

A close-up photograph of a hemp flower bud, showing its intricate structure of green bracts and developing seeds. The bud is covered in fine, light-colored trichomes. The background is a soft, out-of-focus green, suggesting a field of hemp plants.

Hemp Variety Trials in Tennessee 2019

Hemp Variety Trials in Tennessee

2019

Virginia Sykes, Assistant Professor, Extension/Research Variety Testing and Agroecology

Eric Walker, Assistant Professor,^a Extension/Research Tobacco and Specialty Crops

Timothy Robertson, Research Specialist II,^b Tobacco and Specialty Crops

Zachariah Hansen, Assistant Professor, Extension Specialty Crops Pathologist

Heather Kelly, Associate Professor, Extension/Research Plant Pathologist and IPM Coordinator

Madison Cartwright, Graduate Research Assistant, Plant Pathology

Alex Wilson, Research Associate, Variety Testing and Agroecology

Liesel Schneider, Assistant Professor, Animal Science

^aCurrent position: Burley Stabilization Corporation

^bCurrent position: Plant Inspector II, Tennessee Department of Agriculture

Acknowledgments

This research was funded by the UT AgResearch and Education Centers and UT Extension with partial support from participating companies.

We gratefully acknowledge the assistance of the following individuals in conducting these experiments:

The AgResearch and Education Center at Greeneville (Greeneville, TN)

Justin McKinney, Director

Cory Malone, Service Supervisor IV

Dale Gregg, Field and Livestock Worker

Jeff Neas, Field and Livestock Worker

Wayne Gibson, Field and Livestock Worker

Highland Rim AgResearch and Education Center (Springfield, TN)

Robert Ellis, Director

Brad S. Fisher, Research Associate I

Roy Biggs, Senior Farm Crew Leader

Chris Adcock, Senior Farm Equipment Operator

Becky Ramsey, Senior Plot Caretaker

Robert Russell, Senior Field Worker

Donald Spivey, Senior Farm Equipment Operator

Table of Contents

Experimental Procedures -----	4
Statistical Analysis and Interpretation of Data -----	4
Growing Season -----	5
Results Summary -----	5
<i>Location and Treatment Information</i>	
Table 1. Trial Location Information-----	7
Table 2. Variety, Source, and Planting/Harvest Date-----	8
<i>Results</i>	
Table 3. Biomass and CBD Yield Across and By Location-----	9
Table 4-a. Cannabinoid Analysis Across and By Location-----	10
Table 4-b. Cannabinoid Analysis Across and By Location-----	11
Table 5-a. Plant Morphology and Maturity Traits Across and By Location-----	12
Table 5-b. Plant Morphology and Maturity Traits Across and By Location-----	13
Table 6. Disease Ratings Across and By Location-----	14

HEMP VARIETY TRIALS IN TENNESSEE

2019

Experimental Procedures:

Hemp variety trials were conducted at three locations in TN: The University of Tennessee AgResearch and Education Center at Greeneville in Greeneville, TN; the University of Tennessee Highland Rim AgResearch and Education Center in Springfield, TN; and an on-farm location in Jackson, TN. At the Greeneville, Springfield and Jackson locations, 29, 19 and 16 treatments were included in the trials, respectively. These treatments represented 23, 19 and 14 varieties, respectively. Some varieties were sourced from multiple distributors and were therefore included multiple times within a trial. Each variety by source combination was considered a treatment. Two varieties, “Cherry” and “T1,” were also evaluated both topped (top portion removed at two weeks after rooting and prior to transplanting to promote increased branching) and not topped, with each variety by management practice considered a separate treatment.

At Greeneville and Springfield, each trial was established using a randomized complete block design with four replications. At Jackson, the trial was established using a randomized complete block design with six replications. Plots consisted of two rows, five plants per row on 6-ft centers, with 6 ft between plants within rows at Greeneville and Springfield, and with 4 to 4.5 ft between plants within rows at Jackson. The Greeneville, Springfield and Jackson trials were planted 28 Jun, 17 Jun and 17-19 Jun, respectively. Fertility was managed at Greeneville and Springfield by applying a per-acre total of 240 lb N, 96 lb P and 312 lb K preplant, and at Jackson by applying a per-acre total of 196 lb N, 148 lb P and 112 lb K preplant. The trials were irrigated at transplanting, but not after that. Weeds were managed by cultivation throughout the season.

Hemp plants were harvested at maturity using standard stalk-cured tobacco harvest methods: hand-cutting plants at the base, spiking plants on tobacco sticks, and hanging whole plants in a barn for approximately three months. Drying locations were selected with adequate air flow and fans were used to further facilitate circulation. After plants dried, they were stripped to remove flower/bud and leaf matter from the stem. Flower bud and leaf material were then bagged and weighed. All plants in each plot were harvested, but the actual number of plants harvested per plot varied due to differences in survival. Because of this, plot weights were divided by the number of harvested plants, and yields are reported on a lbs per plant basis. Yields are reported in Table 3.

Material was sent to Altitude Lab Solutions (Englewood, CO) for analysis of cannabinoid potency using high-performance liquid chromatography (HPLC). Values for max active cannabidiol (CBD), max active tetrahydrocannabinol (THC), delta-9 THC, and cannabigerol (CBG) are given in Table 4. Mean max active CBD values were determined for each plot and used to calculate CBD yield in lbs per plant. This value, given in Table 3, represents the mean biomass per plant multiplied by the mean percent CBD per plant.

