	0.75*	0.50*	0.75	1.50
Elektra	1.75	1.88*	5.00*	13.8*	0.00	0.00	0.00	0.00
Hawaiian Haze	0.75*	1.25	1.25*	28.8	0.00	0.00	0.00	0.00
Lifter	0.88*	3.75*	5.00*	51.3	0.00	0.00	0.00	0.00
Lifter Seedless	1.17*	5.63	8.75*	15.1	0.00	0.00	0.00	0.00
Rincon C	0.29*	3.13*	0.00	23.8	0.00	0.00	0.00	0.00
Sky Temple	1.00*	2.50*	3.75*	20.0	0.00	0.00	0.00	0.00
Sour Brulee	0.25*	3.13*	5.00*	53.8	0.00	0.00	0.25*	1.00*
Sour Candy Kush Seedless	1.00*	3.13*	7.50*	38.8	0.50*	0.50*	0.25*	0.25*
Star Mind	0.58*	6.25	2.50*	20.0*	0.00	0.00	0.00	0.00
Stem Cell	0.92*	6.88	2.50*	70.0	0.75*	0.50*	0.25*	0.75*
Stem Cell Seedless	0.46*	3.75*	12.5	27.5	0.00	0.00	0.00	0.00
Suver Haze	1.50*	5.63	12.5	30.0	0.00	0.00	0.00	0.00
Suver Haze Seedless	0.79*	3.75*	2.50*	23.8	0.00	0.00	0.00	0.00
Tsunami x Wife	0.67*	3.75*	5.00*	17.6*	0.00	0.00	0.00	0.00
Vitality Seedless	0.92*	1.88*	0.00	6.25	0.00	0.00	0.00	0.00
White CBG	0.08	5.63	2.50*	77.5	2.25	1.00	0.25*	1.25
White CBG Seedless	0.63*	1.88*	20.0	25.0	0.25*	0.25*	0.00	0.00
Wife x purple star	2.13	5.63	6.25*	13.8*	0.00	0.00	0.00	0.00
LSD (0.10) §	1.35	3.31	9.86	14.5	0.912	0.551	0.353	1.09
Trial mean	0.900	3.72	5.00	33.7	0.250	0.159	0.080	0.216
Autoflower varieties ¶								
Phylos NBS-1	0.00	0.00	0.00	35.0	0.00	0.00	0.00	0.00
QP 1010	0.00	0.00	0.00	52.5	0.00	0.00	0.00	0.00
QP 1148	0.00	0.00	0.00	45.0	0.00	0.00	0.00	0.00
QP 1151	0.00	0.00	0.00	62.5	0.00	0.00	0.00	0.00

[†]Rating on a 0 to 10 scale; where 0 = no disease and 10 = severe.

[‡]Treatments with an asterisk (*) are not significantly different from the top performer in **bold**.

§ LSD – Least significant difference at p=0.10.

¶Autoflower varieties were not statistically analyzed with the full season varieties and are shown for comparison.

Within the variety trial, Lifter Seedless was the tallest at 201 cm and was statistically similar in height to Sky Temple and Vitality Seedless (Table 6). Widest plants included the top performer Hawaiian Haze at 159 cm and was statistically similar to Cherry Abacus, Sky Temple, Stem Cell, Stem Cell Seedless, Suver

Haze, Tsunami x Wife, and Wife x Purple Star. Rincon C was the most prone to lodging and was given a rating of 5 indicating completely toppled plants and broken branching. Abacus, Suver Haze, Star Mind, Stem Cell, and Stem Cell Seedless were also more prone to lodging when compared to the other varieties in the trial showing similarly poor resistance to breaking or toppling.

For each of the measured metrics, Autoflower varieties are included for comparison. Autoflower plants were generally much smaller ranging from 51 cm to 84 cm plant widths, having the potential to be planted at a greater density. Given growth habits of these plants, and maturing over a month or more ahead of other full term plants, autoflower varieties experienced no lodging.

Table 6. Hemp whole plant weight, height, and width, Alburgh, VT, 2022.

Variety	Height cm	Width cm	Lodging 0-5 [†]
Abacus	94	82	2.75
Cakeberry Brulee	158	123	1.00*
Cherry Abacus	155	144* ‡	1.75*
Death Eater	177	137	0.25
Elektra	156	121	0.25
Hawaiian Haze	162	159	2.00*
Lifter	156	134	0.25
Lifter Seedless	201	128	1.50*
Rincon C	94	104	5.00
Sky Temple	190*	146*	1.50*
Sour Brulee	162	129	2.00*
Sour Candy Kush Seedless	173	125	1.00*
Star Mind	166	136	2.50
Stem Cell	146	146*	2.25
Stem Cell Seedless	150	146*	0.50*
Suver Haze	165	141*	2.75
Suver Haze Seedless	169	132	0.25
Tsunami x Wife	150	155*	0.75*
Vitality Seedless	182*	135	0.50*
White CBG	142	128	0.75*
White CBG Seedless	128	139	1.50*
Wife x Purple Star	171	143*	0.50*
LSD (0.10) §	22.0	19.9	1.98
Trial Mean	157	133	1.43
Autoflower varieties[¶]			
Phylos NBS-1	71	70	0.00
QP 1010	67	71	0.00
QP 1148	72	84	0.00
QP 1151	61	51	0.00

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

§ LSD – Least significant difference at p=0.10.

