

Preliminary Research Report

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Industrial hemp trials were initiated in spring 2019 at the University of Florida Institute of Food and Agricultural Sciences Tropical Research and Education Center (TREC) located in Homestead, Florida (25.4687° N, 80.5007° W). A direct seeded variety trial and planting date trial were carried out simultaneously throughout the season. Measurements were taken to assess plant performance, including flowering date, cannabinoid concentration, stand establishment, and yield.

Varietal differences were found in terms of plant development, growth, and yield. Preliminary results do not point to a clearly superior variety that is well adapted for South Florida, is sufficiently productive, and meets legal requirements for industrial hemp. Several varieties showed promise for future trials and breeding efforts. Differences among varieties were largely driven by flowering behavior. The total THC concentration of some, but not all, varieties exceeded 0.3%, the current legal definition for industrial hemp. Top performing varieties generally did better when planted in May before the hot rainy season. Several varieties had competitive or exceptional yield compared to commercial targets for fiber or grain harvest.

It should be noted that the research presented in this document was obtained from a single field season, at a single location, and from a limited number of hemp varieties. There will certainly be variation between seasons, locations, and hemp varieties. **The mention of variety names in this document is not meant to serve as an endorsement nor are these data to be considered a recommendation. Additionally, hemp is predicted to have a high risk of invasion in natural areas according to the UF/IFAS Assessment of Non-Native Plants in Florida's Natural Areas and may be problematic as an agricultural weed. Thus UF/IFAS will continue to conduct research on invasive risk, variety selection, and management options for FL conditions to address these concerns.**

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Variety trial

Methods

The variety trial was planted at TREC on May 22nd, 2019 with 23 hemp varieties representing diverse latitude of origin from regions across the world including North America, Europe, and Asia and the various purposes of fiber, grain, and essential oil production (Table 1). The hemp varieties in the trial were not specifically selected for adaptive qualities for Florida, but rather the varieties accessible to the research program for the 2019 planting season. Plants in the variety trial were monitored for flowering behavior and, when ample material was available, sampled for cannabinoid concentration.

The environment at UF/IFAS TREC is characterized by a subtropical climate with a wet season from May to October, a mean annual temperature of 74.1°F, and a rainfall of 65 in. Soil is rocky, called rockdale or Krome gravelly loam, and is derived from Miami oolitic limestone. Soil depth is 6-12 in resulting from excavation and rock plowing. The land was cultivated, disked, and fertilized prior to planting. Fertilizer was broadcast at a rate of 112 lb N, 56 lb P₂O₅, and 300 lb K₂O per acre with a slow release granular fertilizer. Plots were irrigated with overhead sprinklers as needed to keep soil moist. Each variety was planted in four 6 ft x 10 ft plots. Planting density was 1500, 900, and 60 seeds per plot for fiber, grain/dual, and essential oil, respectively. The seeding rate of 1500 seeds per plot is approximately equivalent to 60 lbs/ac, while 900 seeds per plot is approximately 35 lbs/ac. Fiber and grain seeds were evenly distributed along 8 rows separated by 8 inches. CBD seeds were planted into mounds at 2 ft x 2 ft spacing.

Flowering behavior

Plots were monitored frequently for flower development and recorded as percent of each plot at floral induction determined visually. Floral induction was determined for individual plants when the upper nodes changed to indicate the initiation of flower development. Flowering date was defined when the plot reached 50% of individuals with flower induction (Table 1).

Hemp varieties in our trial demonstrated flowering behavior indicative of short-day photoperiod sensitive plants. Short-day hemp plants require the long days of summer to grow vegetatively before flowering as days shorten to a critical length. Differences in flowering date were largely driven by latitude of origin (Table 1, Fig 1). Because the critical day length for flowering in varieties adapted to northern latitudes is high, we expected them to flower early given the lack of those long days in Florida. No Canadian or northern European varieties grew later than a few weeks before flowering which is far short of harvestable size or maturity. In contrast, some southern European and Chinese varieties showed a month or more of growth prior to flowering. Latitude of origin was an indicator of the date each variety flowered. Time to flowering impacted production outcomes (i.e., fiber vs. grain) and yield.

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Table 1. List of varieties planted and evaluated in the variety trial with their origin, production purpose and date of flowering. Date of flowering was determined by the earliest date that 50% of the plants in a plot demonstrated signs of floral induction.

