NORTHWEST CROPS & SOILS PROGRAM

2023 Hemp Flower Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2023 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 14 full season hemp varieties for their growth habit, pest tolerance, flower yields, and flower quality.

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

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 14 individual hemp flower varieties (Table 2). The varieties were assessed for tolerance to disease, yield, and quality at Borderview Research Farm in Alburgh, Vermont.

Fertility amendments were based on soil test results received from the University of Vermont Agricultural and Environmental Testing Laboratory (Burlington, VT). On 14-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, 2023.

Location	**Borderview Research Farm**
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Sweet Potatoes
Plant spacing (ft)	5 x 5
Planting date	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 70-75º F during the day and 68-72º F at night and received 18 hours of supplemental light at 400 W/m^2 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
Oregon CBD	Forbidden V	Seed	CBDV
Oregon CBD	Forbidden V Seedless	Seed	CBDV
Oregon CBD	Lifter	Seed	CBD
Oregon CBD	Lifter Seedless	Seed	CBD
Oregon CBD	Pinewalker Seedless	Seed	CBDV
Oregon CBD	Sour Lifter	Seed	CBD
Oregon CBD	Sour Lifter Seedless	Seed	CBD
Oregon CBD	Sour Special Sauce	Seed	CBD
Oregon CBD	Sour Special Sauce Seedless	Seed	CBD
Oregon CBD	Stem Cell	Seed	CBG
Oregon CBD	Stem Cell Seedless	Seed	CBG
Oregon CBD	Vitality Seedless	Seed	CBDV
Oregon CBD	White CBG	Seed	CBG
Oregon CBD	White CBG Seedless	Seed	CBG

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, 2023.

Variety	Planting week†	Flower week	Harvest week
Forbidden V	24	35	41
Forbidden V Seedless	24	34-35‡	41
Lifter	24	31-33	38
Lifter Seedless	24	34-35	41
Pinewalker Seedless	24	34-35	41
Sour Lifter	24	31-34	38
Sour Lifter Seedless	24	34	40
Sour Special Sauce	24	31-32	39
Sour Special Sauce Seedless	24	32-34	41
Stem Cell	24	31-33	39
Stem Cell Seedless	24	32-35	41
Vitality Seedless	24	34-35	41
White CBG	24	31-32	39
White CBG Seedless	24	32-34	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.

Prior to harvest, plant height and width were measured from all harvested plants in each plot and a percentage of plant affected by leaf spot was recorded. 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

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

buds were collected. Wet bud and leaf material was then run through the Centurion Pro Gladiator Trimmer (Maple Ridge, BC, Canada) (Image 2). Wet bud weight and unmarketable bud weight were recorded. The flower buds were then dried at 80º 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.

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-value ≤ 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-value ≤ 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). Much of the growing season in 2023 was defined by heavy rains and below average temperatures during the peak vegetative growth period of the season. For the given cultivation period, temperatures were on average 4.7°F below the 30-year average for Alburgh, VT up through September, with a much warmer October that was 4.11°F above average. Additionally, precipitation was significantly higher, 9.84” above average, as a result of major storms and flooding that occurred throughout the region with greatest storm events observed in July and August. As a result of these conditions, we saw significantly less cumulative growing degree days (GDDs) during critical maturation periods in August for floral hemp, 101 GDDs below average during that month, and a total cumulative GDDs of 2409 for the season.

Table 4. Seasonal weather data collected in Alburgh, VT, 2023.