† Lodging was rated on a 0 to 5 scale where 0= no lodging and 5 = Severe breaking of branches and fallen plant.

¶ Autoflower varieties were not statistically analyzed with the full season varieties and are shown for comparison.

Total bud weight, leaf weight, and stem weight were measured at harvest to further evaluate growth characteristics of each variety (Table 7). Vitality Seedless had the highest overall whole plant weight at 23.1 lbs plant⁻¹ and was statistically similar to Lifter Seedless, Wife x Purple Star, and Tsunami x Wife. Each of these varieties, exhibiting highest overall plant weights, were triploid genetics. Lifter seedless also had the highest overall stem weight at 8.65 lbs plant⁻¹ and was statistically similar to Sky Temple, Sour Brulee, Tsunami x Wife, and Wife x Purple Star, whereas the highest percentage of stem material belonged solely to Sky Temple at 47.1%. Tsunami x Wife was the stand alone top performer for overall flower weight at 9.70 lbs plant⁻¹ however, Wife x Purple Star also yielded strongly at 8.00 lbs plant⁻¹. Tsunami x Wife also had the highest percentage of flower material at 46.6% though was statistically similar to Rincon C at 43.2% though this variety had comparably very low overall flower yields at 2.95 lbs plant⁻¹. Leaf weight of plants were highest in Vitality Seedless at 8.80 lbs plant⁻¹ and was statistically similar to Lifter Seedless, Sour Candy Kush Seedless, Sour Brulee, Suver Haze, and Wife x Purple Star. The amount of total leaf or stem material can greatly affect how long it takes to harvest the crop, especially if much of the harvest is by hand. A few documented harvest times in 2019 and 2020 showed a great range in total hours to harvest by hand. 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. When looking at the proportions of plant material in relation to one another, those showing a flower to stem ratio above 1 and leaf to stem ratio below 1 would maximize harvest efficiency. Those plants would result in less time spent removing leaf materials while maximizing flower output such as with Tsunami x Wife, Wife x Purple Star, and a number of the other “seedless” or triploid varieties. 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. Each autoflower variety had substantially larger proportions of flower material when compared to full term cultivars, yet plants as a whole were also much smaller compared to most full-term cultivars in this case.

Table 7. Wet hemp plant harvest growth metrics, Alburgh, VT, 2022.

Variety	Whole plant weight	Stem weight	Stem weight	Flower weight	Flower weight	Leaf weight	Leaf weight	Flower:Stem	Leaf:Stem
	lbs plant ⁻¹	lbs plant ⁻¹	%	lbs plant ⁻¹	%	lbs plant ⁻¹	%		
Abacus	3.75	1.15	30.7	1.20	31.8	1.40	37.5*	1.10	1.26
Cakeberry Brulee	12.4	4.45	35.5	4.25	34.0	3.65	30.5	0.97	0.88
Cherry Abacus	13.6	5.50	38.9	4.10	31.6	3.95	29.5	0.85	0.78
Death Eater	16.0	6	37.1	5.20	32.9	4.80	30.0	0.90	0.82
Elektra	13.8	4.4	31.9	4.75	35.1	4.60	33.0*	1.12	1.04
Hawaiian Haze	16.8	5.9	35.2	5.25	31.3	5.65	33.5*	0.91	0.95
Lifter	15.9	5.4	34.2	4.90	30.6	5.60	35.2*	0.91	1.05
Lifter Seedless	22.5*	8.65	37.7	6.10	26.7	7.70*	35.6*	0.72	0.98
Rincon C	7.10	1.95	26.4	2.95	43.2*	2.20	30.4	1.80	1.26
Sky Temple	17.4	8.20*	47.1	5.10	29.3	4.10	23.6	0.63	0.51
Sour Brulee	19.1	6.75*	35.2	5.95	32.1	6.40*	32.7*	0.97	1.00