Prior to harvest, hemp plants were evaluated for morphological traits, including height and width at Greeneville and Springfield and height and number of branches at Jackson. At Greeneville and Springfield, percentages of clear, cloudy and amber trichomes were visually estimated. These data are presented in Table 5.

The Greeneville, Springfield and Jackson trials were rated for disease on 2 Oct, 7 Oct and 14-19 Sep, respectively. Leaf spot disease incidence and severity were recorded. Incidence was rated as the percentage of leaves with at least one leaf spot per plot, and severity was rated as the average percentage diseased area of affected leaves per plot. Results for disease data are presented in Table 6.

Statistical Analysis and Interpretation of Data:

The tables on the following pages have been prepared with the entries listed in alphabetical order. Yield, quality and morphological data were analyzed using the GLIMMIX procedure in SAS v. 9.4 (Cary, NC), with

mean separation performed using the Fisher's Protected LSD (Least Significant Difference) test. Disease data were analyzed using the LMER (linear mixed-effects model) function in R ver. 3.5.1, with means separated using the HSD.test (Tukey's Honestly Significant Difference [HSD]) test. All analyses used a mixed model with treatment as a fixed effect and replicated as a random effect with an alpha level of 0.05 to determine significance. Across location analyses were evaluated only for treatments that were represented at all three locations. The model for these analyses includes treatment as a fixed effect and location and replicated as random effects. Mean separation letters have been listed next to mean values for each trait. Varieties that have any letter in common within a column are not significantly different at the 5 percent level of probability. Varieties with performance statistically equivalent to the top-performing variety will have an "a" included in the list of mean separation letters next to that entry.

Growing Season

Rain totals were higher than 30-year averages at each location in June, higher at Greeneville and Jackson but slightly lower than average at Springfield in July, lower at Greeneville and Jackson but higher than average at Springfield in August, and much lower than average at each location in September. Temperatures were similar to 30-year averages at each location during each month except September, where temperatures were 7-9 percent higher at each location.

Results

Significant differences in yield, quality and morphological traits were observed among varieties both within and across locations. With exception to plant height and plant width, all traits exhibited a significant variety by location interaction, indicating the differences among varieties differed by location. Biomass yields were similar between Greeneville and Springfield, ranging from 0.3 to 2.4 lbs DM plant⁻¹ and averaging 1.25 lbs DM plant⁻¹. However, biomass yields were much lower at Jackson, ranging from 0.01 to 0.7 lbs DM plant⁻¹ and averaging 0.3 lbs DM plant⁻¹. This may be due to fertility or plant spacing, both of which differed between the Jackson site and the other two locations. Highest biomass yielding varieties at Greeneville were 'Carolina', 'Cherry' sourced from MMH, 'Cherry Wine', 'Sweetened', and 'T-Rex'. At Springfield, 'Super CBD' had the highest biomass yield. At Jackson, 'CBD Therapy', 'Cherry Wine', 'Super CBD', and 'T-Rex' had the highest biomass yields. Of the 14 treatments evaluated at all three locations, 'Cherry Wine' and 'Super CBD' had the highest biomass yields across locations.

Because hemp value is determined by both biomass yield and the percentage of CBD within that biomass, selecting varieties based on highest CBD yield (biomass multiplied by concentration of CBD in that biomass) can help maximize profit. Top biomass yielding varieties tended to also have the highest CBD yield, but this did not hold true for all varieties. The most notable exception was the variety 'T-Rex', which had above average biomass yield but below average CBD yield due to a much lower than average CBD concentration at the Greenville location. Although average percent CBD values were similar among Greeneville, Springfield and Jackson, the much lower biomass yields at the Jackson location resulted in similarly lower CBD yields.

In addition to maximizing CBD yield, hemp producers need to also be sure to select varieties that are within the legal limits for delta-9 THC in Tennessee. Current Tennessee legislation mandates delta-9 THC must be below 0.3 percent. If that limit is exceeded, a crop must be destroyed. The variety 'CBD Therapy' was the only variety to exceed this limit, with a delta-9 THC value of 0.39 percent at Greeneville and 0.38 percent at Springfield.

Leaf spot incidence, severity and disease index were similar among the three trial locations and ranged from 1 to 95 percent incidence and 0.1 to 17 percent severity. Significant differences among varieties regarding leaf spot incidence, severity and disease index were observed at each trial location. Varieties with higher leaf spot incidence also tended to have higher leaf spot severity. The following varieties had the lowest disease index values: 'Late Sue', 'T-Rex', 'Franklin', 'Super CBD', 'OG', 'Frosted Lime', 'ACDC' and 'Siskiyou Gold'. 'Frosted Lime' showed higher phenotypic variability among individuals in each trial, so only the predominant phenotype was rated. The following varieties had the highest disease index values: 'Tangerine', 'Baoux', 'Cherry' (sourced from PWP), 'T1', and 'Cherry Tart'.

Two varieties, 'Cherry' and 'T1', both sourced from SCG, were evaluated both topped (top portion removed at two weeks after rooting and prior to transplanting to promote increased branching) and not topped. Topping impacted percent CBG at Jackson for the variety 'T1'. Topping also resulted in a significantly lower percentage of amber trichomes in the variety 'Cherry', potentially indicated a delay in maturity due to topping. Topping did not impact any other quality, yield morphological or disease traits for either variety.