Alburgh, VT	June	July	August	Sept	Oct
Average temperature (°F)	65.7	72.2	67	63.7	54.4
Departure from normal	-1.76	-0.24	-3.73	1.03	4.11
Precipitation (inches)	4.4	10.75	6.27	2.4	5.38
Departure from normal	0.14	6.69	2.73	-1.27	1.55
Growing Degree Days (50-86°F)	483	712	540	449	225
Departure from normal	-41	17	-101	62	87

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

Within the variety trial, Pinewalker Seedless was the tallest at 175 cm and was statistically similar in height to Forbidden V, Forbidden V Seedless, Lifter Seedless, Sour Lifter Seedless, Sour Special Sauce, and Vitality Seedless (Table 5). Similarly, Pinewalker had the greatest overall plant width at 148 cm, and was similar to Forbidden V, Lifter Seedless, Sour Special Sauce, Sour Special Sauce Seedless, and Vitality Seedless. Lodging was not noticeable in this growing season and was thus not recorded. Leaf spots were the primary observed group of diseases leading up to harvest. 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. These are presented as a visual assessment of the percentage of the total plant affected by these leaf spot diseases.

Table 5. Hemp whole plant weight, height, and width, Alburgh, VT, 2023.

Variety	Height	Width	Leaf spot
	cm	cm	%
Forbidden V	165*‡	131*	52.5
Forbidden V Seedless	162*	128	25.0*
Lifter	96	127	87.5
Lifter Seedless	162*	132*	50.0
Pinewalker Seedless	**175**	**148**	**12.8**
Sour Lifter	138	130	80.0
Sour Lifter Seedless	148*	117	45.0
Sour Special Sauce	135	132*	92.5
Sour Special Sauce Seedless	158*	143*	37.5
Stem Cell	121	124	75.0
Stem Cell Seedless	144	124	60.0
Vitality Seedless	158*	143*	30.0*
White CBG	109	111	67.5
White CBG Seedless	145	129	75.0
LSD (0.10) §	28.0	18.0	21.8
Trial mean	144	130	56.4

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

§LSD – Least significant difference at p=0.10.

Total bud weight, leaf weight, and stem weight were measured at harvest to further evaluate growth characteristics of each variety (Table 6). Vitality Seedless had the highest overall whole plant weight at 23.1 lbs plant^{-1} and was statistically similar to Sour Special Sauce Seedless, Pinewalker Seedless and Forbidden V. Pinewalker Seedless had the highest overall stem weight at 8.72 lbs plant^{-1} and was statistically similar to Forbidden V, Forbidden V Seedless, Sour Special Sauce Seedless, and Vitality Seedless, whereas the highest percentage of stem material belonged to White CBG Seedless at 43.7%, alongside Pinewalker Seedless, Forbidden V Seedless, and Forbidden V. Vitality seedless was the top performers for flower weight at 7.46 lbs plant^{-1} however was statistically similar to Lifter Seedless, and Sour Special Sauce Seedless, in which the latter two also had comparably high percentages of floral material per plant at 34.9% and 34.1% respectively. The highest total percentage was observed in Stem Cell Seedless at 39.4%, although this variety was not amongst the top performers in terms of a per plant yield. Leaf weight was highest in Vitality Seedless at 7.20 lbs plant^{-1} and was statistically similar to Forbidden V, Forbidden V Seedless, Lifter Seedless, Pinewalker Seedless, Sour Lifter Seedless, and Sour Special Sauce Seedless.

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 1.0 and leaf to stem ratio below 1.0 would maximize harvest efficiency. Those plants would result in less time spent removing leaf materials while maximizing flower output. 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.

Table 6. As harvested, hemp plant harvest growth metrics, Alburgh, VT, 2023.