Sour Candy Kush Seedless	18.2	5.8	31.3	5.40	29.9	7.00*	38.8*	0.97	1.26
Star Mind	14.1	4.85	33.9	4.70	33.5	4.50	32.6*	1.09	1.15
Stem Cell	13.0	4.75	36.1	3.70	28.9	4.50	35.0*	0.84	1.01
Stem Cell Seedless	15.7	5.78	36.7	4.90	31.7	4.98	31.6*	0.89	0.89
Suver Haze	16.3	5.05	34.0	3.70	24.2	7.55*	41.9	1.01	5.07
Suver Haze Seedless	17.5	6.20	35.2	6.45	37.0	4.85	27.8	1.06	0.80
Tsunami x Wife	20.9*	6.90*	32.9	9.70	46.6	4.25	20.4	1.44	0.63
Vitality Seedless	23.1	8.3*	35.0	6.00	27.2	8.80	37.8*	0.82	1.10
White CBG	11.1	2.90	27.1	4.10	37.6	4.05	35.3*	2.75	3.68*
White CBG Seedless	15.7	5.40	33.7	4.45	28.6	5.80	37.8*	0.86	1.15
Wife x Purple Star	22.1*	7.65*	34.5	8.00	36.4	6.45*	29.1	1.07	0.85
LSD (0.10) §	3.92	1.94	8.24	1.29	5.92	2.45	10.4	0.90	2.71
Trial Mean	15.7	5.54	34.5	5.04	32.7	5.13	32.7	1.08	1.28
Autoflower varieties¥									
Phylos NBS-1	0.827	0.131	15.9	0.496	60.0	0.199	24.1	3.77	1.52
QP 1010	0.919	0.127	13.9	0.598	65.0	0.194	21.1	4.69	1.52
QP 1148	1.52	0.272	18.0	0.796	52.6	0.446	29.5	2.92	1.64
QP 1151	0.637	0.097	15.2	0.465	73.0	0.075	11.7	4.79	0.77

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

§LSD – Least significant difference at p=0.10.

¥Autoflower varieties were not statistically analyzed with the full season varieties and are shown for comparison.

At harvest, a composite subsample of flower material was collected from each plot and dried down to determine dry matter and calculate dry matter flower yields (Table 8, Figure 1). Cakeberry Brulee had the highest dry matter at 40.3%, likely indicating that this was well past optimal harvest period as ranges generally fall between 20-25% dry matter at harvest. Additionally, this variety had one of the higher amounts of unmarketable flower material within the trial.

Unmarketable flower included any flower that had suffered from disease, rot, soil contamination, or otherwise damaged flower material. Sour Candy Kush Seedless had the highest overall amount of unmarketable flower material at 0.649 lbs plant⁻¹ alongside Sour Brulee and the aforementioned Cakeberry Brulee. Conversely Rincon C had the lowest overall unmarketable flower material at 0.001 lbs plant⁻¹. Tsunami x Wife had the highest overall dry matter flower yields at 3609 lbs ac⁻¹ alongside Cakeberry Brulee, Sour Brulee which yielded 2973 and 3499 lbs ac⁻¹ respectively despite also having some of the highest amounts of unmarketable flower material. Lowest observed yields were seen with the Abacus variety at 668 lbs ac⁻¹. Dry matter yields on a per acre basis for autoflower varieties were comparatively low this year as planted with yield calculations are based on 3' x 3' plant spacing. Higher plant density may have resulted in increased yields comparable to other full season varieties, however seed costs as well as potential for disease may be significantly higher.

Table 8. Hemp flower yield, Alburgh, VT, 2022.

Variety	Flower dry matter	Unmarketable flower	Dry matter flower yield†	Yield at 8% moisture
	%	lbs plant ⁻¹	lbs ac ⁻¹	lbs ac ⁻¹
Abacus	31.7	0.042* ‡	668	726
Cakeberry Brulee	40.3	0.344	2973*	3232*
Cherry Abacus	23.4	0.044*	1668	1814
Death Eater	29.4	0.112*	2612	2839
Elektra	23.6	0.019*	1958	2128
Hawaiian Haze	25.6	0.028*	2418	2629
Lifter	18.2	0.045*	1629	1771
Lifter Seedless	23.6	0.007*	2498	2715
Rincon C	25.8	0.001	1323	1438
Sky Temple	29.6	0.021*	2629	2857
Sour Brulee	33.7	0.418	3499*	3803*
Sour Candy Kush Seedless	28.4	0.649	2584	2809
Star Mind	28.8	0.231	2368	2574
Stem Cell	26.0	0.040*	1691	1838
Stem Cell Seedless	19.5	0.003*	1665	1810
Suver Haze	26.3	0.194*	1738	1889
Suver Haze Seedless	20.6	0.011*	2313	2514
Tsunami x Wife	21.5	0.008*	3609	3923
Vitality Seedless	22.1	0.011*	2309	2509
White CBG	26.8	0.042*	1932	2100
White CBG Seedless	18.7	0.005*	1462	1589
Wife x Purple Star	19.2	0.092*	2681	2914
LSD (0.10) §	4.33	0.209	703	764
Trial mean	25.6	0.105	2192	2383
Phylos NBS-1 ¶	21.7	0.00	520	562
QP 1010	25.5	0.00	737	795
QP 1148	23.9	0.00	922	996
QP 1151	26.1	0.00	587	633

† 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.

