UF|IFAS UNIVERSITY of FLORIDA

Preliminary Research Report

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Introduction

Industrial hemp (IH) is *Cannabis sativa* with less than 0.3 % tetrahydrocannabinol (THC) per dry weight. It is a potential new crop for the state of Florida so there are many unknowns regarding its production. The most basic agronomic questions including planting date, planting density, appropriate varieties, soil fertility, and harvest date must be determined to achieve successful production. Most IH varieties are sensitive to day length, when days are long the plant grows vegetatively and when days begin to shorten the plant enters a reproductive phase. There are a multitude of uses for IH which include: fiber, grain for human and animal consumption, and the production of essential oils. Research was conducted during the 2019 growing season at the UF/IFAS North Florida Research and Education Center (NFREC) in Quincy, Florida on IH varieties for essential oil production. These oils are extracted primarily from unpollinated female flowers and contain compounds of interest such as cannabidiol (CBD) and cannabigerol (CBG), all known as cannabinoids. IH is predominately a dioecious plant, meaning it typically has separate male and female plants, but monoecious plants (male and female flowers on the same plant) also exist. Female plants can be obtained by rooting vegetative cuttings from known female plants or by planting feminized seed. At harvest, female flowers are removed, dried and processed to extract the oils.

It should be noted that the research presented in this document was obtained from a single field season and from a limited number of IH varieties. There will certainly be variation between seasons, locations, and IH 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.***

Objective

To evaluate industrial hemp varieties and management practices to determine which may be suitable for production in northern Florida.

Methods

For all field experiments, feminized seeds were germinated and grown in a greenhouse with supplemental lighting using peat based potting media. Uniform seedlings were transplanted to the field at around 21 days after seeding. All experiments were produced utilizing raised beds and the plasticulture production system that is typical for many vegetable crops. Raised beds were 8 in tall and 30 in wide and were covered with white colored plastic to reduce the soil temperature. Irrigation was provided to the crop through drip tubing located under the plastic.

Variety trial

For any crop, the appropriate variety is a critical factor in achieving successful production. This article only presents flower yield and cannabinoid content which are just a few factors that should be considered in choosing an IH variety for essential oil production. There are also two planting dates presented here. In these experiments, day-length sensitive varieties showed the beginning of flowering around August 7th (day length ~13 h 27 m). This date may not represent a critical day length for all IH varieties.

Three day-length sensitive varieties, including Cherry Blossom (CBL), Cherry×T1 (CT1), and Cherry Wine (CW), were planted on July 3 and 25, 2019, while two day-length neutral (often referred to as auto flower) varieties, including Kayagene 9201 (KG9201) and Kayagene 9202 (KG9202) were planted on July 3 and September 11, 2019.

Spacing between beds was 6 ft and between plants was 5 ft. This row and plant spacing results in 1450 plants per acre.

Fertilizer (N-P_2O_5-K_2O: 10-10-10) was applied under the plastic prior to planting and soluble fertilizer was delivered though the irrigation system during the growing season. Total fertilizer application for the season was 150, 100, and 200 lb/acre for N, P_2O_5, and K_2O, respectively.

Plants were harvested at maturity, dried in a forced-air drier at 130 °F for 72 h, flowers were removed by hand and flower yield was recorded. Flowers were then ground into fine powder using a small coffee grinder for cannabinoid analysis. USDA allows a measurement of "uncertainty" (analytical error) in addition to the result. The analytical method used in our study has an uncertainty of 0.05%, therefore, the THC threshold of 0.35% was used in the following comparison. It should be noted that final rules for hemp production have not been set at the time this article was written.

Different lowercase letters indicate differences among varieties for each planting date.

Day-length sensitive varieties

Overall, the 1st planting date had greater flower yield relative to the 2nd planting date. Cannabinoid concentrations were not significantly different between the two planting dates.

Variety	Flower yield (lb/acre)	THC	CBD	CBG
		% dry weight		
Planting date July 3, 2019 – Harvest September 26				
CBL	2730 a	0.521 ab	9.589 a	0.197 ab
CT1	2424 b	0.582 a	10.254 a	0.260 a
CW	2352 b	0.474 b	8.927 a	0.189 b
Planting date July 25, 2019 – Harvest October 17				
CBL	1326 ab	0.502 ab	9.477 a	0.208 a
CT1	1467 a	0.607 a	10.923 a	0.246 a
CW	703 b	0.473 b	8.895 a	0.201 a

Day-length neutral varieties

The two day-length neutral varieties had significantly lower flower yield and cannabinoids compared to the day-sensitive varieties.