It is important to note that varieties sharing the same name but sourced from different suppliers may not exhibit the same characteristics, yields and cannabinoid potencies. The variety 'Cherry', sourced from MMH and SCG (South Central Growers), was included at Greeneville and Springfield. The Greeneville trial also contained 'Cherry' sourced from PWP as well as varieties 'Wife', sourced from MMH and PWP, and 'T1' sourced from PWP and SCG. For the variety 'Cherry', plants sourced from MMH had significantly higher biomass yield than those sourced from PWP or SCG. The MMH plants also had higher CBD than those sourced from PWP but did not differ from those sourced from SCG. Delta-9 THC was also higher in the SCG plants compared to the other two sources. Morphological traits varied significantly among plants from the three different sources. At Greeneville 'Cherry' sourced from MMH had lower leaf spot incidence, severity and disease index compared to 'Cherry' sourced from SCG and PWP. At Springfield 'Cherry' was sourced from MMH and SCG only, and they did not differ in leaf spot incidence, severity or disease index. Fewer differences were observed between plants from differing sources for the other two varieties, 'T1' and 'Wife'. Plants of 'T1' sourced from MMH were shorter and narrower than those from SCG, but did not differ for yield, quality or disease traits. Plants of 'Wife', sourced from MMH, had higher biomass yield than plants sourced from PWP, but did not differ for quality, morphological or disease traits.

Table 1. Location information from AgResearch and Education Centers where hemp variety tests were conducted in Tennessee in 2019.

Location		Irrigation	Plant Spacing	Pre-plant Fertilizer Application (N-P-K)	Soil Type
Springfield	Highland Rim AgResearch and Education Center	at transplant only	6 ft centers	240-96-312	Dickson Silt Loam
Greeneville	AgResearch and Education Center at Greeneville	at transplant only	6 ft centers	240-96-312	Ooltewah Silt Loam
Jackson	On-farm location	at transplant only	4 - 4.5 centers	196-148-112	Feliciana Silt Loam

Table 2. Variety, source and planting/harvest date for each University of Tennessee AgResearch Center location at which hemp variety trials were evaluated in 2019. Some varieties were obtained from several sources. Each variety/source combination was evaluated as a separate treatment.

Variety	Source ^z	<u>Greeneville</u>		<u>Springfield</u>		<u>Jackson</u>	
		Planting Date	Harvest Date	Planting Date	Harvest Date	Planting Date	Harvest Date
ACDC	PWP	6/28/19	10/23/19	-	-	-	-
Baox	MMH	6/28/19	10/23/19	6/17/19	10/11/19	-	-
Carolina	Bluhen	6/28/19	10/23/19	6/17/19	10/11/19	6/17/19	10/15/19
CB Dawg	Buffalo River Hemp	7/31/19	10/23/19	7/12/19	10/11/19	-	-
CBD Therapy	MMH	6/28/19	10/23/19	6/17/19	10/11/19, 11/4/19	6/17/19	10/25/19
Cherry	MMH	6/28/19	10/23/19	6/17/19	10/11/19	-	-
Cherry	PWP	6/28/19	10/23/19	-	-	-	-
Cherry	South Central Growers	6/28/19	10/23/19	6/17/19	10/11/19	6/17/19	10/3/19
Cherry - Topped ^y	South Central Growers	6/28/19	10/23/19	-	-	6/17/19	10/3/19
Cherry Tart	PWP	6/28/19	10/23/19	-	-	-	-
Cherry Wine	MMH	6/28/19	10/23/19	6/17/19	11/4/19	6/17/19	10/19/19
Franklin	MMH	6/28/19	11/15/19	6/17/19	11/4/19	6/17/19	10/21/19
Frosted Lime	Buffalo River Hemp	7/31/19	10/23/19	7/12/19	10/11/19	-	-
Ha3eZ	MMH	6/28/19	10/23/19	6/17/19	10/11/19	6/17/19	10/2/19
Hawaiian Haze	Corbin Sciences	6/28/19	10/23/19	6/17/19	10/11/19	6/17/19	10/3/19
Late Sue	Corbin Sciences	6/30/19	11/15/19	-	-	-	-
OG	PWP	6/28/19	10/23/19	-	-	-	-
Siskiyou Gold	Buffalo River Hemp	7/31/19	10/23/19	7/12/19	10/11/19, 11/4/19	-	-
Super CBD	MMH	6/28/19	10/23/19	6/17/19	11/4/19	6/17/19	10/21/19
Suver Haze	Bluhen	6/28/19	10/23/19	6/17/19	10/11/19	6/17/19	10/2/19
Sweetened	MMH	6/28/19	10/23/19	6/17/19	10/11/19	-	-
T1	PWP	6/28/19	10/23/19	-	-	-	-
T1	South Central Growers	6/28/19	10/23/19	6/17/19	10/11/19	6/17/19	10/13/19
T1 - Topped ^y	South Central Growers	6/28/19	10/23/19	-	-	6/17/19	10/11/19
Tangerine	Corbin Sciences	6/28/19	10/23/19	6/17/19	10/11/19	6/17/19	10/10/19
T-Rex	PWP	6/28/19	11/15/19	6/17/19	11/13/19	6/17/19	11/6/19
VG	PWP	6/28/19	10/23/19	-	-	-	-
Wife	MMH	6/28/19	10/23/19	6/17/19	10/11/19	6/17/19	10/17/19
Wife	PWP	6/28/19	10/23/19	-	-	-	-

^zIndoor Growers World, Goodlettsville, TN; PWP Greenhouses Inc., Pall Mall, TN; MMH, Athens, TN; Oregon CBD, Independence, OR; Blühen, Knoxville, TN; Corbin Sciences, Springfield, TN; South Central Growers, Springfield, TN.