¶ Autoflower varieties were not statistically analyzed with the full season varieties and are shown for comparison.

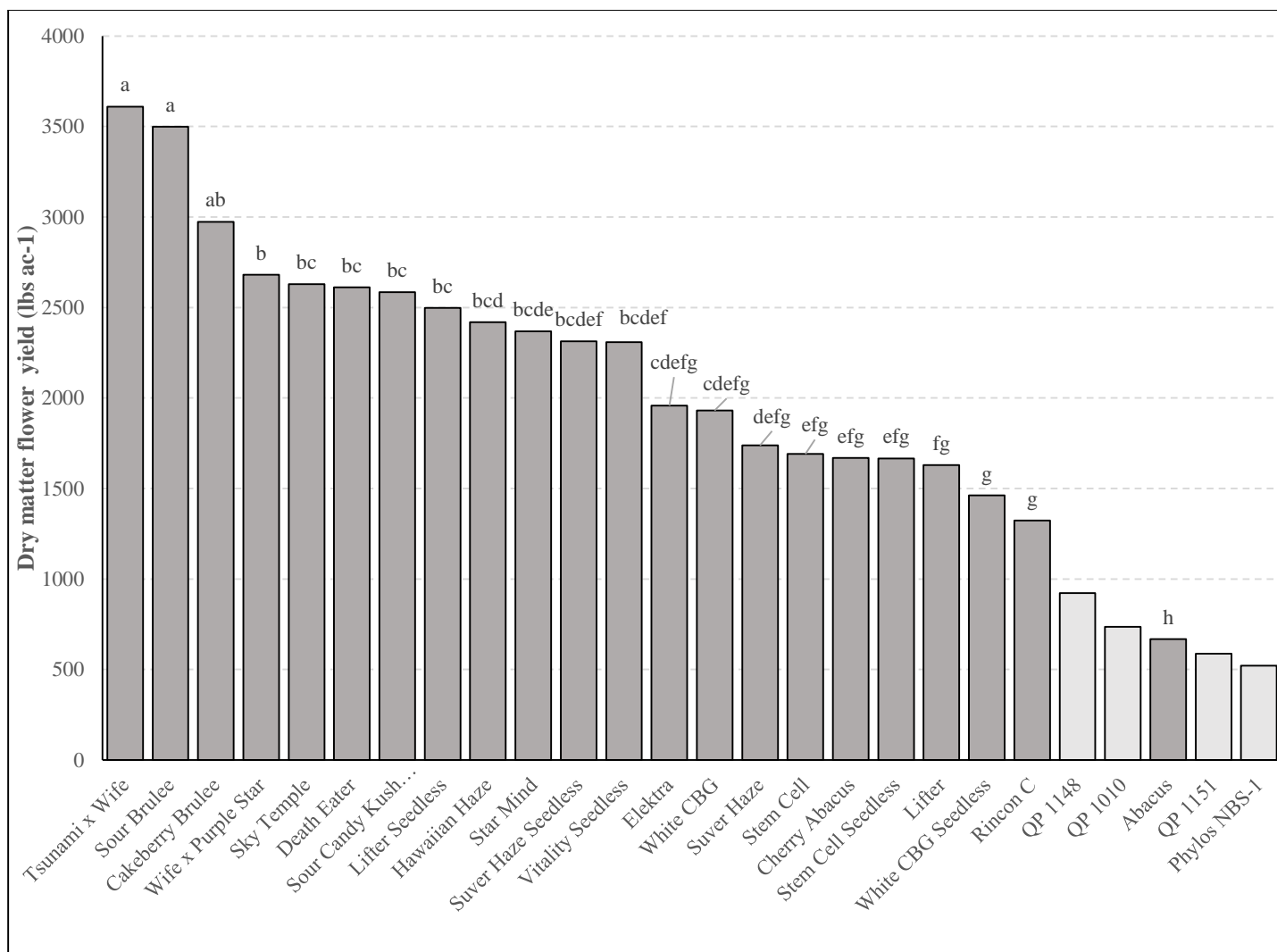


Figure 1. Dry matter flower yield of hemp varieties for the flower market, 2022.

Autoflower varieties are included and are denoted by light gray bars.

Each cultivar within the trial (3 replicates only) was also analyzed for cannabinoid content and terpenes (Table 9; Figure 2). Results for cannabinoids are on a dry matter basis (0% moisture). Autoflower varieties are included with these results for comparison. Each autoflower variety showed comparatively low concentrations of cannabinoids, yet were all compliant under current regulatory standards for total THC when grown and sampled at peak maturity. Peak, dominant cannabinoid concentration for each variety ranged from 4.33% to 14.9%. Within the study, Suver Haze Seedless had the highest total concentrations of CBD at 14.9% whereas White CBG Seedless had the highest total concentration of CBG at 8.41%. Other top performing varieties for total potential CBD included Lifter Seedless at 13.5% with each of these having highest total cannabinoid concentrations as well. Based on current regulations, there were nine varieties that would not be compliant given the sample test date as total potential THC exceeded the 0.30% total THC limit. Those varieties showing the lowest total potential THC included each of the CBG varieties (White CBG, White CBG Seedless, Stem Cell, and Stem Cell Seedless), whereas highest values for total potential THC included Suver Haze Seedless and Lifter seedless at 0.543% and 0.493% respectively. The

level of THC in the plant can possibly be managed through earlier harvest dates. It is important to consult individual state regulations and recognize that varieties may perform differently in other growing regions.