Variety	Origin	Purpose	Trial Flowering
CFX-1	Canada	Grain	6/10/19
CFX-2	Canada	Grain	6/11/19
Joey	Canada	Dual	6/11/19
Canda	Canada	Dual	6/12/19
CRS-1	Canada	Grain	6/12/19
Carmagnola	Italy	Dual	6/13/19
Han FN-Q	North China	Dual	6/13/19
Carmagnola Selezionata	Italy	Dual	6/14/19
Helena	Serbia	Dual	6/14/19
Tygra	Poland	Dual	6/14/19
Han FN-H	North China	Dual	6/15/19
Fibranova	Italy	Fiber	6/17/19
Eletta Campana	Italy	Fiber	6/19/19
Han NE	Central China	Dual	6/24/19
Han NW	Central China	Dual	7/03/19
Cherry Blossom x T1	USA	Essential oil	7/27/19
Berry Blossom	USA	Essential oil	7/31/19
Puma-3	South China	Fiber	8/29/19
Puma-4	South China	Fiber	8/31/19
Bama	South China	Dual	9/07/19
Yuma	South China	Dual	9/07/19
Yuma-2	South China	Dual	9/07/19
Si-1	South China	Dual	9/09/19

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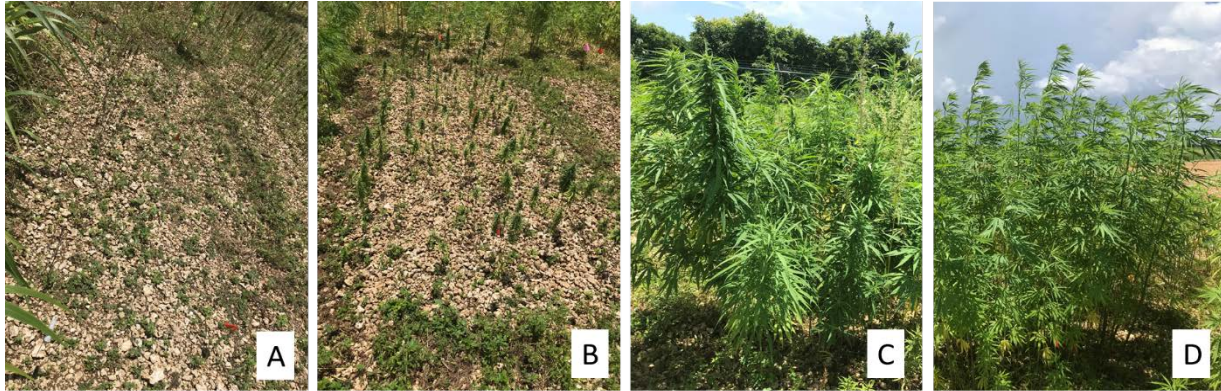


Figure 1. Four hemp varieties planted at TREC May 22, 2019 photographed August 8, 2019. A) Canadian hemp B) European hemp C) Middle Chinese hemp D) South Chinese hemp

Cannabinoid concentration

Approximately 10 g of inflorescence and leaf tissue were sampled at harvest from the main stem of each variety approximately 100 days after planting. The samples were oven-dried at 158 °F for at least 48 hours. Dried tissue was processed and analyzed by UPLC-MS/MS at the UF College of Pharmacy in Gainesville, FL.

Cannabinoid concentration results were limited to a single batch sampling event taken at harvest. Permitted and compliant hemp harvests at the time of this report require total THC concentration by dry weight to not exceed 0.3%. The variety trial results indicated that producing plants with less than 0.3% total THC at harvest may be problematic in South Florida, especially for unpollinated essential oil crops and for several of the grain and fiber genetics that performed well in the trial (Table 2). Because our trial was conducted in the same field, the essential oil varieties were exposed to pollen from the flowering male hemp plants. Essential oil varieties did not exceed 0.3% total THC, but total CBD also did not accumulate above 6%. Two Chinese and two European varieties harvested for grain had total THC under 0.3%. Han NE contained THC above 0.3%, which is notable because it had the highest seed yield of all tested grain varieties. All fiber varieties grown to harvest were Chinese and exceeded THC of 0.3%, most expressing cannabinoid profiles that were dominant in THC.