^yCultivars were topped prior to transplanting.

Table 3. Across and by location mean yield traits of 29 hemp treatments (variety by source) evaluated in small plot replicated trials at three AgResearch and Education Center locations in Tennessee during 2019.

Variety - Source	Biomass Yield*				CBD Yield*			
	(lbs DM / plant)				(lbs / plant)			
	Greeneville	Springfield	Jackson	Across Locs	Greeneville	Springfield	Jackson	Across Locs
ACDC - PWP	1.9 cd ²				0.15 cd			
Baox - MMH	1.0 f-k	0.8 fg			0.12 d-g	0.08 d-f		
Carolina - B	2.3 ab	1.5 b-d	0.4 b-d	1.4 bc	0.28 a	0.17 a	0.05 a	0.17 a
CB Dawg - BRH	0.8 i-n	1.0 ef			0.08 g-l	0.10 c-e		
CBD Therapy - MMH	2.0 b-d	1.2 c-f	0.6 ab	1.3 c	0.10 f-h	0.06 ef	0.04 bc	0.07 ef
Cherry - MMH	2.1 a-c	1.5 b-d			0.26 a	0.18 a		
Cherry - PWP	0.9 h-m				0.09 f-j			
Cherry - SCG	0.4 o	0.3 h	0.0 h	0.2 g	0.04 l	0.03 f	0.00 e	0.03 g
Cherry - Topped - SCG	0.3 o		0.1 gh		0.04 kl		0.01 de	
Cherry Tart - PWP	0.9 h-m				0.10 f-i			
Cherry Wine - MMH	2.2 a-c	1.8 b	0.5 a-c	1.5 ab	0.20 b	0.17 a	0.05 a	0.14 b
Franklin - MMH	1.0 g-l	1.0 ef	0.2 f-h	0.7 e	0.08 h-l	0.08 d-f	0.02 de	0.06 f
Frosted Lime - BRH	0.4 no	0.8 fg			0.05 kl	0.08 d-f		
Ha3eZ - MMH	0.8 j-n	0.5 gh	0.1 gh	0.5 f	0.08 g-k	0.05 ef	0.01 de	0.05 f
Hawaiian Haze - CS	1.2 f-h	1.0 ef	0.2 e-h	0.8 de	0.13 d-f	0.12 b-d	0.03 b-d	0.09 cd
Late Sue - CS	0.6 m-o				0.04 l			
OG - PWP	2.4 a				0.25 a			
Siskiyou Gold - BRH	0.5 m-o	1.7 bc			0.05 j-l	0.16 ab		
Super CBD - MMH	2.0 b-d	2.3 a	0.7 a	1.6 a	0.18 bc	0.17 a	0.04 ab	0.13 b
Suver Haze - B	1.4 ef	1.1 d-f	0.2 f-h	0.9 de	0.16 cd	0.13 a-c	0.03 b-d	0.11 c
Sweetened - MMH	2.3 ab	1.4 b-e	0.4 c-e	1.4 bc	0.25 a	0.11 b-d	0.04 a-c	0.13 b
T1 - PWP	0.6 l-o				0.06 i-l			
T1 - SCG	1.0 g-l	0.8 fg	0.3 d-g	0.7 e	0.08 g-k	0.06 ef	0.02 c-e	0.06 f
T1 - Topped - SCG	0.8 k-n		0.3 d-g	0.8 e	0.07 h-l		0.03 b-e	0.08 de
Tangerine - CS	1.1 f-j	1.0 ef	0.2 e-h		0.13 d-f	0.10 c-e	0.03 c-e	
T-Rex - PWP	2.2 a-c	1.6 bc	0.5 a-c	1.4 bc	0.06 i-l		0.04 a-c	
VG - PWP	1.3 e-g				0.14 c-e			
Wife - MMH	1.2 f-i	1.5 b-d	0.4 c-f	1.0 d	0.11 e-h	0.13 a-d	0.04 a-c	0.09 cd
Wife - PWP	1.6 de				0.15 cd			
Average	1.3	1.2	0.3	1.0	0.12	0.11	0.03	0.09
Standard Error	0.2	0.2	0.1	0.1	0.02	0.02	0.01	0.01
ANOVA p-values								
- Variety	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
- Location	-	-	-	<0.001	-	-	-	<0.001
- Variety x Location	-	-	-	<0.001	-	-	-	<0.001

* Traits marked with an asterisk exhibited significant variety by location interaction, meaning differences in variety performance differed by location.

² Means followed by the same letter(s) within columns are not significantly different (Fisher's Protected LSD, $P < 0.05$).

Table 4-a. Across and by location mean quality traits of 29 hemp treatments (variety by source) evaluated in small plot replicated trials at three AgResearch and Education Center locations in Tennessee during 2019.

