NORTHWEST CROPS & SOILS PROGRAM

2018 Hemp Cannabidiol Drying Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2018 HEMP CANNABIDIOL DRYING TRIAL

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Hemp is a non-psychoactive variety of *cannabis sativa L.* Hemp is a crop of historical importance in the U.S. and is re-emerging as a popular crop, as it is sought out as a renewable and sustainable resource for a wide variety of consumer and industrial products. Hemp that is grown for fiber, grain, or as an intended health supplement contains less than 0.3% tetrahydrocannabinol (THC). When hemp is grown to produce cannabidiol (CBD) as an intended health supplement, CBD concentrations are relatively high, ranging from 8 to 15%. The hemp flowers are cultivated for maximum growth, as they contain the highest concentrations of CBD. The CBD can also be extracted from other parts of the plant and from plants grown as a row crop for seed or fiber. There is very little research-based information available to growers that are interested in producing high yield and quality hemp for CBD production. In 2018, the Northwest Crops and Soils (NWCS) Program conducted a trial to determine the impact of drying temperature on CBD concentration of hemp flowers.

MATERIALS AND METHODS

Female plants grown from clonal propagation of the CBD hemp variety, Boax, were planted on 27-Jun at Borderview Research Farm in Alburgh, VT. The plots were fertilized with 100 lbs N ac^{-1}, 70 lbs P ac^{-1}, and 70 lbs K ac^{-1} (Table 1). An additional 50 lbs N ac^{-1} was applied on 20-Jul. Plants were grown as part of the Northwest Crop and Soils Program's cannabidiol hemp planting date x spacing trial. All plant biomass used in the drying trial were from one planting date and contained an equal amount of biomass from 3' x 3' and 5' x 5' spacings. The plants were harvested by hand on 16-Oct using a small chainsaw. Then the plants were broken down into smaller branched sections and larger "fan" leaves were removed. Flower buds were removed by hand using an EZTrim Debudder (Broomfield, CO).

Table 1. Agronomic information for the hemp used in this CBD hemp drying trial, 2018, Alburgh, VT.

Location	Borderview Research Farm, Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Silage corn
Plant spacing (feet)	3 x 3, 5 x 5
Field planting date	27-Jun
Fertilization	150 lbs N ac^{-1}, 70 lbs P ac^{-1}, 70 lbs K ac^{-1}
Harvest date	16-Oct

The drying trial was conducted first with hemp flower buds alone, then with buds attached to small stems. On 17-Oct, Boax hemp buds were debudded, weighed, and placed in two dryers, one with an 80°F temperature treatment and one with a 105°F treatment. The three middle shelves of each dryer were filled with hemp buds where each shelf was a replicate. Two dryer shelves were placed on sawhorses in the same building as the dryers and were filled with the hemp buds to air dry, as the ambient temperature treatment. A fan was kept on the ambient treatment. Temperature and humidity recording i-buttons (Embedded Data Systems, LLC, Lawrenceburg, KY) were installed in the trays designated as replicates

on 17-Oct at 4:30pm EST. Temperature and humidity measurements were recorded every hour. Driers remained on until the buds were considered entirely dry for storage. The 80°F dryer was turned off at 1:30pm EST and the 105°F dryer was turned off at 5:15pm EST on 18-Oct. The i-buttons were removed from the ambient temperature shelves on 22-Oct at 10:30am EST when the buds were dry. On 19-Oct, six drier trays were filled with 3.4 lbs of whole stems of the Boax plants with intact buds. There were two temperature treatments (80°F, 105°F) and three replicates. Dryers were turned on at 2:10pm EST on 19-Oct. The i-buttons remained in the dryers and each i-button represented a replicate. The 105°F treatment dryer was turned off on 20-Oct at 5pm, and the 80°F dryer was turned off on 21-Oct at 3pm.

Subsamples of buds from each replicate were sent to the Nutraceutical Science Laboratories (Waterbury, VT) on 10-22 for analysis in order to determine the total potential cannabidiol. Analysis was performed by supercritical fluid chromatography, which does not heat the sample. Total potential cannabidiol is the maximum amount of CBD that can be contained in a sample, and takes into account both cannabidiol concentrations at the time of analysis and cannabidiolic acid (CBDA) concentrations. Cannabidiolic acid is converted to CBD during decarboxylation (the removal of a carboxyl group). Decarboxylation occurs when the hemp is exposed to heat, such as through combustion, or sunlight.

Data were analyzed using a general linear model procedure of SAS (SAS Institute, 1999). Replications were treated as random effects, and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure where the F-test was considered significant, at $p<0.10$. Variations in genetics, soil, weather, and other growing conditions can result in variations in yield and quality. Statistical analysis makes it possible to determine whether a difference between treatments is significant or whether it is due to natural variations in the plant or field. At the bottom of each table, a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. This means that when the difference between two treatments within a column is equal to or greater to the LSD value for the column, there is a real difference between the treatments 90% of the time. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk.