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}	%		
Forbidden V	19.2* ‡	7.55*	39.0*	5.85	30.3	5.80*	30.7*	0.807	0.876*
Forbidden V Seedless	18.0	7.14*	39.9*	5.57	32.2	5.23*	27.9	0.821	0.702
Lifter	8.1	2.76	34.2	2.27	28.2	3.00	**37.6**	0.824	**1.10**
Lifter Seedless	18.2	6.05	32.8	6.24*	34.9*	5.86*	32.3*	1.08*	1.01*
Pinewalker Seedless	20.9*	**8.72**	41.3*	5.63	27.7	6.50*	31.0*	0.680	0.752
Sour Lifter	12.0	4.11	34.3	3.82	31.7	4.10	34.0*	0.90*	0.999*
Sour Lifter Seedless	17.0	5.87	34.7	5.80	34.2*	5.28*	31.2*	0.959*	0.905*
Sour Special Sauce	12.2	4.44	36.5	4.04	33.4	3.70	30.1	0.910*	0.762
Sour Special Sauce Seedless	21.5*	7.76*	35.5	7.26*	34.1*	6.43*	30.4	0.977*	0.893*
Stem Cell	10.8	3.61	33.5	3.32	31	3.90	35.5*	0.926*	1.07*
Stem Cell Seedless	15.3	5.36	35.3	6.00	**39.4**	3.90	25.4	**1.12**	0.839*
Vitality Seedless	**23.1**	8.42*	35.2	**7.46**	33.2	**7.20**	31.6*	0.990*	0.925*
White CBG	8.9	3.14	35.1	2.79	31.3	3.00	33.6*	0.935*	0.981*
White CBG Seedless	13.6	5.94	**43.7**	4.80	35.2*	2.90	21.1	0.828	0.484
LSD (0.10) **§**	4.03	2.08	5.71	1.31	5.33	1.68	6.86	0.2254	0.303
Trial mean	15.6	5.78	36.5	5.06	32.6	4.8	30.9	0.922	0.878

‡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 dry matter and calculate dry matter flower yields (Table 7, Figure 1). Lifter had the highest dry matter at 27.4% and was statistically similar to Sour Lifter, Sour Special Sauce, and White CBG. Typical harvest period ranges generally fall between 20-25% dry matter. Unmarketable flower included any flower that had suffered from disease, rot, soil contamination, or otherwise damaged flower material. A number of varieties had very low amounts of unmarketable flower despite season growing conditions conducive to high disease pressure. Forbidden V Seedless had the lowest overall amount of unmarketable flower material at 0.006 lbs plant^{-1}, similar to 9 of the other varieties within the trial, which included all CBDV varieties. Vitality Seedless had the highest overall dry matter flower yields at 2508 lbs ac^{-1} and was statistically similar to Stem Cell Seedless, Sour Special Sauce Seedless, Sour Lifter Seedless, Pinewalker Seedless, Lifter Seedless, Forbidden V Seedless, and Forbidden V. Lowest observed dry matter yields were seen in Lifter at 1073 lbs ac^{-1}

Table 7. Hemp flower yield, Alburgh, VT, 2023.

Variety	Flower dry matter†	Unmarketable flower	Dry matter flower yield†	Yield at 8% moisture
	%	lbs plant^{-1}	lbs ac^{-1}	lbs ac^{-1}
Forbidden V	21.1	0.023*‡	2148*	2335*
Forbidden V Seedless	24.2	**0.006**	2339*	2543*
Lifter	**27.4**	0.208*	1073	1167
Lifter Seedless	21.8	0.037*	2357*	2562*
Pinewalker Seedless	21.0	0.025*	2063*	2242*
Sour Lifter	27.2*	0.999	1815	1972
Sour Lifter Seedless	22.4	0.100*	2284*	2482*
Sour Special Sauce	25.0*	0.449	1767	1920
Sour Special Sauce Seedless	19.0	0.626	2454*	2667*
Stem Cell	23.7	0.216*	1383	1504
Stem Cell Seedless	19.9	0.014*	2078*	2258*
Vitality Seedless	19.4	0.029*	**2508**	**2726**
White CBG	25.0*	0.518	1212	1318
White CBG Seedless	18.8	0.084*	1567	1703
LSD (0.10)§	2.51	0.353	541	588
Trial mean	22.6	0.238	1932	2100

† 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.