Unlike the day-length sensitive varieties, flower yield did not differ between the two planting dates of the day-length neutral varieties.

Variety	Flower yield (lb/acre)	THC	CBD	CBG
		% dry weight		
Planting date July 3, 2019 – Harvest August 22				
KG 9201	66 a	0.28 a	4.54 a	0.20 a
KG 9202	149 a	0.31 a	5.56 a	0.21 a
Planting date September 11, 2019 – Harvest November 6				
KG 9201	77 a	0.33 a	6.28 a	0.22 b
KG 9202	100 a	0.38 a	7.30 a	0.32 a

All day-length sensitive and day-length neutral varieties evaluated at NFREC in 2019 tested above the THC threshold at harvest except for KG 9201 on the July 3rd planting date.

Plant density study

Plant density or plant population is another critical factor that can have tremendous impact on crop yield per acre and therefore profitability. This article only presents flower yield and cannabinoid content which are just a few factors that should be considered in choosing an IH planting density.

Two of the day-length sensitive varieties, CT1 and CW, were evaluated using the same field setup as the variety trial, except for the plant densities. Four different plant densities were achieved (1210, 1613, 2420, and 4840 plants per acre) by using different in-row spacing (1.5, 3.0, 4.5, and 6.0 ft).

There was no interaction between IH variety and plant density, so the data were combined to demonstrate the impact of plant density. Different lowercase letters indicate differences among plant densities.

On a per plant basis flower yield gradually increased as the plant density decreased (less plants per acre led to more flower yield per plant). However, this trend was reversed when flower yield was considered on a per acre basis. Flower yield per acre increased as plant density increased (more plants per acre increased flower yield per acre). Cannabinoids did not significantly differ among plant densities. It should be noted that at harvest the average THC content of these two varieties was above 0.35% per dry weight. It should be noted that this study was carried out on one planting date. Because IH is sensitive to day length, any change to an earlier or later planting date may impact the results.

Plant density (plants/acre)	Flower yield (lb/plant)	Flower yield (lb/acre)	THC	CBD	CBG
			% dry weight		
4840	0.85 b	4288 a	0.56 a	11.82 a	0.24 a
2420	1.34 a	3256 b	0.54 a	11.78 a	0.22 a
1613	1.58 a	2452 c	0.58 a	11.99 a	0.23 a
1210	1.69 a	2056 c	0.58 a	11.96 a	0.22 a

