W 1081

DUAL-PURPOSE INDUSTRIAL HEMP CULTIVAR TRIAL IN TENNESSEE 2021

Mitchell D. Richmond, Assistant Professor and Tobacco, Hemp and Specialty Crop Extension Specialist, Department of Plant Sciences

Real. Life. Solutions.™

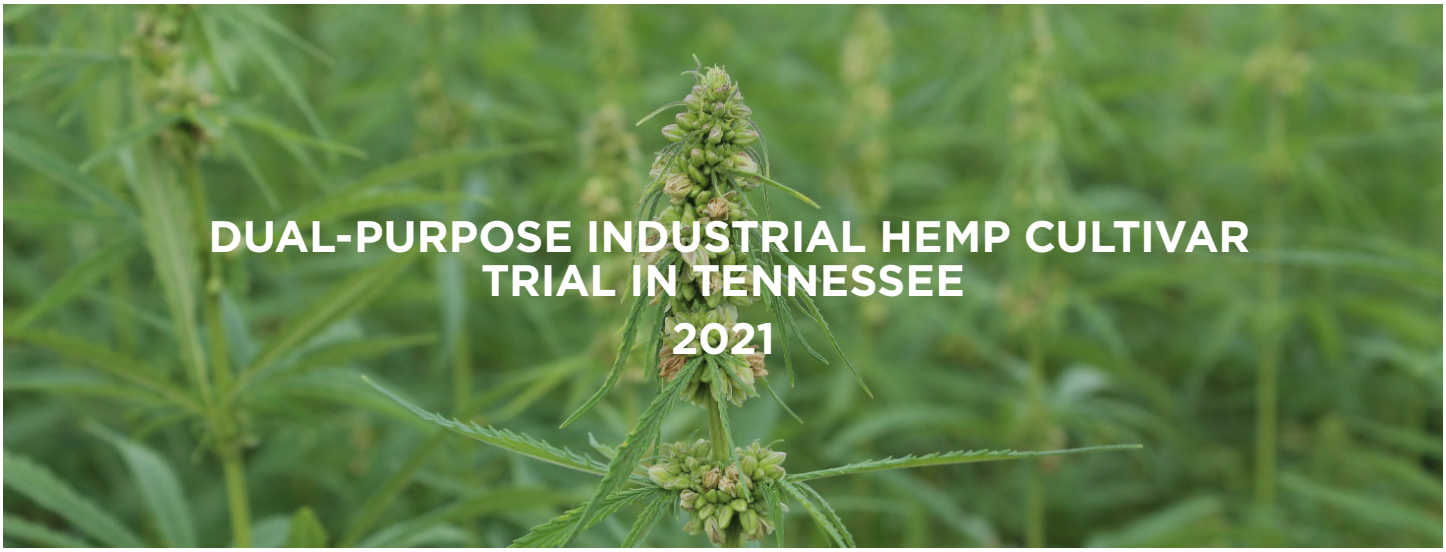
UTEXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Table of Contents

Acknowledgments

We gratefully acknowledge the assistance of the following individuals in conducting this experiment:

Highland Rim AgResearch and Education Center (Springfield, Tennessee)
Rob 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
Catarino Ramirez, Field Worker
Fernando Barreto, Field Worker
Ricardo Barreto, Field Worker
Jordin Barreto, Field Worker



DUAL-PURPOSE INDUSTRIAL HEMP CULTIVAR TRIAL IN TENNESSEE 2021

Experimental Procedures

A dual-purpose hemp variety trial was conducted at the Highland Rim AgResearch and Education Center in Springfield, Tennessee. During 2021, 13 cultivars were evaluated for dual-purpose fiber and grain production (Table 1). This trial was conducted in collaboration with S1084: Industrial Hemp Production, Processing, and Marketing in the US, which is a multistate research project.

The experiment was arranged in a randomized complete block design with four replications. Soil type was a Dickson silt loam (fine-silty, siliceous, semiactive, thermic Glossic Fragiudults) with a pH of 6.6. Plots were 9.34 feet wide and planted to a length of 20 feet. Plots were established using a drill with seven rows on a 7-inch (4.67-foot) spacing on May 27, 2021, with emergence noted on June 1, 2021. The drill was adjusted to place hemp seed at 0.75 inches deep.