Variety - Source	Max Active CBD*				Max Active THC* ^z			
	(%)				(%)			
	Greeneville	Springfield	Jackson	Across Locs	Greeneville	Springfield	Jackson	Across Locs
ACDC - PWP	8.1 lm ^y				0.40 k			
Baox - MMH	11.4 a-d	8.7 e-i			0.55 b-f	0.44 d-h		
Carolina - B	12.1 ab	10.7 a-d	12.9 b	11.9 b	0.63 b	0.55 b-d	0.67 c	0.60 bc
CB Dawg - BRH	9.5 g-k	9.6 b-e			0.45 jk	0.47 b-f		
CBD Therapy - MMH	5.3 n	4.6 j	6.1 i	5.3 h	2.67 a	2.03 a	3.00 a	2.47 a
Cherry - MMH	12.5 a	11.4 a			0.62 bc	0.58 b		
Cherry - PWP	11.0 b-e				0.54 c-h			
Cherry - SCG	11.2 a-d	10.2 a-e	11.1 c-f	10.8 cd	0.53 c-i	0.50 b-e	0.51 d-f	0.51 de
Cherry - Topped - SCG	10.7 c-h		10.7 d-f		0.49 f-k		0.48 ef	
Cherry Tart - PWP	10.9 b-e				0.53 d-i			
Cherry Wine - MMH	9.4 g-l	9.0 d-h	10.2 f	9.5 e	0.44 jk	0.39 f-j	0.48 f	0.43 f
Franklin - MMH	7.7 m	7.6 f-i	9.0 g	8.1 fg	0.34 l	0.31 j	0.38 g	0.33 g
Frosted Lime - BRH	10.6 c-g	9.4 c-g			0.50 f-j	0.46 b-g		
Ha3eZ - MMH	10.4 d-i	10.0 a-e	12.0 b-d	10.8 cd	0.50 e-j	0.49 b-e	0.54 d-f	0.50 e
Hawaiian Haze - CS	10.7 c-g	11.2 ab	12.2 bc	11.4 bc	0.54 c-h	0.55 b-d	0.61 cd	0.56 cd
Late Sue - CS	6.3 n				0.26 m			
OG - PWP	10.6 c-h				0.54 b-g			
Siskiyou Gold - BRH	10.2 d-j	9.5 b-f			0.47 g-k	0.42 e-i		
Super CBD - MMH	9.3 h-l	7.2 i	6.6 hi	7.7 g	0.47 g-k	0.33 ij	0.30 h	0.39 g
Suver Haze - B	11.8 a-c	11.2 a-c	15.2 a	12.7 a	0.59 b-d	0.56 bc	0.76 b	0.61 b
Sweetened - MMH	10.8 c-f	7.7 f-i	10.9 d-f	9.8 e	0.49 e-j	0.36 h-j	0.49 f	0.44 f
T1 - PWP	9.7 e-k				0.47 h-k			
T1 - SCG	8.6 k-m	7.4 hi	10.1 fg	8.7 f	0.45 i-k	0.37 g-j	0.51 ef	0.43 f
T1 - Topped - SCG	9.5 f-k		10.0 fg	10.6 d	0.49 e-j		0.50 ef	0.51 de
Tangerine - CS	10.9 b-e	9.3 d-f	11.4 c-e		0.53 d-i	0.47 b-f	0.56 de	
T-Rex - PWP	2.7 o		7.4 h		0.11 n		0.31 h	
VG - PWP	11.4 a-d				0.58 b-e			
Wife - MMH	9.3 i-l	8.6 e-i	10.7 ef	9.5 e	0.48 f-j	0.44 c-g	0.54 d-f	0.48 e
Wife - PWP	8.8 j-m				0.47 f-k			
Average	9.7	9.1	10.4	9.8	0.56	0.54	0.66	0.63
Standard Error	0.5	0.1	0.5	0.3	0.03	0.03	0.03	0.02
ANOVA p-values								
- Variety	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
- Location	-	-	-	0.01	-	-	-	0.01
- Variety x Location	-	-	-	<0.001	-	-	-	<0.001

* Traits marked with an asterisk exhibited significant variety by location interaction, meaning differences in variety performance differed by location.

^z Data were log-transformed for analysis due to non-normal distribution. Non-transformed means are reported.

^y Means followed by the same letter(s) within columns are not significantly different (Fisher's Protected LSD, $P < 0.05$).

Table 4-b. Across and by location mean quality traits of 29 hemp treatments (variety by source) evaluated in small plot replicated trials at three AgResearch and Education Center locations in Tennessee during 2019.