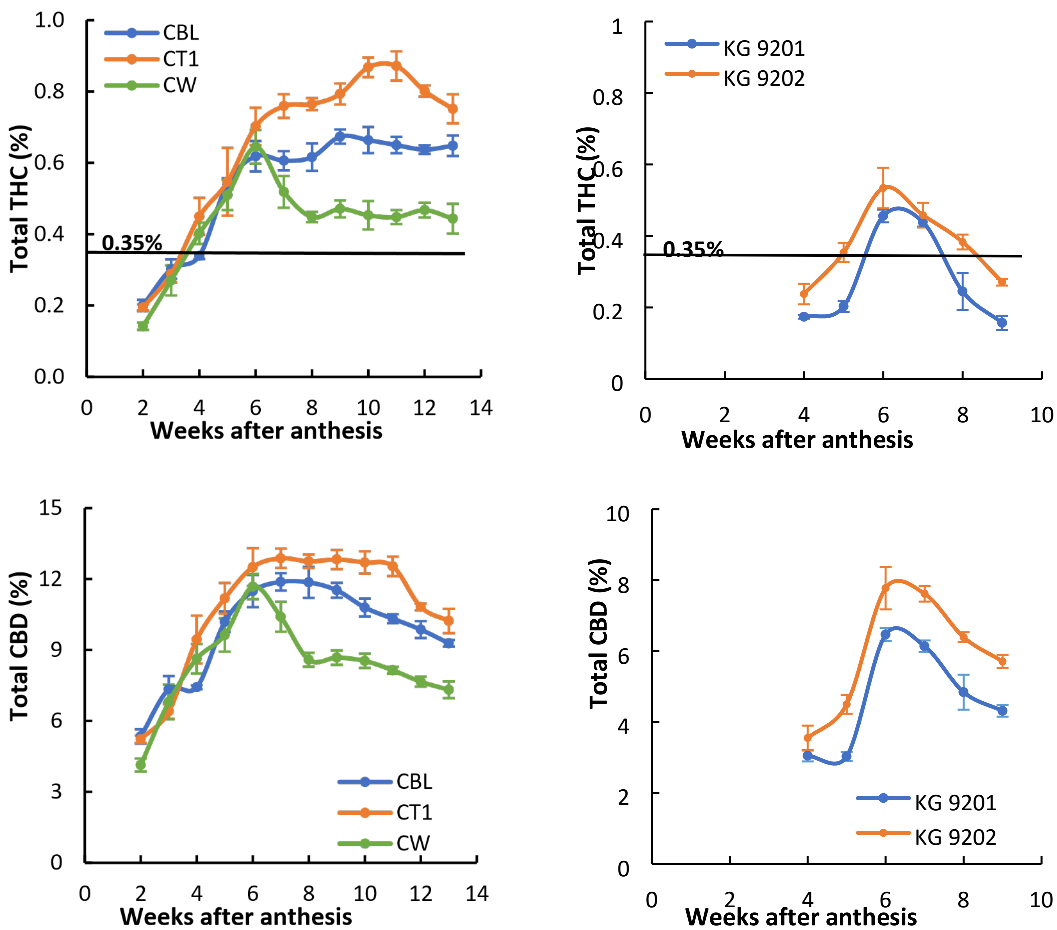
Cannabinoid development

One potential use and market for IH is the production of essential oils. These oils contain many compounds including several cannabinoids. A few of these are cannabidiol (CBD) and cannabigerol (CBG). For this market, the value of the crop is determined by the cannabinoid content in the flowers. Therefore, in order to maximize profit, it would be critical to harvest flowers when these compounds are at or near their maximum concentrations. Another critical factor to consider in these data is the THC concentration in female flowers. To be legally considered industrial hemp, the THC content must be below 0.3±0.05% per dry weight (dependent on final USDA and Florida Department of Agriculture and Consumer Services rules).

The same field setup as the variety trial was adopted for this study. Flower samples were taken from the top 1/3 of 5 uniform plants within a plot on a weekly basis from 2-4 weeks after anthesis (beginning of flowering) until full senescence of the plants. Flower samples were dried in an oven at 130 °F for 72 h and ground for cannabinoid analysis.

<u>Total THC</u>

A significant difference was observed between varieties. For CW, the THC content in flowers gradually increased, sharply dropped after reaching a peak, and remained relatively consistent as flowers continued to age. For the CBL and CT1, the THC content remained relatively consistent after reaching the peak. For all the three varieties, THC went above threshold at 4 weeks after anthesis and stayed above threshold for the rest of the season. For the two day-length neutral varieties, the change of THC content in flowers increased quickly and then dropped below the threshold at 8 weeks after anthesis.



<u>Total CBD</u>

The change in CBD concentration approximately synchronized with THC concentration. After CBD content reached the peak, the CT1 and CBL had a plateau stage of about 6 and 4 weeks, respectively, whereas the CBD content sharply dropped for CW and the two day-length neutral varieties.

A change in 2-3% in CBD content could make a significant difference in the profitability of IH so it is important for producers to track the CBD concentration during the season. These data also illustrate the potential of the varieties tested to rapidly go above the THC threshold and for the day-sensitive varieties, to remain above the threshold for the rest of the season. Based on proposed regulations, this scenario could render the crop unmarketable. It is unclear if this trend will be repeatable in other seasons but certainly THC concentration should be closely monitored in an IH crop to avoid undesirable outcomes for the crop. It should be noted that the CBD/THC curve data presented here is based only on flower samples with no leaf and stem included. The final rules for sampling may require the top 8” of flower or the top 1/3rd of a plant which would include some stem and leaf. This could marginally reduce the CBD and THC content compared to what is presented here.