Table 9. Hemp flower major cannabinoid analysis, Alburgh, VT, 2022.

Variety	CBDVa	CBDV	CBDa	CBGa	CBG	CBD	D9-THC	THCa	Total THC	Total CBD	Total Cannabinoids	CBD : THC
	%	%	%	%	%	%						
Cakeberry Brulee	0.030	0.010	4.85	0.227	0.010	0.073	0.007	0.210	0.190	4.33	5.42	22.7
Cherry Abacus	0.037	0.007	9.23	0.247	0.037	0.043	0.000	0.353	0.307	8.14	9.95	26.2*
Death Eater	0.043	0.000	7.21	0.213	0.037	0.033	0.000	0.283	0.247	6.36	7.82	25.6*
Abacus	0.053	0.027	12.0	0.167	0.057	0.057	0.017	0.450	0.410	10.6	12.9	25.8*
Elektra	0.050	0.000	8.40	0.167	0.010	0.060	0.000	0.333	0.293	7.43	9.02	25.1*
Hawaiian Haze	0.053	0.020	12.2	0.223	0.020	0.070	0.000	0.440	0.383	10.8	13.0	27.9
Lifter	0.050	0.000	6.08	2.86	0.020	0.027	0.000	0.287	0.250	5.36	9.33	16.4
Lifter Seedless	0.053	0.007	15.3*	0.403	0.017	0.050	0.000	0.560*	0.493*	13.5*	16.4*	27.2*
Rincon C	0.030	0.023*	10.8	0.313	0.030	0.147	0.010*	0.437	0.390	9.59	11.8	24.5*
Sky Temple	0.030	0.003	6.28	0.207	0.030	0.030	0.000	0.230	0.200	5.54	6.81	27.9
Sour Brulee	0.023	0.000	5.31	0.217	0.010	0.037	0.000	0.223	0.197	4.70	5.84	24.4*
Sour Candy Kush Seedless	0.083	0.000	7.58	0.093	0.017	0.053	0.000	0.293	0.257	6.70	8.14	26.2*
Star Mind	0.040	0.007	6.81	0.233	0.013	0.057	0.000	0.277	0.243	6.02	7.44	25.1*
Stem Cell	0.000	0.000	0.860	5.14	0.073	0.000	0.000	0.103	0.090	0.753	6.19	5.60
Stem Cell Seedless	0.000	0.010	0.000	9.49	0.073	0.000	0.000	0.113	0.103	0.00	9.71	0.00
Suver Haze Seedless	0.137	0.000	16.9	0.290	0.013	0.050	0.000	0.623	0.543	14.9	18.0	27.1*
Tsunami x Wife	0.127	0.000	11.0	0.393	0.113	0.067	0.000	0.410	0.357	9.70	12.1	27.1*
Vitality Seedless	4.45	0.007	7.01	0.460	0.043	0.043	0.000	0.260	0.230	6.19	12.3	27.3*
White CBG	0.000	0.000	0.007	5.82	0.093*	0.000	0.000	0.087	0.073	0.01	6.03	0.10
White CBG Seedless	0.000	0.000	0.000	9.47*	0.100*	0.000	0.000	0.120	0.107	0.00	9.70	0.00
Wife x Purple Star	0.060	0.000	14.0	0.277	0.047	0.080	0.000	0.513	0.450	12.3	15.0	27.4*
Suver Haze	0.057	0.023*	10.6	0.180	0.027	0.070	0.000	0.413	0.360	9.38	11.4	25.9*
LSD (0.10) §	0.044	0.012	2.79	1.46	0.034	0.048	0.007	0.095	0.087	2.47	2.62	5.10
Trial mean	0.246	0.007	7.83	1.685	0.040	0.048	0.002	0.319	0.281	6.92	10.2	21.2
Autoflower varieties€												
Phylos NBS-1	0.010	0.000	2.70	0.087	0.000	0.023	0.000	0.107	0.097	2.39	2.93	25.5
QP1010	0.040	0.010	5.05	0.117	0.013	0.110	0.000	0.223	0.197	4.54	5.56	23.4
QP1148	0.043	0.007	5.05	0.183	0.020	0.067	0.000	0.207	0.183	4.49	5.58	24.8
QP1151	0.037	0.027	4.73	0.193	0.040	0.117	0.000	7.130	0.177	4.26	5.34	24.1

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

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

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

¥ LSD – Least significant difference at p=0.10.