In the example to the right, treatment C was significantly different from treatment A, but not from treatment B. The difference between C and B is 1.5, which is less than the LSD value of 2.0 and so these treatments were not significantly different. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these treatments were significantly different from one another. Treatments that were not significantly different in a particular column are indicated by sharing the same letter. In the example to the right, treatment C is significantly different from treatment A but not from treatment B. Top performers are displayed in bold.

Treatment	Yield
A	6.0[b]
B	7.5[ab]
C	**9.0[a]**
LSD	2.0

RESULTS

Weather data were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 2). July through August were hotter and drier than normal, though a more expected amount of precipitation fell at the end of the season. There were 2379 base 50°F Growing Degree Days (GDDs), which was 366 more than the 30-year

normal. July through September were an average of 3.41º F warmer and received only 60% of normal precipitation. There was no irrigation or watering.

Table 2. Seasonal weather data collected in Alburgh, VT for July-October 2018.

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	64.4	74.1	72.8	63.4	45.8
Departure from normal	-1.38	3.51	3.96	2.76	-2.36
Precipitation (inches)	3.70	2.40	3.00	3.50	3.50
Departure from normal	0.0500	-1.72	-0.950	-0.160	-0.0700
Growing Degree Days (base 50°F)	447	728	696	427	81
Departure from normal	-27	88	115	109	81

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

At harvest, the moisture of the flower buds was statistically similar (Table 3). The average actual temperature and relative humidity for each treatment indicated that the 105°F treatment dryer with buds did not reach 105°F. It is unclear why the drier was unable to maintain a constant temperature over the drying period. The drier had an average temperature that was only 7 degrees higher than the drying treatment 80°F. When drying the bud & stems, the 105°F dryer did not reach its average temperature until after 7 hours, and fluctuated the most in temperature in the first 3 hours as it warmed up, though after the first 7 hours it remained more consistent in temperature. The 80°F dryer did not have this problem and temperatures neared 80°F right away.

Table 3. Actual dryer temperatures, relative humidities, and final biomass moisture, 2018.

Treatment	Average actual temperature	Average relative humidity	Harvest moisture
	°F	%	%
80°F buds-only	79.3	74.7	71.2
105°F buds-only	86.4	34.6	69.1
Ambient buds-only	59.0	60.8	NA
80°F bud & stem	81.5	33.3	68.1
105°F bud & stem	104	14.0	66.0

NA, not applicable.

Hourly temperatures and relative humidities for the buds-only experiment are displayed in Figure 1. The bud & stem experiment average dryer temperatures were approximate to the desired temperatures, and hourly temperatures and humidities are displayed in Figure 2.

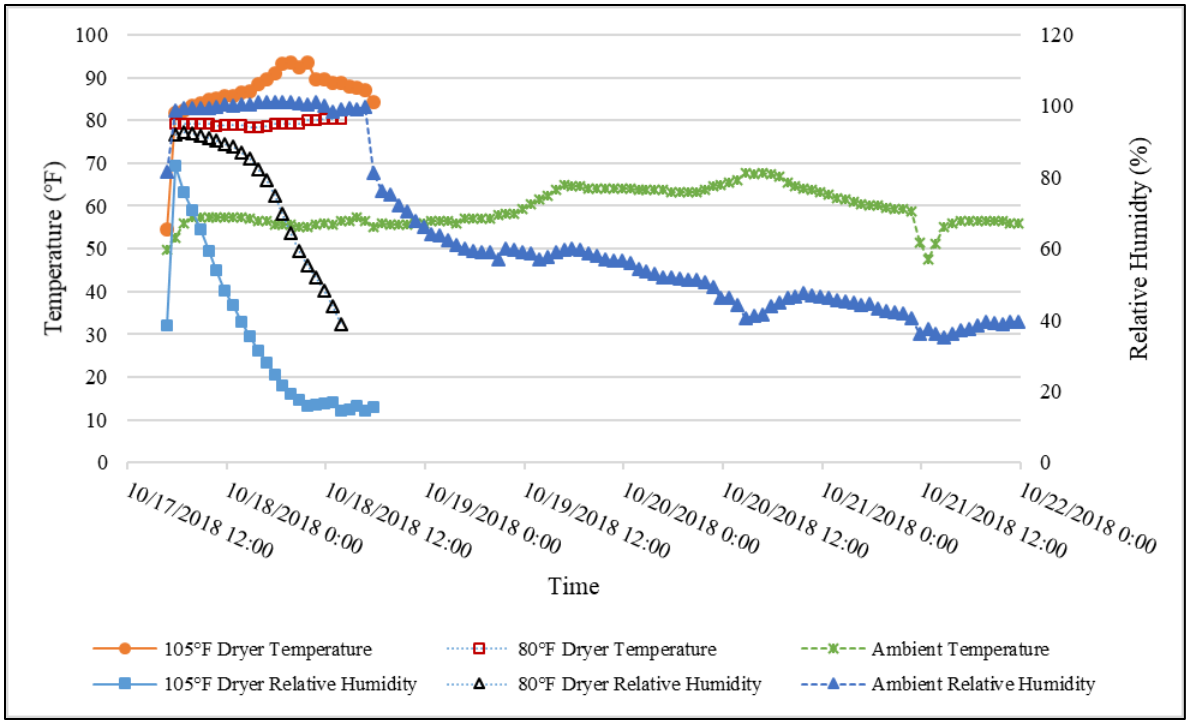

Figure 1. Buds-only hourly temperatures and relative humidities by treatment, Alburgh, VT, 2018.