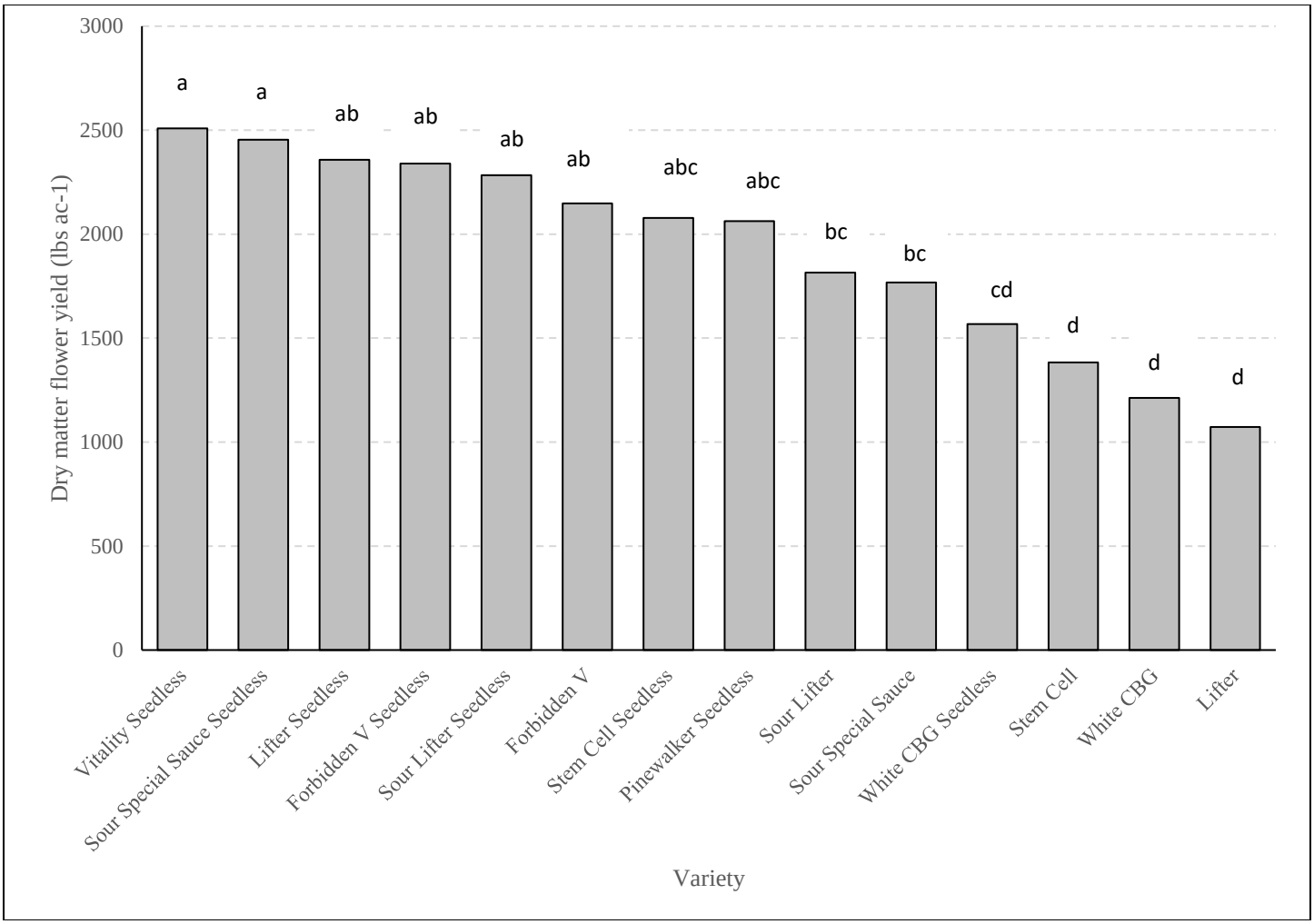

Figure 1. Dry matter flower yield of hemp varieties for the flower market, 2023.