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Table 2. Varieties remaining viable at the end of the growing season sampled for cannabinoid concentration [%]. Average total THC and average total CBD are represented as a batch value for a single sampling event. Total THC values above 0.3% are bolded.

Variety	Origin	Purpose	Total THC [%]	Total CBD [%]
Berry Blossom	USA	Essential Oil	0.229	3.569
Cherry Blossom x T1	USA	Essential Oil	0.261	4.196
Puma-4	South China	Fiber	0.433	0.903
Puma-3	South China	Fiber	0.715	0.674
Yuma-2	South China	Fiber	0.718	0.448
Bama	South China	Fiber	0.839	0.59
Si-1	South China	Fiber	0.943	< 0.05
Han FN-Q	North China	Grain	0.054	< 0.05
Han NW	Central China	Grain	0.152	< 0.05
Carmagnola Selezionata	Italy	Grain	0.169	1.421
Eletta Campana	Italy	Grain	0.195	2.773
Han NE	Central China	Grain	0.527	< 0.05

Planting date trial

Methods

The planting date trial was planted in 2019 consistently across four dates spaced by approximately 3 weeks: May 1, May 22, June 21, and July 18. Trials were designed with consistent plot size, seeding rates, fertilizer rates, and management as per the variety trial methods described above. Eight hemp varieties were selected among available varieties to represent the span of growing purposes (fiber, grain/dual, and essential oil) and region of origin (North America, Europe, and Asia). Stand establishment and yield for fiber and grain producers were evaluated to assess performance of the hemp varieties across planting dates.

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Stand establishment

Stand establishment was determined by counting each individual plant within each plot and dividing that value by the number of live seeds planted into the plot. Stand establishment across the planting date trial was relatively low (Fig 2). This should not be an indication of seed quality as seeding rates were adjusted to live seed based on germination tests conducted prior to planting for each variety. Germination tests were generally greater than 80%. Stand establishment declined with later plantings across most varieties. The May 1 and May 22 plantings may represent an important seasonal shift for South Florida as the start of the hot rainy season tends to be mid-May. Heavy rain and flooding may have contributed to poor stand establishment in later plantings. Challenges to plant growth were also observed with plants established in later plantings.