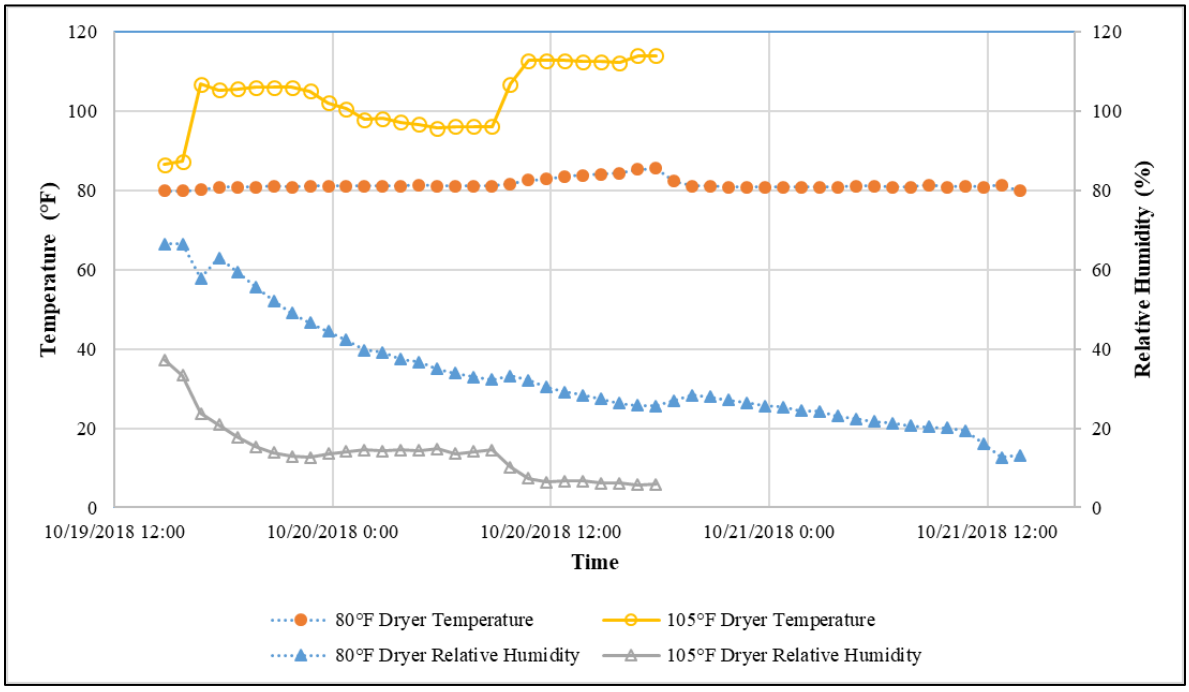

Figure 2. Buds & stem hourly temperatures and relative humidities by treatment, Alburgh, VT, 2018.

In the buds only study, drying the buds at ambient temperature resulted in significantly higher total potential CBD (7.71%) than drying the buds at 105°F (5.88%) (Table 4). The total potential CBD of buds dried at 80°F did not significantly differ from the higher and lower temperature treatments, and resulted in

a CBD percentage between the two extremes (7.01%). When drying bud & stem materials there was no significant difference between the CBD concentrations of the 105°F and 80°F treatments. This study should be repeated because of the aforementioned issues with the driers maintaining constant temperatures.

Table 4. Total potential cannabidiol by temperature treatment, 2018.

Treatment	Buds-only total potential CBD	Bud & stem total potential CBD	Trial total potential CBD
	%	%	%
80°F	7.01[ab]	**7.51**	**7.26[a]**
105°F	5.88[b]	6.89	6.39[b]
Ambient temperature	**7.71[a]**	NA	NA
LSD (0.10)	1.29	NS	0.75
Trial Mean	6.87	7.21	6.83

Treatments within a column with the same letter are statistically similar.
LSD, Least significant difference.
NS, No significant difference between treatments. NA, Not applicable.

DISCUSSION

While the use of higher temperatures results in faster drying rates, producers should consider the potential impact of drying temperature on the quality of their product. In this trial, drying at a higher temperature (above 80°F) resulted in significantly lower total potential CBD concentrations. It is important to remember this is only one year of data with limited replicates and drying capacity. The whole stems were dried at approximately the target temperature, but the buds were dried at lower temperatures than planned due to technical difficulties with the driers. However, a comparison between treatments can still be made as there was still higher and lower temperature treatments, though less of a difference in temperature than intended. Further research is needed, and this trial should be replicated with dryers that are more accurate.

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