€ Autoflower varieties were not statistically analyzed with the full season varieties and are shown for comparison.

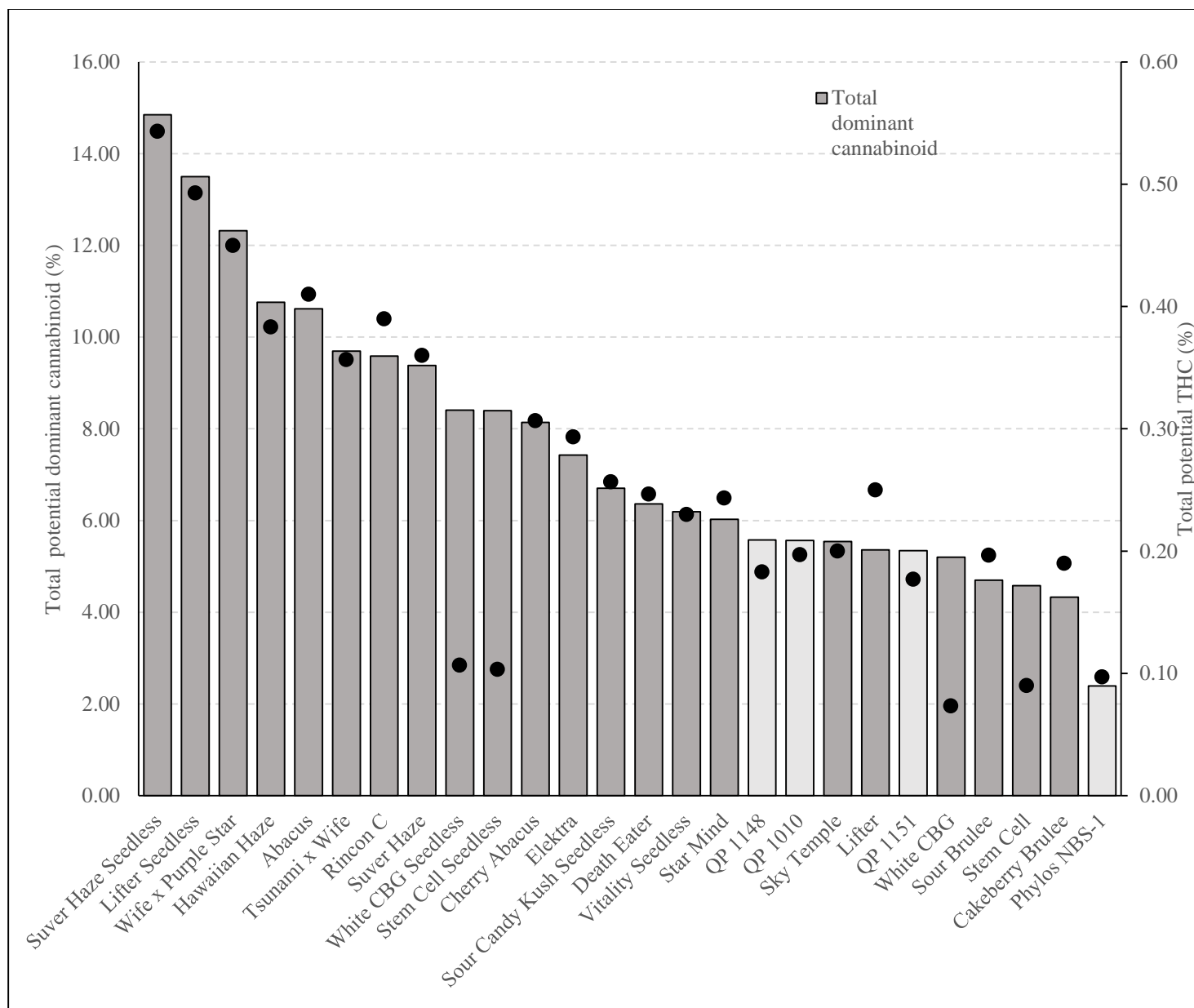


Figure 2. Dominant hemp flower cannabinoid concentrations, 2022.

Autoflower varieties are denoted by light gray bars for comparison with other 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 17 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 remain 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, 2022.