Assessment of Plant Population at Establishment

Plant population was measured 11 days after planting (June 7, 2021) by counting the number of plants in one row along a yardstick (3 feet). Four measurements per plot were collected. Data are reported in number of plants per acre (Table 2).

Assessment of Plant Height at Harvest

Height of dual-purpose hemp cultivars was measured at harvest by measuring the tallest point from the soil surface of hemp plants while in the field. A random sample of 10 hemp plants per plot were measured.

Assessment of Stem Diameter at Harvest

Stem diameter was measured immediately after hand-harvesting samples. These data were collected by measuring the stem diameter of three hemp plants in each hand-harvested sample.

Assessment of Plant Population at Harvest

Plant population was measured at harvest by counting the number of plants in a 0.25 m2 hand-harvested sample. Two samples per plot were evaluated for plant population at harvest. Data are shown in number of plants per acre (Table 2).

Assessment of Grain and Fiber Yield

Grain yield data for dual-purpose industrial hemp cultivars were collected by both hand and machine. Two passes with the drill (Hege 1000 Cone Plot Drill) were completed to establish the industrial hemp plots. Half of each plot was designated for hand-harvest with the remaining half designated for machine-harvest. Hand-harvest occurred on Sept. 2, 2021, by manually removing all aboveground biomass in 0.25 m2 quadrats replicated four times within each plot. Hand-harvested samples were threshed using a Wintersteiger LD350 Stationary Thresher to separate the grain, fiber and chaff. Machine (Almaco SPC40) harvest occurred on Sept. 8, 2021, and only collected data for grain yield. Fiber samples were collected by sampling aboveground biomass from 0.25 m2 quadrats that were threshed using a Wintersteiger LD350 Stationary Thresher. After threshing, fiber and grain samples were dried using a forced-air oven (Oven-King, Seattle, Washington) set to 114 F.

Statistical Analysis and Interpretation of Data

The tables on the following pages have been prepared with cultivars listed in ascending alphabetical order. Plant population, height, stem diameter, and yield of fiber and grain data were assessed for assumptions of analysis of variance (ANOVA) and analyzed using the GLIMMIX procedure in SAS version 9.4 (Cary, North Carolina). Means were separated using the Fisher's Protected LSD (Least Significant Difference) test. All analyses used a mixed model with cultivar as a fixed effect and replication as a random effect with an alpha level of 0.05 to determine significance. Mean separation letters were assigned to each mean value for each variable, if significant. Means within a column followed by the same letter are not significantly different.

Growing Season

Precipitation for the growing season (20.76 inches) was higher than the 30-year average (17.40 inches) at Highland Rim AgResearch and Education Center in 2021. Precipitation totals for May (4.48 inches) were lower than 30-year averages (5.53 inches). In June, total precipitation (5.10 inches) was higher than average (4.51 inches), with 95 percent of the rain occurring in a 10-day period after June 2, 2021. July precipitation (4.72 inches) was comparable to the 30-year average (4.17 inches) while August rainfall totals (6.46 inches) were more than double the 30-year average (3.19 inches) precipitation totals. Monthly average daily temperatures were similar to the 30-year averages during each month except May, where temperatures were 8 percent lower.

Results

Plant Population

Emergence of dual-purpose industrial hemp cultivars occurred within six days after sowing, likely as a result of adequate soil moisture and ideal temperatures. Plant population at establishment was assessed 11 days after sowing (Table 2). The cultivar 'Bialobrzeskie' (1,001,880 plants per acre) had the highest plant population and 'Hliana' (132,236 plants per acre) had the lowest population. The average plant population at establishment was 621,568 plants per acre. Similar results for plant population were recorded at harvest. At harvest, 'Bialobrzeskie' and 'Hliana' maintained the highest and lowest plant population, respectively. The average plant population at harvest was 145,064 plants per acre. The difference in establishment population and harvest population is not clearly understood. There was significant weed pressure from mid-season through harvest, which could have impacted the overall plant population at harvest. In addition, male hemp plants were past maturity and many were senesced at the time of harvest and sample collection. Data for male:female ratios were not collected in this experiment.