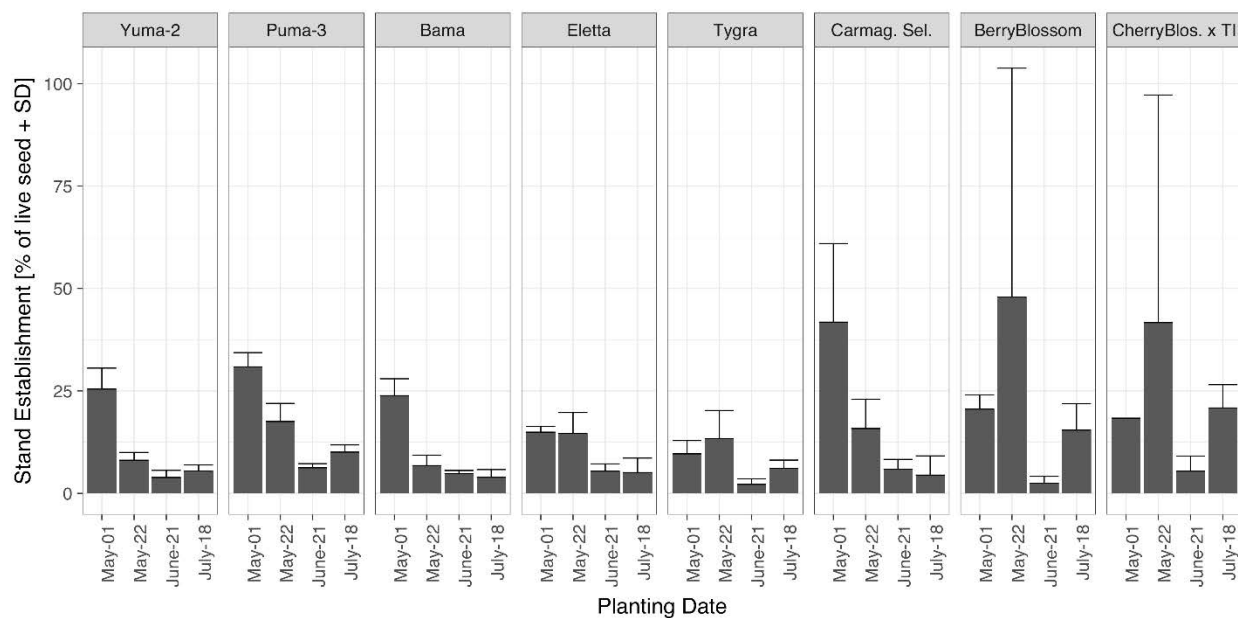


Figure 2. Stand establishment for varieties across planting date in 2019 at TREC as determined by percentage of live seed planted. Error bars represent one standard deviation of the mean.

Fiber and grain yield

Yield measurements were conducted on plants from the first planting of the planting date trial (May 1) and the variety trial (May 22) through August and September at the date each respective variety was ready for harvest. Harvest corresponded to approximately 90-120 days after planting. For fiber crops, stems were harvested at 50% flowering induction for the plot. For grain crops, seeds were harvested from plants that had at least 50% seeds hardened. For dual varieties, the age of plants when they flowered determined if they would be harvested for grain or fiber. Varieties that flowered in August or September developed no seed and were harvested as fiber, while varieties which flowered midsummer and developed seeds during the growing season were harvested as grain. The harvest was taken from a 10.76 ft² area defined as a 3 ft section of the 4 middle rows of the plot.

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Fiber yield is reported as dry straw which was the weight of dried stem tissue. To measure dry straw, plants were cut at ground level from the harvest zone and manually defoliated. Fresh stems were weighed, and then a sample was oven-dried at 158 °F for at least 48 hours. Dry weight was recorded for moisture content estimation and yield conversion. Target dry straw weight for commercial fiber production is about 8,000-10,000 lbs/ac. Multiple varieties met that production goal on average, including Bama, Puma-3, Puma-4, Si-1, and Yuma-2 (Fig 3). However, individual stem diameter may be larger than desirable by processing specifications.