Variety	Total Terpenes mg/g	α -Pinene mg/g	Camphene mg/g	β -Myrcene mg/g	b-Pinene mg/g	3-Carene mg/g	α -Terpinene mg/g	Limonene mg/g	p-Cymene mg/g	Ocimene mg/g	Eucalyptol mg/g
Abacus	28.5	4.64	0.057	7.28	1.48	0.00	0.00	2.37	0.00	0.00	0.131
Cakeberry Brulee	41.9	6.32	0.109	11.6	4.56	0.00	0.036	3.42	0.00	0.00	0.00
Cherry Abacus	39.1	0.562	0.000	8.72	0.682	0.00	0.00	3.56	0.00	0.00	0.396
Death Eater	20.1	0.576	0.087	3.98	0.940	0.00	0.00	3.94	0.00	0.00	0.00
Elektra	44.4	7.31	0.108	15.4	3.91	0.00	0.00	2.45	0.00	0.00	0.00
Hawaiian Haze	29.8	4.09	0.053	9.34	2.65	0.00	0.00	4.15	0.00	0.00	0.233
Lifter	42.7	1.16	0.000	16.6	0.563	0.00	0.00	3.29	0.00	4.01	0.166
Lifter seedless	44.0	2.31	0.000	13.8	1.28	0.00	0.00	1.63	0.00	3.26	0.00
Rincon C	32.8	0.887	0.059	9.29	0.944	0.00	0.00	4.32	0.00	0.00	0.000
Sky Temple	18.0	0.250	0.000	2.56	0.352	0.00	0.00	1.52	0.00	0.00	0.109
Sour Brulee	30.1	0.620	0.000	5.24	1.02	0.00	0.257	2.07	0.00	0.00	0.247
Sour Candy Kush Seedless	64.7	3.77	0.000	14.1	2.95	0.00	0.546	1.97	0.00	3.70	0.516
Star Mind	31.5	2.84	0.000	14.5	1.60	0.00	0.00	0.96	0.00	2.13	0.091
Stem Cell	10.7	0.105	0.000	1.73	0.114	0.00	0.00	0.56	0.00	0.00	0.00
Stem Cell Seedless	29.8	0.172	0.000	1.87	0.238	0.00	0.00	0.96	0.00	0.00	0.00
Suver Haze Seedless	62.4	6.02	0.000	20.9	3.09	0.00	0.00	2.37	0.00	2.18	0.154
Suver Haze Seedless	27.2	0.520	0.000	8.52	0.391	0.00	0.00	1.48	0.00	2.66	0.00
Tsunami x wife	42.5	0.647	0.106	7.68	1.07	0.00	0.00	6.13	0.00	3.09	0.00
Vitality Seedless	44.2	1.72	0.000	9.89	0.692	0.00	0.00	2.01	0.00	4.21	0.286
White CBG	14.1	0.236	0.000	3.11	0.191	0.00	0.00	1.09	0.00	0.00	0.00
White CBG Seedless	19.2	0.109	0.000	1.44	0.134	0.00	0.00	0.57	0.00	0.00	0.00
Wife x Purple Star	54.5	1.56	0.076	9.53	2.75	1.65	0.559	5.40	0.00	0.00	0.159
Autoflower varieties											
QP 1148	11.1	0.825	0.000	3.01	0.466	0.00	0.00	0.61	0.00	0.00	0.039
QP 1151	8.6	0.205	0.000	1.83	0.184	0.00	0.00	0.61	0.00	0.00	0.00
QP 1010	13.8	0.845	0.000	3.60	0.503	0.00	0.00	1.01	0.00	0.00	0.00
Phylos NBS-1	10.8	0.096	0.000	0.58	0.080	0.00	0.00	0.36	0.00	0.18	0.00

Table 10 continued. Total flower bud terpene profiles, Alburgh, VT, 2022.