Plant Height and Stem Diameter

There was a significant main effect of cultivar, with the 'Anka', 'Hliana' and 'Lara' grouping as significantly taller than other tested cultivars. The cultivar 'Grandi' was the shortest cultivar tested. The range for plant height at harvest was 38 inches to 75 inches, with an average of 60 inches. Stem diameter was measured on hand-harvested samples immediately after sample collection. The cultivars 'Altair', 'Anka', 'Hlesia', and 'Hliana' were wider in stem diameter, while 'Grandi' was narrower (Table 2). The range in stem diameter was 0.07 to 0.12 inches and the average stem diameter was 0.10 inches.

Dry Grain and Fiber Yield

There was a significant main effect of cultivar on dry grain yield within each method of harvest (Table 3). The overall trends of dry grain yield between the harvest methods are similar. The cultivar 'X-59' had the highest yield in both hand (258 pounds per acre) and machine (130 pounds per acre) harvest while the cultivar 'H-51' was lowest (137 and 13 pounds per acre, respectively). The cultivars 'Anka' and 'Bialobrzeskie' grouped with the statistically higher-yielding groups in both harvest methods. Grain yields from this dual-purpose industrial hemp experiment were lower than expected. The range in dry grain yield was 139 to 258 pounds per acre with an average of 182 pounds per acre for hand-harvest. The range in dry grain yield was 13 to 130 pounds per acre with an average of 66 pounds per acre for the machine-harvest. Interestingly, 'Grandi' and 'Henola' grouped with the higher-yielding statistical grouping when harvested with the combine. This is likely due to more variability associated with the machine-harvest when comparing the overall average yield and standard error across harvest method.

Differences in dry grain yield averages were expected between machine-harvest and hand-harvest due to weed pressure, seed shatter, and handling of samples. Hand-harvested samples only collected the dual-purpose hemp from the sampled area, whereas the machine harvested the entire plot. Machine-harvested samples were cleaned after harvest using a stationary thresher to separate weed and hemp seed. It is possible that hemp grain yield reductions occurred during this process, which would explain overall lower yields with the machine-harvested grain. Regardless, the two harvesting methods provided similar results for dry grain yield as related to rankings of cultivar performance.

Overall fiber yields were lower than expected (Table 4). Data for dry fiber yield ranges from 129 to 289 pounds per acre, with an average of 207 pounds per acre. The highest performing cultivar was 'Lara', with cultivars 'Altair', 'Anka', 'Bialobrzeskie', 'H-51' and 'Hlesia' not significantly different from the higher statistical grouping. Hurd and bast data were not collected. Nitrogen (N) fertility may have impacted overall fiber yields at Highland Rim AgResearch and Education Center in 2021 as a total of 50 pounds nitrogen per acre was applied to the experimental area prior to sowing. However, no nitrogen deficiency symptoms were noticed throughout the growing season.

Conclusion

Fiber and grain yields noted from the dual-purpose industrial hemp for fiber and grain cultivar trial conducted at Highland Rim AgResearch and Education Center in 2021 were lower than expected. Grain yields were highest in 'Anka', 'Bialobrzeskie' and 'X-59' cultivars regardless of harvesting method. Fiber yields were highest in 'Altair', 'Anka', 'Bialobrzeskie', 'H-51', 'Hlesia' and 'Lara'. Further experimentation with cultivars and production practices are warranted to maximize dual-purpose industrial hemp grain and fiber yields in Tennessee.

Table 1. Cultivar and seed source for dual-purpose fiber and grain hemp cultivar trial at Highland Rim AgResearch and Education Center in 2021. All cultivars were planted May 27, 2021, and either hand-harvested or machine-harvested on September 2, 2021, or September 8, 2021, respectively.

Cultivar†	Source‡
Altair	UniSeeds
Anka	UniSeeds
Bialobrzeskie	International Hemp
CFX-1	Hemp Genetics International
CFX-2	Hemp Genetics International
Grandi	Hemp Genetics International
H-51	Rohrer Seeds
Henola	International Hemp
Hlesia	Rohrer Seeds
Hliana	Rohrer Seeds
Lara	Omni Trade Inc
Vega	UniSeeds
X-59	IND Hemp

† Plots were 9.34 feet wide by 20 feet in length. Hand-harvest was performed by sampling 1/4-m quadrats four times in half of each plot; machine harvest was performed on the remaining half of each plot with an ALMACO SPC40.

