2020

Industrial Hemp Fertility Trial

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NORTHWEST CROPS & SOILS PROGRAM

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THE UNIVERSITY OF VERMONT EXTENSION

2020 INDUSTRIAL HEMP FERTILITY TRIAL

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Hemp is a non-psychoactive variety of *cannabis sativa L*. The crop is one of historical importance in the U.S. and reemerging in worldwide importance as manufacturers seek hemp as a renewable and sustainable resource for a wide variety of consumer and industrial products. The crop produces a valuable oilseed and oilseed meal. The fiber has high tensile strength and can be used to create cloth, rope, building materials, and even a form of plastic. Today, industrial hemp is re-emerging as a locally grown product in the U.S. To help farmers succeed, agronomic research on hemp is needed, as much of the historical production knowledge for the region has been lost. Specifically, there is a lack of nitrogen (N) response information for New England, which is important for establishing nutrient recommendations in the region. In this trial, the impact of five nitrogen rates on industrial hemp grain yield and quality was evaluated.

MATERIALS AND METHODS

The trial was initiated at Borderview Research Farm in Alburgh, Vermont (Table 1) to evaluate the impact of nitrogen fertility rates on hemp grain yield. The experimental design was a randomized complete block with four replications. In April, fertilizer was applied to the tract of land where the trial was later initiated including 1000 lbs of Kreher's 8-2-2 (Kreher Family Farms), 1000 lbs of Probooster (10-0-0, North Country Organics), and 100 lbs of 0-0-52. The ground was prepared for planting with a disk & spike tooth harrow. Industrial hemp seed of the variety 'Anka' (Uniseeds, Cobden, Ontario, 110 days to maturity) was planted into 5 x 20' plots at a rate of 25 lbs ac^{-1} with a Kverneland seed drill on 26-Jun. There were 5' buffers and the soil type was Benson rocky silt loam with 8-15% slopes.

Table 1. Agronomic information for the industrial hemp grain variety trial 2020, Alburgh, VT.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam, 8-15% slopes
Previous crop	Corn
Variety	Anka
Plot size (ft)	5 x 20
Planting date	26-Jun
Row spacing	7"
Replicates	4
Planting equipment	Kverneland seed drill
Seeding rate (lbs ac^{-1})	25
Harvest date	8-Sep

Treatments included five N application rates (50, 75, 100, 125, and 150 lbs N ac^{-1}) and an untreated control. Heights and populations were measured on 2-Sep by measuring three heights of stems and by counting plant populations in three 1-foot sections of rows within each plot. On 28-Jul, N treatments were applied in the form of urea (46-0-0). On 8-Sep, the plots were harvested for grain with an Almaco

(Nevada, IA) SPC50 small plot combine. Harvest moisture was calculated by using an OHaus (Parsippany, New Jersey) MB 23 moisture analyzer, and by weighing seed before and after drying. After the grain harvest, 5 stems per plot were harvested and decorticated on 20-Sep to determine the percent of bast and hurd fractions. Oil was extruded from the seeds with an AgOil M70 oil press (Mondovi, WI) on 14-Jan 2021, and the amount of oil captured was measured to determine oil content.

Data were analyzed using a general linear model procedure of SAS (SAS Institute, 2008). 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. 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 in yield. 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. Treatment B was not significantly lower than the top yielding treatment, indicated in bold. A lack of significant difference is indicated by shared letters.

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 3). The 2020 field season saw increased Growing Degree Days (GDDs), especially in July, which had had 751 GDDs, 121 greater than the 30-year average.

Table 2. Temperature and precipitation summary for Alburgh, VT, 2020.