Variety - Source	Delta 9 THC*				CBG*			
	(%)				(%)			
	Greeneville	Springfield	Jackson	Across Locs	Greeneville	Springfield	Jackson	Across Locs
ACDC - PWP	0.09 d-h ^y				0.25 e-g			
Baox - MMH	0.10 d-h	0.15 b-f			0.20 e-i	0.15 fg		
Carolina - B	0.08 d-h	0.10 d-f	0.05 de	0.07 e-g	0.40 c	0.28 b	0.53 b	0.40 a
CB Dawg - BRH	0.11 d-g	0.13 c-f			0.24 e-h	0.19 c-g		
CBD Therapy - MMH	0.39 a	0.38 a	0.12 b	0.29 a	0.41 bc	0.27 bc	0.52 b	0.40 a
Cherry - MMH	0.12 d-f	0.19 b-d			0.61 a	0.56 a		
Cherry - PWP	0.10 d-h				0.21 e-i			
Cherry - SCG	0.22 bc	0.24 b	0.12 b	0.19 b	0.20 e-i	0.16 d-g	0.27 ef	0.21 de
Cherry - Topped - SCG	0.23 bc		0.12 b		0.17 g-j		0.26 ef	
Cherry Tart - PWP	0.14 c-e				0.21 e-i			
Cherry Wine - MMH	0.10 d-h	0.11 c-f	0.04 de	0.08 ef	0.25 e-h	0.16 e-g	0.33 c-e	0.25 cd
Franklin - MMH	0.05 f-h	0.06 f	0.01 f	0.04 g	0.26 d-f	0.22 b-f	0.55 b	0.35 b
Frosted Lime - BRH	0.06 e-h	0.12 c-f			0.29 de	0.22 b-f		
Ha3eZ - MMH	0.25 b	0.20 bc	0.18 a	0.21 b	0.22 e-i	0.21 b-g	0.37 cd	0.27 c
Hawaiian Haze - CS	0.16 cd	0.19 b-e	0.08 c	0.14 cd	0.21 e-i	0.16 d-g	0.38 c	0.25 cd
Late Sue - CS	0.02 gh				0.27 d-f			
OG - PWP	0.15 c-e				0.19 f-i			
Siskiyou Gold - BRH	0.10 d-h	0.09 ef			0.35 cd	0.20 b-g		
Super CBD - MMH	0.12 d-f	0.06 f	0.01 f	0.07 fg	0.43 bc	0.24 b-d	0.34 c-e	0.33 b
Suver Haze - B	0.16 b-d	0.17 b-e	0.11 b	0.15 c	0.17 g-i	0.20 c-g	0.40 c	0.26 c
Sweetened - MMH	0.11 d-f	0.12 c-f	0.04 e	0.09 ef	0.44 bc	0.24 b-e	0.55 b	0.41 a
T1 - PWP	0.10 d-h				0.16 h-j			
T1 - SCG	0.08 d-h	0.10 d-f	0.06 cd	0.08 ef	0.21 e-i	0.14 fg	0.65 a	0.20 e
T1 - Topped - SCG	0.11 d-g		0.05 c-e	0.11 d-f	0.23 e-i		0.26 f	0.24 c-e
Tangerine - CS	0.10 d-h	0.15 b-f	0.06 c-e		0.21 e-i	0.16 d-g	0.29 d-f	
T-Rex - PWP	0.01 h		0.01 f		0.08 j		0.34 c-e	
VG - PWP	0.13 c-f				0.50 b			
Wife - MMH	0.11 d-g	0.15 b-f	0.08 c	0.11 c-e	0.16 h-j	0.13 g	0.16 g	0.15 f
Wife - PWP	0.10 d-h				0.14 ij			
Average	0.12	0.15	0.07	0.13	0.26	0.22	0.39	0.29
Standard Error	0.04	0.05	0.01	0.02	0.03	0.03	0.03	0.01
ANOVA p-values								
- Variety	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
- Location	-	-	-	0.03	-	-	-	<0.001
- Variety x Location	-	-	-	<0.01	-	-	-	<0.001

* Traits marked with an asterisk exhibited significant variety by location interaction, meaning differences in variety performance differed by location.

^y Means followed by the same letter(s) within columns are not significantly different (Fisher's Protected LSD, $P < 0.05$).

Table 5-a. Across and by location mean morphological traits of 29 hemp treatments (variety by source) evaluated in small plot replicated trials at three AgResearch and Education Center locations in Tennessee during 2019.

Variety - Source	Plant Height (in.)				Plant Width (in.)			Branches (count)
	Greeneville	Springfield	Jackson	Across Locs	Greeneville	Springfield	Across Locs	Jackson
ACDC - PWP	40 g-j ²				70 bc			
Baox - MMH	32 l-n	30 hi			37 h-l	30 ef	33 f-h	
Carolina - B	61 c	47 cd	55 c	54 b	74 b	46 bc	60 b	33 cd
CB Dawg - BRH	43 f-h	56 ab			33 k-n	40 cd	37 ef	
CBD Therapy - MMH	54 d	49 bc	58 bc	54 b	61 de	45 bc	53 c	36 bc
Cherry - MMH	40 g-k	35 f-h			60 de	41 c	51 c	
Cherry - PWP	29 n-p				34 j-m			
Cherry - SCG	17 q	14 j	23 ij	18 f	19 o	18 g	19 i	20 f-h
Cherry - Topped - SCG	16 q		21 j		20 o			14 h
Cherry Tart - PWP	31 m-o				35 i-l			
Cherry Wine - MMH	49 de	46 c-e	46 d	47 c	66 cd	50 b	58 b	36 bc
Franklin - MMH	37 i-l	37 f-h	38 ef	37 d	48 fg	42 c	45 d	31 c-e
Frosted Lime - BRH	35 k-m	52 bc			25 no	35 de	30 h	
Ha3eZ - MMH	27 op	26 i	28 g-i	27 e	36 i-k	26 f	31 gh	24 d-g
Hawaiian Haze - CS	39 h-k	38 fg	39 e	39 d	44 gh	34 e	39 e	24 d-g
Late Sue - CS	47 ef				41 g-j			
OG - PWP	44 fg				75 ab			
Siskiyou Gold - BRH	35 k-m	52 bc			26 m-o	44 bc	35 e-g	
Super CBD - MMH	66 b	62 a	61 ab	63 a	76 ab	64 a	70 a	51 a
Suver Haze - B	39 h-k	39 e-g	36 ef	38 d	44 gh	31 ef	37 ef	19 gh
Sweetened - MMH	41 g-i	36 f-h	36 ef	38 d	63 cd	42 c	53 c	28 c-g
T1 - PWP	26 p				28 l-n			
T1 - SCG	37 i-l	36 f-h	33 e-g	35 d	40 g-k	30 ef	35 e-g	27 c-g
T1 - Topped - SCG	36 j-l		32 f-h	31 e	37 h-k		37 ef	26 d-g
Tangerine - CS	32 mn	33 g-i	28 hi		41 g-i	33 e		23 e-h
T-Rex - PWP	70 a	63 a	64 a	66 a	83 a	66 a	74 a	42 ab
VG - PWP	41 g-i				46 g			
Wife - MMH	37 i-l	41 d-f	35 ef	38 d	55 ef	47 bc	51 c	28 c-f
Wife - PWP	36 j-l				62 de			
Average	39	42	40	42	48	40	45	29
Standard Error	2	3	4	2	4	3	2	5
ANOVA p-values								
- Variety	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
- Location	-	-	-	0.84	-	-	0.84	
- Variety x Location	-	-	-	0.31	-	-	0.31	