Each cultivar within the trial (3 replicates only) was also analyzed for cannabinoid content and terpenes. Results for cannabinoids are on a dry matter basis (0% moisture) (Table 8, Figure 2). Peak, total cannabinoid concentrations for each variety ranged from 8.26% to 23.6%. Within the study, Sour Lifter Seedless had the highest total potential CBD at 19.4% and was statistically similar to Lifter Seedless at 19.4%. Amongst the CBG varieties, Stem Cell Seedless had the highest overall concentration of CBGA at 13.5%, whereas Forbidden V had the highest concentration of CBDVA at 8.93%. Based on current regulations, there were eight varieties that would not be compliant given the sample test date as total potential THC exceeded the 0.300% 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), as well as CBDV varieties Forbidden V Seedless and Vitality Seedless. Conversely, highest values for total potential THC included Lifter Seedless (0.780%), Sour Lifter Seedless (0.747%), and Sour Special Sauce Seedless (0.640%). 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 8. Hemp flower major cannabinoid analysis, Alburgh, VT, 2023.

Variety	CBDVA	CBDV	CBDA	CBGA	CBG	CBD	D9-THC	THCA	Total THC‡	Total CBD†	Total Cannabinoids
	%	%	%	%	%	%	%	%	%	%	%
Forbidden V	**8.93**	**0.063**	13.0	0.400	0.137	0.077	0.000	0.527	0.460	11.5	23.2*
Forbidden V Seedless	7.38	**0.063**	10.9	0.400	0.070	0.073	0.000	0.313	0.273	9.65	19.2*
Lifter	0.13	0.037	13.3	0.153	0.010	**0.373**	0.000	0.520	0.457	12.0	14.5
Lifter Seedless	0.13	0.000	21.9*	0.410	0.070	0.083	0.000	**0.887**	**0.780**	19.3*	23.5*
Pinewalker Seedless	7.67	0.037	9.68	0.490	0.083	0.037	0.000	0.383	0.337	8.52	18.4
Sour Lifter	0.09	0.000	11.0	0.210	0.010	0.110	0.000	0.453	0.400	9.73	11.8
Sour Lifter Seedless	0.18	0.000	**22.0**	0.483	0.033	0.113	0.000	0.853*	0.747*	**19.4**	**23.6**
Sour Special Sauce	0.06	0.000	10.6	0.247	0.017	0.117	0.000	0.447	0.397	9.44	11.5
Sour Special Sauce Seedless	0.10	0.000	17.7	0.343	0.027	0.140	0.000	0.730*	0.640*	15.7	19.1*
Stem Cell	0.00	0.020	0.00	9.27	0.140	0.000	0.000	0.040	0.037	0.00	9.60
Stem Cell Seedless	0.00	0.000	0.00	**13.5**	0.173*	0.000	0.000	0.183	0.160	0.00	13.8
Vitality Seedless	6.88	0.057*§	10.7	0.543	0.053	0.063	0.000	0.290	0.257	9.40	18.6
White CBG	0.00	0.000	0.00	7.90	**0.190**	0.000	0.000	0.123	0.107	0.00	8.26
White CBG Seedless	0.00	0.000	0.00	11.7	0.173*	0.000	**0.010**	0.213	0.200	0.00	12.3
LSD (0.10)¥	0.961	0.206	3.86	1.40	0.046	0.102	0.006	0.217	0.191	3.40	4.60
Trial mean	2.25	0.020	10.1	3.287	0.085	0.085	0.001	0.426	0.375	8.90	16.2

‡ 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.