‡ UniSeeds, Cobden, Ontario, Canada; International Hemp, Denver, Colorado, USA; Hemp Genetics International, Saskatoon, Saskatchewan, Canada; Rohrer Seeds, Lancaster, Pennsylvania, USA; Omni Trade Inc, Plymouth, Michigan, USA; IND Hemp, Fort Benton, Montana, USA

Table 2. Plant population, plant height and stem diameter of dual-purpose hemp cultivars evaluated at Highland Rim AgResearch and Education Center in Tennessee during 2021.

Cultivar	Plant Population		Plant Height	Stem Diameter
	Establishment† (plants/acre)	Harvest‡ (plants/acre)	Harvest‡ (inches)	Harvest‡ (inches)
Altair	563,169 cd§	145,687 b-f	68 c	0.11 ab
Anka	527,387 cd	178,062 ab	72 a	0.11 ab
Bialobrzeskie	1,001,880 a	194,250 a	66 c	0.10 b-d
CFX-1	802,748 b	119,382 d-f	44 f	0.08 ef
CFX-2	594,283 c	141,640 b-f	47 f	0.08 ef
Grandi	802,749 b	103,195 gf	38 g	0.07 f
H-51	608,284 c	169,968 a-c	67 c	0.11 b-d
Henola	654,956 bc	184,132 ab	55 e	0.08 ef
Hlesia	409,153 d	117,359 e-g	70 bc	0.11 ab
Hliana	132,236 e	82,961 g	75 a	0.12 a
Lara	676,736 bc	159,851 a-e	74 a	0.11 bc
Vega	631,620 bc	161,875 a-d	60 d	0.09 c-e
X-59	675,180 bc	127,476 c-f	43 f	0.09 de
Average	**621,568**	**145,064**	**60**	**0.10**
Standard Error	**70,640**	**15,873**	**1.64**	**0.01**
ANOVA p-values - Cultivar	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*

† Establishment population data were collected on June 7, 2021 (11 days after planting).

‡ Harvest population data were collected on September 2, 2021 (day of harvest).

§ Means followed by the same letter(s) within columns are not significantly different (Fisher's Protected LSD, P<0.05). Cultivars within the "a group" are highlighted in orange.

Table 3. Grain yield from hand- and machine-harvest of dual-purpose hemp cultivars evaluated at Highland Rim AgResearch and Education Center in Tennessee during 2021.

Cultivar	Dry Grain Yield	
	Hand lbs/acre	Machine lbs/acre
Altair	183 b-d†	68 b-d
Anka	203 ab	84 a-c
Bialobrzeskie	208 ab	83 a-c
CFX-1	183 b-d	71 bc
CFX-2	166 b-d	68 b-d
Grandi	166 b-d	82 a-c
H-51	137 d	13 e
Henola	196 bc	95 ab
Hlesia	172 b-d	41 c-e
Hliana	143 cd	20 de
Lara	179 b-d	46 b-e
Vega	166 b-d	65 b-d
X-59	258 a	130 a
Average	**181.56**	**66.49**
Standard Error	**23.21**	**21.58**
ANOVA p-values - Cultivar	*0.0085*	*0.0045*

†Means followed by the same letter(s) within columns are not significantly different (Fisher's Protected LSD, P<0.05). Cultivars within the "a group" are highlighted in orange.

Table 4. Fiber yield from hand-harvest of dual-purpose hemp cultivars evaluated at Highland Rim AgResearch and Education Center in Tennessee during 2021.

Cultivar	Dry Fiber Yield
	Hand Harvest lbs/acre
Altair	237 a-c†
Anka	262 ab
Bialobrzeskie	257 ab
CFX-1	142 ef
CFX-2	129 f
Grandi	133 f
H-51	251 ab
Henola	206 b-d
Hlesia	254 ab
Hliana	199 b-e
Lara	289 a
Vega	185 c-f
X-59	152 d-f
Average	**207**
Standard Error	**28**
ANOVA p-values - Cultivar	*<0.0001*

†Means followed by the same letter(s) within columns are not significantly different (Fisher's Protected LSD, P<0.05). Cultivars within the "a group" are highlighted in orange.

UTIA.TENNESSEE.EDU

Real. Life. Solutions.™

W 1081 5/22 22-0174 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.