* Traits marked with an asterisk exhibited significant variety by location interaction, meaning differences in variety performance differed by location.

² Means followed by the same letter(s) within columns are not significantly different (Fisher's Protected LSD, $P < 0.05$).

Table 5-b. Across and by location mean morphological traits of 29 hemp treatments (variety by source) evaluated in small plot replicated trials at three AgResearch and Education Center locations in Tennessee during 2019.

Variety - Source	Clear Trichomes*			Cloudy Trichomes*			Amber Trichomes*		
	(%)			(%)			(%)		
	Greeneville	Springfield	Across Locs	Greeneville	Springfield	Across Locs	Greeneville	Springfield	Across Locs
ACDC - PWP	8 d-g ^z			90 a			3 gh		
Baox - MMH	3 g-i	4 bc	3 d-g	71 b-d	71 a-e	71 b-f	17 e-g	26 c-f	21 cd
Carolina - B	6 f-i	9 ab	7 b-d	81 a-c	73 a-e	77 a-d	14 e-h	19 d-g	17 cd
CB Dawg - BRH	6 f-i	14 a	10 b	75 a-c	73 a-e	74 a-e	20 d-f	13 fg	16 cd
CBD Therapy - MMH	5 g-i	4 bc	4 c-g	90 a	71 a-e	80 a-c	6 f-h	25 c-f	15 cd
Cherry - MMH	7 e-h	10 ab	8 bc	66 cd	75 a-d	71 b-f	7 e-h	16 e-g	11 de
Cherry - PWP	6 f-i			79 a-c			17 e-g		
Cherry - SCG	1 i	0 c	0 fg	20 f	36 g	28 h	80 a	64 a	72 a
Cherry - Topped - SCG	0 i			26 f			50 b		
Cherry Tart - PWP	1 hi			86 ab			14 e-h		
Cherry Wine - MMH	14 cd	6 bc	10 b	81 a-c	58 d-f	70 b-f	6 f-h	36 b-d	21 cd
Franklin - MMH	16 bc	0 c	8 b-d	85 ab	72 a-e	78 a-c	0 h	28 b-f	14 cd
Frosted Lime - BRH	13 c-e	8 a-c	10 b	71 b-d	51 e-g	61 ef	17 e-g	17 e-g	17 cd
Ha3eZ - MMH	0 i	0 c	0 g	29 f	35 g	32 h	68 a	65 a	67 a
Hawaiian Haze - CS	1 hi	0 c	1 fg	48 e	45 fg	46 g	52 b	45 b	48 b
Late Sue - CS	22 b			79 a-c			0 h		
OG - PWP	8 d-g			84 ab			9 e-h		
Siskiyou Gold - BRH	12 c-f	0 c	6 b-e	84 ab	51 e-g	68 c-f	5 gh	24 c-f	14 cd
Super CBD - MMH	2 g-i	0 c	1 e-g	90 a	62 b-f	76 a-d	9 e-h	38 bc	23 c
Suver Haze - B	3 g-i	5 bc	4 c-g	55 de	62 b-f	58 fg	43 bc	34 b-e	38 b
Sweetened - MMH	5 g-i	5 bc	5 b-f	83 ab	81 a-c	82 ab	13 e-h	14 fg	13 cd
T1 - PWP	8 d-g			85 ab			8 e-h		
T1 - SCG	3 g-i	5 bc	4 c-g	88 a	82 ab	85 a	9 e-h	14 fg	11 de
T1 - Topped - SCG	4 g-i		5 b-f	87 a		75 a-d	10 e-h		20 cd
Tangerine - CS	5 g-i	6 bc		75 a-c	75 a-d		21 de	20 d-g	
T-Rex - PWP	30 a	9 ab	19 a	71 b-d	88 a	79 a-c	0 h	3 g	2 e
VG - PWP	5 g-i			90 a			6 f-h		
Wife - MMH	1 hi	6 a-c	3 c-g	67 cd	59 c-f	63 d-f	33 cd	15 fg	24 c
Wife - PWP	1 i			58 de			41 bc		
Average	7	5	6	72	64	67	20	27	24
Standard Error	2	3	2	6	8	5			
ANOVA p-values									
- Variety	<0.001	0.03	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
- Location	-	-	0.02	-	-	0.07	-	-	0.14
- Variety x Location	-	-	<0.001	-	-	0.01	-	-	<0.001

* Traits marked with an asterisk exhibited significant variety by location interaction, meaning differences in variety performance differed by location.