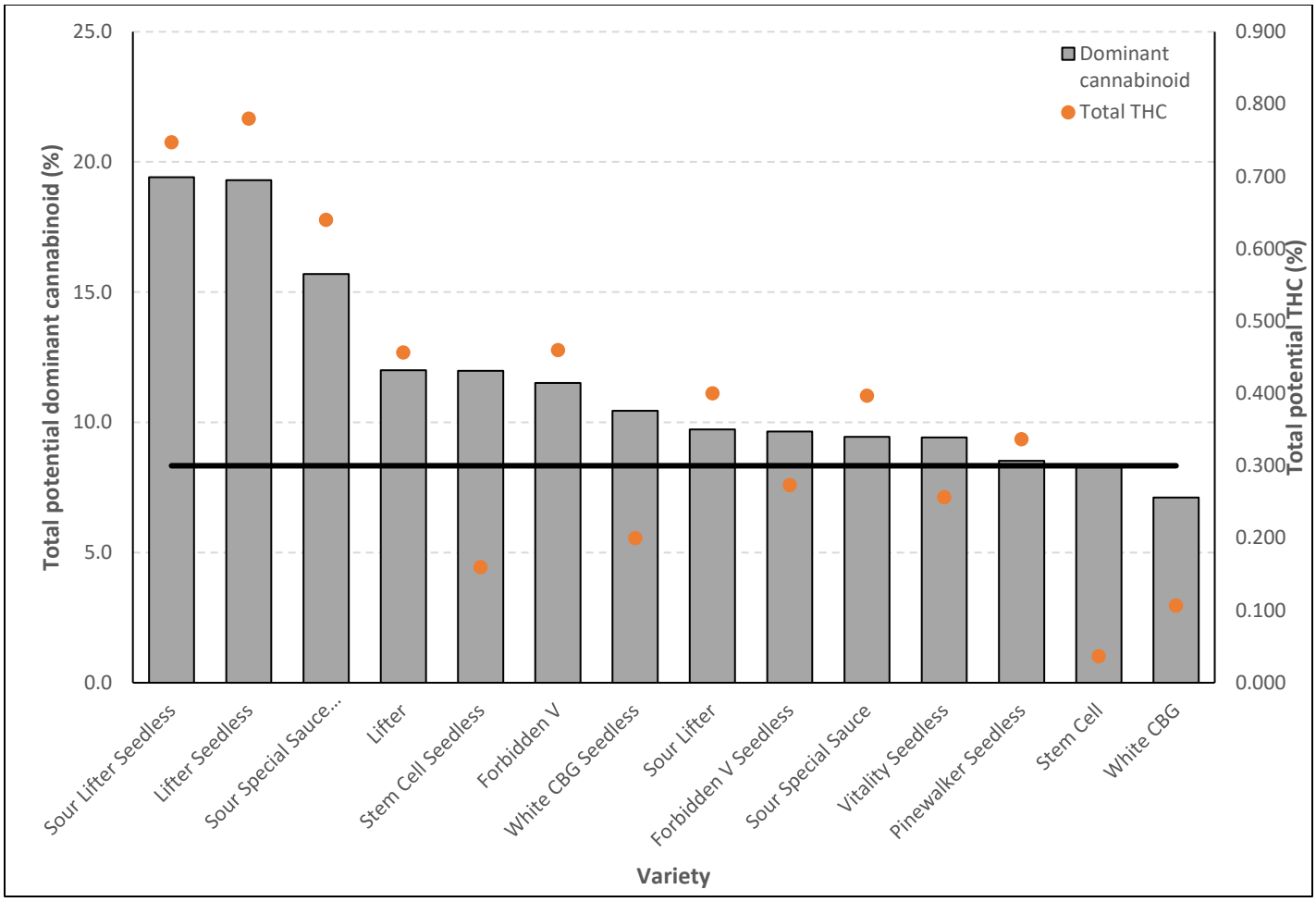

Figure 2. Flower total potential dominant cannabinoids and total potential THC, Alburgh, VT 2023.

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 9). Results are included for 18 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 9. Total flower bud terpene profiles, Alburgh, VT, 2023.

