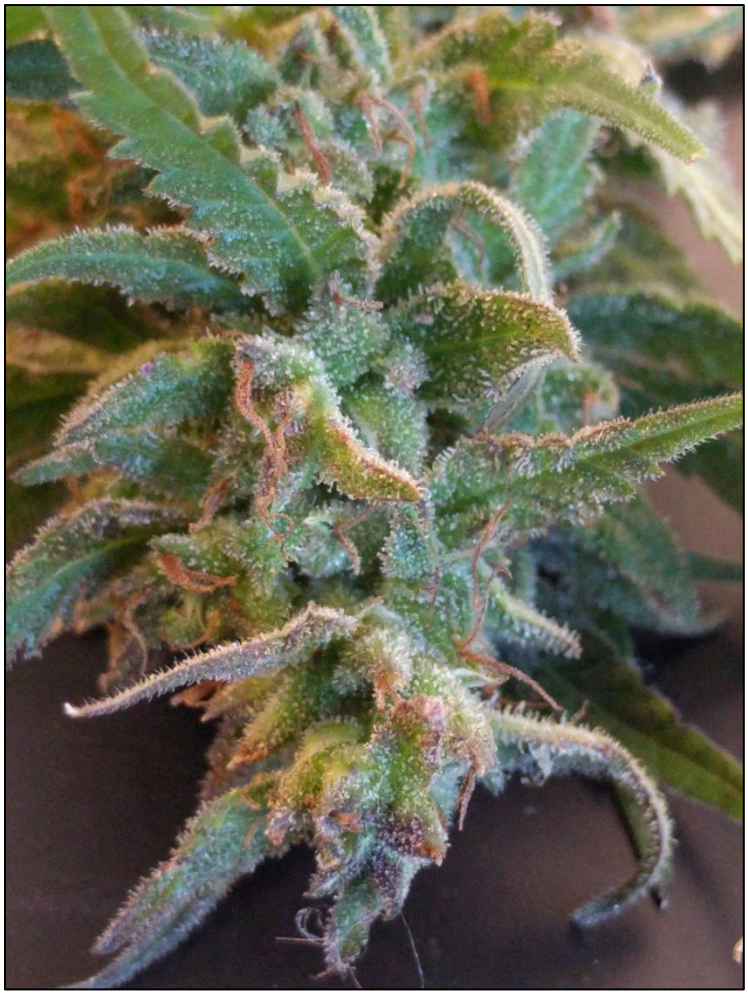
NORTHWEST CROPS & SOILS PROGRAM

2018 Cannabidiol Cold Tolerance Trial



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THE UNIVERSITY OF VERMONT EXTENSION

2018 CANNABIDIOL COLD TOLERANCE 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 re-emerging worldwide 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 oil, 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, with concentrations ranging between 8-15%. As demand for hemp across the country increases, industrial hemp may be a new cash crop and market for Vermont farms, as hemp can be worked into rotation with other grasses like cereal grains or grown as a specialty crop. Hemp for CBD production is grown more intensively, similar to vegetable production, and can be grown indoors or in the field. Hemp is cultivated in many diverse climates worldwide and is fairly cold tolerant, though there is a lack of agronomic research specific to the effect of cold temperature on CBD found in industrial hemp plants. In 2018, the Northwest Crops and Soils (NWCS) Program conducted a trial to determine the effects of cold temperature on total potential CBD and the ability for fabric row cover to protect the plant during cold temperatures.

MATERIALS AND METHODS

Female hemp plants grown from clonal propagation of the industrial hemp variety Boax were planted on 27-Jun on Borderview Research Farm in Alburgh, VT. On 27-Jun, the plots were fertilized with 100 lbs N ac^{-1}, 70 lbs P ac^{-1}, 70 lbs K ac^{-1}, using Kreher's poultry manure (5-4-3) and Pro-Gro (5-3-4). An additional 50 lbs N ac^{-1} was applied on 20-Jul in the form of sodium nitrate (16-0-0). Treatments consisted of industrial hemp plants covered with fabric row cover or not covered. Plots consisted of 3 plants spaced 5' x 5'. The fabric row cover was applied on 17-Oct. The row cover used was Agribon+ AG-15 118"-wide insect barrier (Johnny's Selected Seeds, Winslow, Maine). Agronomic information pertaining to the growing season is shown in Table 1.

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

Location	Borderview Research Farm, Alburgh, VT
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Silage corn
Variety	Boax
Plant spacing (feet)	5 x 5
Plot size (feet)	15 x 20
Field planting date	27-Jun
Fertilization N-P-K (lbs ac^{-1})	150-70-70
Cold tolerance trial replicates	3

Two i-buttons (Embedded Data Systems, LLC, Lawrenceburg, KY) per plot, with one in each treatment, were installed on 17-Oct at 3:50pm EST, in order to monitor the temperature at the base of the plants. The

i-buttons recorded temperatures once per hour until 24-Oct at 3pm EST. Approximately 3-4 flower bud clippings from each plant were randomly sampled on 18-Oct, 19-Oct, 21-Oct, 22-Oct, and 24-Oct. Samples from each plant were then combined by plot to yield one combined sample per replicate for each treatment. Samples were sent to the Nutraceutical Science Laboratories (Waterbury, VT) for analysis in order to determine the total potential cannabidiol (CBD). 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. 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	7.5*
C	**9.0**
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 and 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. No additional water was added to the hemp plants.

Table 2. Seasonal weather data collected in Alburgh, VT for June-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	0.05	-1.72	-0.95	-0.16	-0.07
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.