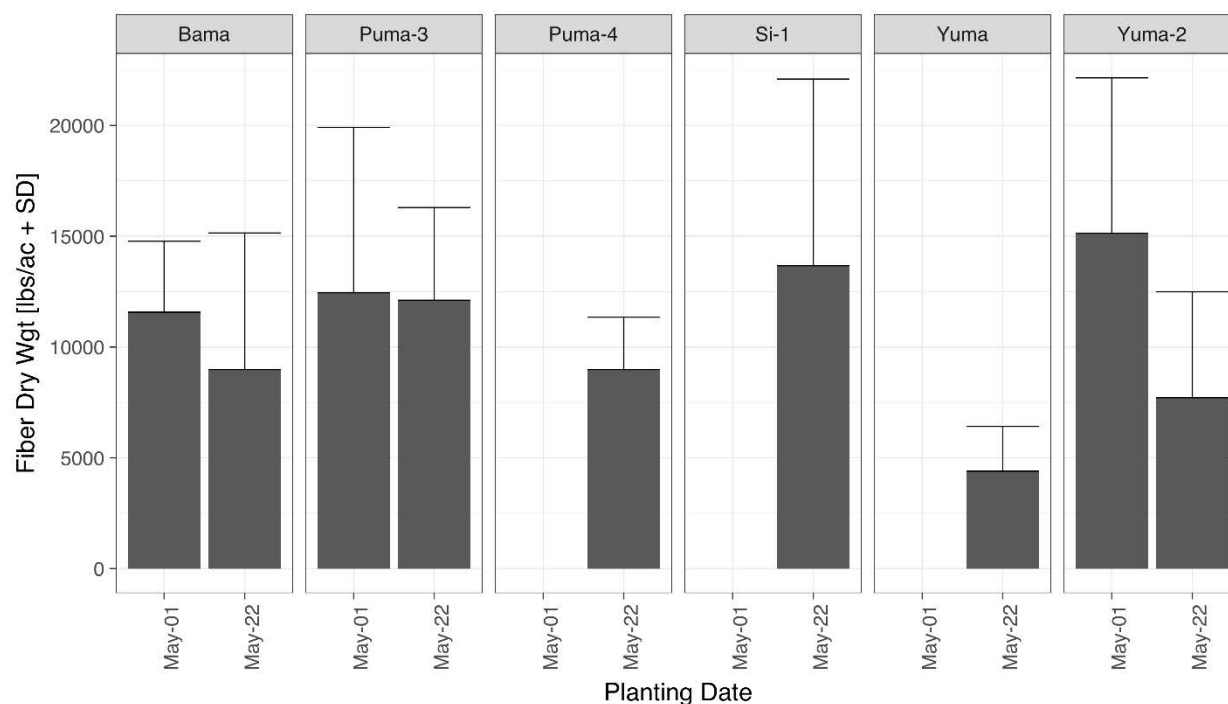


Figure 3. Harvested dry straw weight for varieties selected across planting date in 2019 at TREC as lbs/ac. Error bars represent one standard deviation of the mean.

Grain harvest is reported as total weight of dried seed from the harvested zone. Mature plants were collected and threshed using a small bundle thresher. Fresh grain was weighed and then oven-dried at 158 °F for at least 48 hours for moisture content estimation and yield conversion. Target dry seed weight for commercial grain production is about 800 lbs/ac. Several varieties met that production goal on average, including Carmagnola Selezionata, Eletta, Han NE and Han NW (Fig 4).

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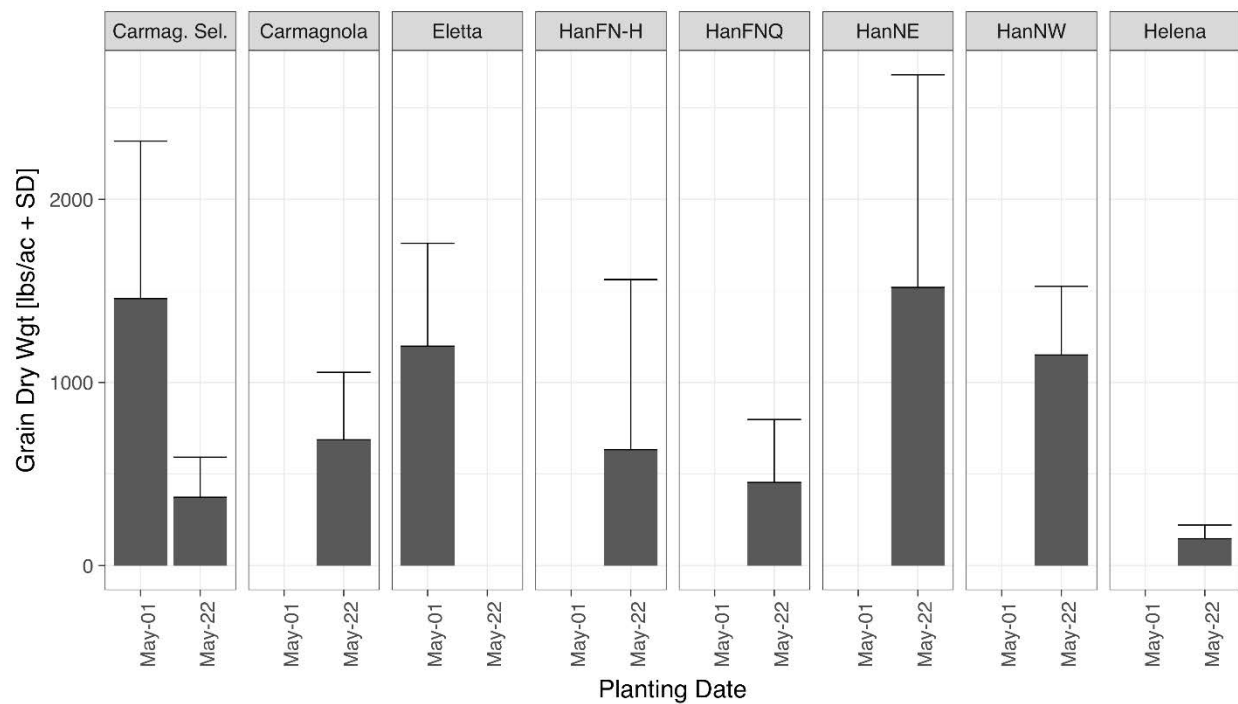


Figure 4. Harvested grain dry weight for varieties selected across planting date in 2019 at TREC as lbs/ac. Error bars represent one standard deviation of the mean.

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