^z Means followed by the same letter(s) within columns are not significantly different (Fisher's Protected LSD, $P < 0.05$).

Table 6. By location mean disease ratings of 29 hemp treatments (variety by source) evaluated in small plot replicated trials at three AgResearch and Education Center locations in Tennessee during 2019.

Variety - Source	Leaf Spot Incidence (%)			Leaf Spot Severity (%)			Disease Index ^z (%)			Leaf Spot Susceptibility ^y (%)		
	Greeneville	Springfield	Jackson	Greeneville	Springfield	Jackson	Greeneville	Springfield	Jackson	Greeneville	Springfield	Jackson
ACDC - PWP	18 a-c ^x			2 ab			0.5 a			low		
Baox - MMH	95 i	79 e		12 hi	11 ef		11.6 f	9.1 e		high	mod-high	
Carolina - B	48 b-g	33 a-d	62 b-d	4 a-d	3 a-c	7 a-d	1.9 a-c	1.0 a	4.9 ab	moderate	low	moderate
CB Dawg - BRH	33 a-f	37 a-d		6 a-g	4 a-e		2.6 a-c	1.5 ab		moderate	low-mod	
CBD Therapy - MMH	3 a	10 ab	14 a	0 a	2 ab	4 a-c	0.0 a	0.2 a	0.6 ab	low	low	moderate
Cherry - MMH	21 a-d	40 b-d		2 ab	8 b-f		0.6 a	2.9 a-c		low	moderate	
Cherry - PWP	94 hi			10 g-i			10.8 f			high		
Cherry - SCG	70 f-i	55 c-e	54 bc	10 d-i	9 c-f	9 c-e	8.6 d-f	5.0 a-e	5.5 ab	mod-high	moderate	moderate
Cherry - Topped - SCG	64 d-i		41 ab	11 e-i		8 b-e	7.2 b-f		3.4 ab	moderate		moderate
Cherry Tart - PWP	91 hi			11 g-i			10.4 f			high		
Cherry Wine - MMH	15 a-c	11 ab	31 ab	2 ab	2 ab	5 a-d	0.3 a	0.2 ab	2.5 ab	low	low	moderate
Franklin - MMH ^w	2 a	4 a	5 a	0 a	1 a	2 a-c	0.0 a	0.1 a	0.2 a	low	low	low
Frosted Lime - BRH	16 a-c	21 a-c		2 ab	3 a-d		0.5 a	0.9 a		low	low	
Ha3eZ - MMH	28 a-e	40 b-d	10 a	5 a-f	9 c-f	2 a-c	1.3 ab	3.6 a-d	0.5 a	low-mod	moderate	low
Hawaiian Haze - CS	54 c-h	66 d-e	61 b-d	6 a-h	10 d-f	7 a-d	3.5 a-e	7.4 b-e	4.0 ab	moderate	moderate	moderate
Late Sue - CS	1 a			0 a			0.0 a			low		
OG - PWP	11 ab			1 ab			0.1 a			low		
Siskiyau Gold - BRH	33 a-f	35 a-d		3 a-c	4 a-e		1.3 a	1.7 ab		low	low-mod	
Super CBD - MMH	4 a	9 ab	9 a	1 a	2 ab	2 ab	0.0 a	0.2 a	0.2 a	low	low	low
Suver Haze - B	65 e-i	55 c-e	64 b-d	5 a-e	6 a-f	11 d-f	3.0 a-d	3.5 a-d	7.1 b	moderate	moderate	moderate
Sweetened - MMH	16 a-c	30 a-c	28 ab	2 ab	3 a-d	6 a-d	0.2 a	1.0 a	1.9 ab	low	low	moderate
T1 - PWP	83 g-i			9 c-i			7.4 c-f			mod-high		
T1 - SCG	89 hi	88 e	74 cd	11 f-i	9 c-f	15 ef	9.8 f	8.2 c-e	13.8 c	high	mod-high	high
T1 - Topped - SCG	93 hi		81 d	10 d-i		16 f	9.3 ef		15.3 c	high		high
Tangerine - CS	95 i	89 e	80 d	13 i	11 f	17 f	12.1 f	10.0 e	15.9 c	high	high	high
T-Rex - PWP	2 a	2 a	2 a	0 a	1 a	1 a	0.0 a	0.0 a	0.0 a	low	low	low
VG - PWP	39 a-f			7 b-i			3.7 a-e			moderate		
Wife - MMH	45 b-g	40 b-d	49 b-d	5 a-e	4 a-d	6 a-d	2.2 a-c	1.6 ab	3.6 ab	moderate	low-mod	moderate
Wife - PWP	60 d-i			4 a-d			2.7 a-d			moderate		

^zDisease index was calculated using the following formula: $DI = (I \times S) / 100$, where DI=disease index, I=disease incidence, S=disease severity, and 100 represents the maximum possible incidence and severity scores.

^yDisease index mean separations were used to categorize cultivars by leaf spot susceptibility. "Low" are significantly different from "high", and "low-mod" are significantly different from "mod-high".

*Means followed by the same letter(s) within columns are not significantly different (Tukey's HSD, $P < 0.05$).

^wFrosted Lime' showed high phenotypic variability among individuals. Only the predominant phenotype was rated.



W 900 05/20 Programs in agriculture and natural resources, 4-H youth development, family and consumer sciences, and resource development. University of Tennessee Institute of Agriculture, U.S. Department of Agriculture and county governments cooperating. UT Extension provides equal opportunities in programs and employment.