Variety	α-Pinene	Camphene	β-Myrcene	b-Pinene	3-Carene	α-Terpinene	Limonene	Ocimene	Eucalyptol
	%	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g
Forbidden V	1.24	0.100	24.3	1.75	0.00	0.00	6.89	0.00	0.00
Forbidden V Seedless	2.28	0.000	18.9	1.11	0.10	0.05	4.22	5.76	0.00
Lifter	0.46	0.000	9.10	0.55	0.12	0.00	1.91	0.00	0.22
Lifter Seedless	4.81	0.000	32.8	2.51	0.00	0.00	5.20	12.87	0.00
Pinewalker Seedless	4.26	0.060	20.8	1.71	0.40	0.06	4.31	7.54	0.00
Sour Lifter	0.66	0.080	6.82	1.05	0.41	0.26	1.63	1.35	0.32
Sour Lifter Seedless	1.45	0.040	15.6	2.46	0.00	1.07	3.98	0.00	0.28
Sour Special Sauce	1.07	0.000	7.40	0.91	0.18	0.13	1.55	0.00	0.21
Sour Special Sauce Seedless	6.19	0.290	26.9	5.00	1.60	0.74	7.17	4.44	0.50
Stem Cell	0.22	0.000	2.40	0.23	0.00	0.00	0.55	0.00	0.00
Stem Cell Seedless	0.11	0.000	2.77	0.19	0.00	0.00	1.20	0.00	0.00
Vitality Seedless	0.27	0.000	20.4	0.44	0.00	0.00	2.59	0.00	0.16
White CBG	0.14	0.000	1.90	0.18	0.00	0.00	1.14	0.00	0.00
White CBG Seedless	0.21	0.000	1.02	0.35	0.00	0.00	2.58	0.00	0.00

Variety	Y-Terpinene	Terpinolene	Linalool	Caryophyllene	α-Humulene	Cis-Nerolidol	Guaiol	Caryophyllene Oxide	α-Bisabolol	Total Terpenes
	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g
Forbidden V	0.07	3.35	6.44	22.9	12.9	0.96	0.93	1.32	1.30	84.4
Forbidden V Seedless	0.00	1.13	2.20	16.9	9.27	0.00	0.83	0.63	1.81	65.2
Lifter	0.00	1.03	2.13	14.3	6.81	0.00	0.00	2.17	1.64	40.4
Lifter Seedless	0.00	1.98	4.58	13.7	6.39	3.21	1.73	1.04	2.55	93.4
Pinewalker Seedless	0.00	0.97	1.23	7.65	3.20	0.23	0.31	0.25	0.32	53.4
Sour Lifter	0.35	5.34	0.58	12.3	7.46	0.00	1.84	0.79	1.68	42.9
Sour Lifter Seedless	0.83	22.8	2.29	17.7	12.0	0.00	1.22	0.40	2.19	84.2
Sour Special Sauce	0.20	1.62	0.32	8.52	4.08	0.52	1.46	2.08	2.20	32.5
Sour Special Sauce Seedless	0.89	16.3	3.42	13.0	6.22	0.83	2.87	1.49	4.23	102.1
Stem Cell	0.00	0.38	0.17	7.48	2.09	0.38	4.85	0.96	4.91	24.6
Stem Cell Seedless	0.00	0.11	0.22	12.7	3.97	0.49	3.91	0.44	3.44	29.4
Vitality Seedless	0.00	0.11	2.05	18.4	8.91	0.59	0.74	0.48	2.93	58.1
White CBG	0.00	0.21	0.24	6.83	1.96	0.00	1.93	0.29	1.64	16.2
White CBG Seedless	0.00	0.28	1.32	13.3	4.19	0.00	2.43	0.34	3.18	29.2

DISCUSSION

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. While not trialed in 2023, autoflower varieties may also be good options for early harvest and diversification. 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 four 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. 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, Bipolaris leaf spot, hemp leaf spot, Cercospora 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 Seedless, Pinewalker Seedless, and Vitality Seedless had much greater disease tolerance across all trialed years, whereas the CBG varieties were most susceptible to powdery mildew and leaf spots. Previous years also yielded similar results in which many of the CBG varieties were more adversely impacted by leaf disease.

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.

Triploid varieties have consistently exhibited higher yields when compared to other flower varieties trialed within our studies, in addition to CBDV varieties, which generally have a longer maturation period and overall larger plants. Other varieties that were high yielding in past years included other triploid genetics with Tsunami x Wife, Suver Haze Seedless, and Wife x Purple Star to name a few. 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 fourteen 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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