Alburgh, VT	June	July	August	September
Average temperature (°F)	66.9	74.8	68.8	59.2
Departure from normal	1.08	4.17	0.01	-1.33
Precipitation (inches)	1.86	3.94	6.77	2.75
Departure from normal	-1.77	-0.28	2.86	-0.91
Growing Degree Days (50°F-86°F)	516	751	584	336
Departure from normal	35	121	2	-24

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 summer had another record-setting July of high heat, with an average temperature of 74.8° F, 4.17° F above the normal. Temperatures were above average June-August, and precipitation was below average in June and July. Overall, 2187 GDDs accumulated June through August, 134 above the norm. There were 15.32 inches of precipitation during the growing season, 0.1 inches below the norm.

The 75 lbs N ac^{-1} treatment was the top performer, yielding 1779 lbs ac^{-1} at 10% moisture, which was significantly higher than the yields of the control and the 100 lbs N ac^{-1} treatment (Table 3). The 50, 125, and 150 lbs N ac^{-1} treatments had yields that were statistically similar to the 75 lbs N ac^{-1} treatment. There were no significant differences between treatments for harvest moisture, average plant height, populations, percent bast and hurd fibers, or stem dry matter content. Grain hemp is generally harvested at a moisture of 10-20% and the average from the trial was 18.5%. The stalks were 33.6% bast fiber on average, and 66.4% hurd fiber on average. Bast fiber grows on the outside of the stalk and provides most of the tensile strength of the plant, while the hurd fibers consist of the woody, inner component.

Table 3. The impact of nitrogen fertility rates on grain hemp yields, Alburgh, VT, 2020.

Treatment	Dry matter yield	Yield @ 10% moisture	Seed moisture at harvest	Height	Population	Bast	Hurd	Stem dry matter
lbs N ac^{-1}	**lbs ac^{-1}**	**lbs ac^{-1}**	**%**	**cm**	**plants ac^{-1}**	**%**	**%**	**%**
0	1077[bf]	1196[b]	19.5	155	441823	30.9	69.1	28.3
50	1574[a]	1749[a]	17.3	157	354703	33.2	66.8	27.1
75	**1601[a]**	**1779[a]**	17.0	168	423154	33.7	66.3	25.4
100	1175[b]	1305[b]	18.5	155	423154	36.9	63.1	26.0
125	1388[ab]	1542[ab]	19.9	163	354703	34.1	65.9	26.2
150	1520[a]	1688[a]	18.5	158	454269	32.9	67.1	26.0
LSD (0.10)	317	352	NS[ł]	NS	NS	NS	NS	NS
Trial mean	1389	1543	18.5	159	408634	33.6	66.4	26.5

[ł] Treatments within a column with the same letter are statistically similar. Top performers are in **bold.**
[ł]NS; There was no statistical difference between treatments in a particular column (p=0.10).

Oil yields from pressing the seed are displayed below in Table 4. On average, the grain was 17.1% oil and yielded 263 lbs ac^{-1} or 34.4 lbs gal ac^{-1}. Oil content did not differ statistically by treatment.

Table 4. Oil yields of hemp grain by nitrogen fertility rate, Alburgh, VT, 2020.

Treatment	Oil Content		
lbs N ac^{-1}	%	**lbs ac^{-1}**	**gal ac^{-1}**
0	18.3	216	28.3
50	17.7	310	40.6
75	12.6	240	31.4
100	17.7	220	28.8
125	20.0	302	39.5
150	16.8	290	38.0
LSD (0.10)	NS[ł]	NS	NS
Trial mean	17.1	263	34.4

[ł]NS; There was no statistical difference between treatments in a particular column (p=0.10).

DISCUSSION

All of the nitrogen treatments resulted in higher yields than the untreated control, but yields did not increase consistently with increasing nitrogen rate. Replications were also significantly different from each other this year due to field variability. It is important to remember that these data represent only one year of research. Further research is needed to establish sound agronomic recommendations for the region.

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils Program would like to give a special thanks to Roger Rainville and the staff at Borderview Research Farm for their generous help with the trials. We would like to acknowledge Catherine Davidson, Hillary Emick, Lindsey Ruhl, and Sara Ziegler for their assistance with data collection, and data entry. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

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