Variety	Y-Terpinene mg/g	Terpinolene mg/g	Linalool mg/g	Isopulegol mg/g	Geraniol mg/g	Caryophyllene mg/g	α -Humulene mg/g	Cis-Nerolidol mg/g	Guaiol mg/g	Caryophyllene Oxide mg/g	α -Bisabolol mg/g
Abacus	0.00	0.474	0.000	0.197	0.00	5.89	3.01	0.00	0.000	0.450	2.50
Cakeberry Brulee	0.034	1.34	1.45	0.325	0.00	6.58	2.97	0.00	1.38	0.453	1.33
Cherry Abacus	0.043	0.173	1.19	0.00	0.00	10.8	5.03	0.00	1.68	0.775	5.51
Death Eater	0.00	0.147	1.14	0.00	0.00	4.70	2.75	0.00	1.04	0.222	0.594
Elektra	0.00	0.269	0.816	0.00	0.00	7.71	2.75	0.00	0.767	0.343	2.55
Hawaiian Haze	0.059	0.256	1.78	0.00	0.00	2.80	1.07	0.348	1.09	0.236	1.66
Lifter	0.00	0.224	0.594	0.00	0.00	8.66	4.92	0.00	0.657	0.348	1.55
Lifter seedless	0.00	0.140	2.09	0.00	0.00	7.40	3.32	0.661	1.47	1.17	5.53
Rincon C	0.00	1.06	0.259	0.00	0.00	7.58	4.54	0.00	0.936	0.483	2.41
Sky Temple	0.00	0.328	0.000	0.00	0.00	7.75	3.43	0.00	0.00	0.773	0.886
Sour Brulee	0.325	6.11	0.701	0.00	0.00	7.63	3.34	0.00	1.31	0.346	0.886
Sour Candy Kush Seedless	0.664	10.5	0.843	0.00	0.00	11.2	5.93	0.00	2.64	1.03	4.32
Star Mind	0.06	1.33	0.161	0.00	0.00	3.02	1.62	0.00	1.01	0.383	1.85
Stem Cell	0.00	0.069	0.037	0.045	0.00	3.55	1.17	0.00	0.869	0.124	2.30
Stem Cell Seedless	0.00	0.173	0.000	0.00	0.00	9.71	3.11	0.870	3.68	0.393	8.60
Suver Haze Seedless	0.05	0.926	1.67	0.00	0.00	12.7	7.28	0.00	1.10	0.438	3.44
Suver Haze Seedless	0.00	0.203	0.854	0.00	0.00	6.42	3.61	0.604	0.00	0.565	1.37
Tsunami x wife	0.00	0.649	2.68	0.00	0.00	11.9	6.85	0.00	0.00	0.675	1.06
Vitality Seedless	0.00	0.374	1.90	0.00	0.00	13.2	5.25	1.01	0.739	1.04	1.85
White CBG	0.00	0.058	0.182	0.095	0.00	4.55	1.56	0.00	0.736	0.168	2.14
White CBG Seedless	0.00	0.125	0.379	0.00	0.00	6.67	2.93	0.00	1.70	0.458	4.71
Wife x Purple Star	0.630	13.6	1.16	0.00	0.00	10.0	5.10	0.00	0.774	0.596	0.972
Autoflower varieties											
QP 1148	0.00	0.000	0.674	0.00	0.00	2.51	1.26	0.00	0.865	0.329	0.480
QP 1151	0.00	0.000	0.205	0.00	0.00	2.93	0.867	0.00	1.05	0.322	0.400
QP 1010	0.00	0.000	0.223	0.00	0.00	3.92	1.46	0.00	0.339	0.631	1.23
Phylos NBS-1	0.00	0.034	0.172	0.00	0.00	3.73	1.33	0.00	1.50	0.256	2.48

DISCUSSION

Many of the varieties within the trial appeared to perform well in the 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 Sky Temple and Vitality Seedless could have benefited from an additional week of growth, and higher yields could potentially have been obtained through maturation. Additionally, there were some stark differences in growth habits and quality across all varieties within the trial.

Various growth characteristics, such as sprawling versus upright growth habits, can be especially important when looking at the potential for high disease pressure. Some disease issues could potentially be mitigated by cultural practices such as adequate plant spacing and selecting varieties with disease tolerance or resistance. Additionally, autoflower varieties may be good options for early harvest and diversification. As in past years, autoflower varieties matured over a month ahead of full season varieties and could be worked into a production system to spread out harvest labor requirements while bringing in a marketable crop at an earlier date.

In the past three years of variety trial evaluation, insect damage has been largely non-impactful in the weeks leading up to harvest. While aphids appear to be present on plants, damage in our area is not noticeable though higher populations may have the potential to impact flower quality, especially in the smokable flower market. During severe years with high populations of leaf hoppers, greater damage to leaves in the form of hopper burn may also be noticed in crops, however, other preferred crops may draw insects away from hemp. While not noticed this year, severe hopper burn has been observed in some autoflower varieties in past years, perhaps coinciding with earlier flights and as a result impacted overall plant size and vigor. With continued growth of the hemp industry and often lack of crop rotation in fields, disease impacts may prove to be more detrimental moving forward. In the past three years of our studies under various weather conditions, septoria leaf spot and powdery mildew have become more noticeable in our trials. From these variety trials, it appeared as if the CBDV varieties, Forbidden V and Pinewalker, and Vitality Seedless had much greater disease tolerance, whereas the CBG varieties were most susceptible to powdery mildew and septoria leaf spot. Previous years also yielded similar results in which many of the CBG varieties were more adversely impacted by powdery mildew.

While varieties were able to be harvested in a timely matter, weather constraints in the region forces all varieties to be harvested due to cold temperatures in late October. In our region, many areas have the potential to experience a killing frost by mid-September, however, these dates have been consistently later allowing for harvest well into October in most years. While many varieties have shown some resistance to frost throughout the past few years, earlier maturing varieties may be more beneficial to reduce the potential for crop loss.

Varieties such as Tsunami x Wife, Suver Haze Seedless, Lifter Seedless, and Wife x Purple Star all stood out for their higher yields and cannabinoids concentrations. Each of these varieties grown from seed are triploid genetics and seemed to perform well when compared to the other diploids within the trial. As regulations may differ from state to state, it is important to refer to your own state specific regulations, or federal regulations to ensure you are selecting compliant cultivars for your area and remain up to date on current regulations. Lower total potential CBD cultivars also appeared to produce lower total THC and may

be safer options to produce a compliant crop. Similarly, CBG and CBDV 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-two 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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