The average hourly temperatures recorded by the i-buttons at the base of the plants are displayed in Figure 1 by treatment. The maximum temperature recorded in the monitoring period was 64.1°F, and the minimum temperature was 27.8°F. Both the maximum and minimum average temperatures recorded were in the uncovered treatment.

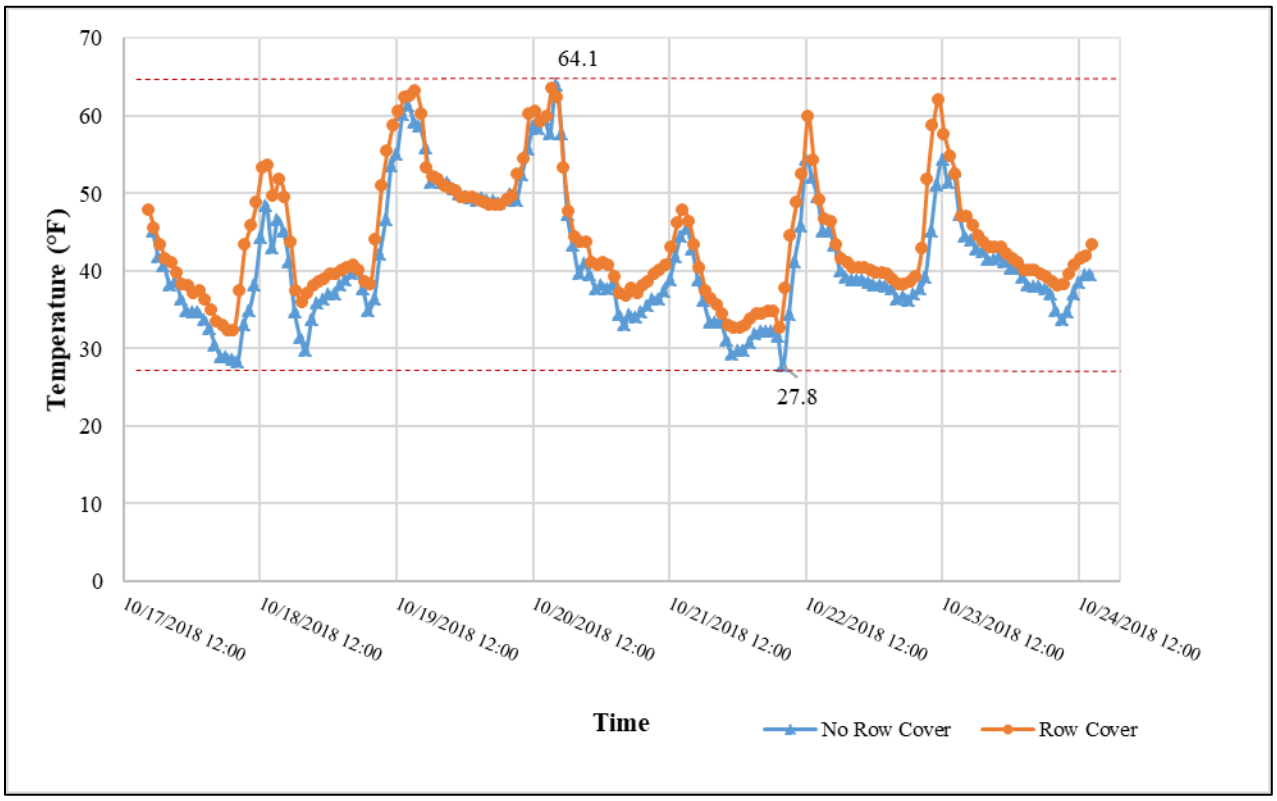

Figure 1. Average hourly temperatures at the base of the plants in row covered plots and uncovered plots.

Total potential CBD concentrations (Table 3) were only significantly different between treatments on the 21-Oct sampling date, where the row cover treatment had significantly higher total potential CBD (9.97%) than the uncovered plants (6.97%). On all other sampling dates, and the average of sampling

dates, total potential CBD concentrations were higher in the uncovered plants, but there were no statistically significant differences between the treatments. The average temperatures at the base of the plant by treatment are also displayed on Table 3. The average temperature at the base of plants with row cover (42.3°F) was significantly higher than the average temperature of those without row cover (39.4°F)

Table 3. Total potential cannabidiol by treatment and average temperature, Alburgh, 2018.

	Total Potential Cannabidiol (%)							Temperature (°F)
Date	18-Oct	19-Oct	21-Oct	22-Oct	24-Oct	26-Oct	Average	Trial average
Row cover	9.36	7.55	**8.97**	11.0	10.3	7.28	9.06	**42.3**
No row cover	**9.72**	**9.13**	6.97	**11.3**	**10.5**	**8.88**	**9.41**	39.4
LSD (0.10)	NS	NS	1.46	NS	NS	NS	NS	1.94
Trial Mean	9.54	8.34	7.97	11.1	10.4	8.08	9.23	40.9

LSD – Least significant difference.

NS – No significant difference in severity between treatments.

DISCUSSION

The results suggest that the presence of row cover on the industrial hemp plants had little impact on total potential CBD concentrations. While the presence of row cover resulted in significantly different average temperatures, and reached less temperature extremes than the uncovered plants, the difference in temperature did not appear to correlate to total potential CBD. In treatments without row cover, the hemp experienced temperatures below freezing were experienced several times throughout the week-long study. These freezing temperatures did not appear to impact the overall CBD concentration of the plant.

ACKNOWLEDGEMENTS

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