Industrial Hemp Weed Control Trial

NORTHWEST CROPS & SOILS PROGRAM

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2016 INDUSTRIAL HEMP WEED CONTROL 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 re-emerging 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, rich in Omega-3 and other essential fatty acids that are often absent in western diets. When the oil is extracted from the seed, what remains is a marketable meal co-product, which is used for human and animal consumption. The fiber has high tensile strength and can be used to create cloth, rope, building materials, and even a form of plastic. For twenty years U.S. entrepreneurs have been importing hemp from China, Eastern Europe, and Canada to manufacture travel gear, apparel and accessories, body care and cosmetics, foods like bread, beer, and salad oils, paper products, building materials and animal bedding, textiles, auto parts, housewares, and sporting equipment. Industrial hemp is poised to be a "new" cash crop and market opportunity for Vermont farms that is nutritious, versatile, and suitable for rotation with other small grains and grasses. To help farmers succeed, agronomic research on hemp is needed, as much of the production knowledge on this crop has been lost. In this trial, we investigated the impact of row spacing on yield and weed pressure.

MATERIALS AND METHODS

A trial was conducted at Borderview Research Farm in Alburgh, Vermont to evaluate the effectiveness of row spacing on weed control and yield in industrial hemp (Table 1). The experimental design was a randomized complete block with four replications. Treatments consisted of three types of row spacing: STANDARD at 7.0" between rows, WIDE at 9.0" between rows, and BANDED with a 5.0" seed spread in a row and 6.0" between rows (Figure 1). A dual purpose (can be grown for grain and fiber) industrial hemp variety, 'Anka' (Valley Bio Limited, Ontario, Canada), was planted into 10' x 50' plots on 24-May.

Figure 1. Banded sowing of industrial hemp, Alburgh, VT, 2016.

The WIDE row treatment was planted with a Kverneland grain drill (Figure 2). The STANDARD treatment was planted with a Sunflower 9412 no-till grain drill (Figure 3). The BANDED treatment was planted with a custom built seeder that was made from a 12 row International row crop cultivator, and converted to an air seeder using a Gandy and a 6212 air box. Parallel linkage units were mounted 12" apart and mounted with precision Dutch openers that created 5" banded seed rows and 6" between rows (Figure 2). The WIDE and BAND treatments were cultivated with a Schmotzer hoe on the 16-Jun. The Schmotzer hoe, imported from Germany, is a manually-guided, rear-mounted implement that can be used to cultivate in-between wide rows of hemp (Figure 3). This allows weed control to take place later in the growing season, after plants are well established.

Figure 2. Kverneland grain drill (left), Gandy air seeder (right), Alburgh, VT.

Figure 3. Sunflower grain drill (left), Schmotzer hoe (right), Alburgh, VT.

Weed cover was assessed on 20-Jun as a percent of total plant cover using the web based IMAGING crop response analyzer. Digital images were taken with a compact digital camera, Canon PowerShot G12 (Melville, NY) (10.4 Megapixels). One picture covering approximately 0.25 m^2 was taken in each plot before weeding and one picture was taken after weeding. Digital images were analyzed with the automated imaging software, which was programmed in MATLAB (MathWorks, Inc., Natick, MA) and later converted into a free web-based software (www.imaging-crops.dk). The outcome of the analysis is a leaf cover index, which is the proportion of pixels in the images determined to be green. Total plant cover (1st picture) – hemp cover (second picture) / total plant cover = weed cover (%).

On 1-Jul the trial was fertilized with 500 lbs ac^{-1} Pro-gro (5-3-4; North Country Organics, Brandon, VT), 500 lbs ac^{-1} Pro-booster (10-0-0; North Country Organics, Brandon, VT), and 50 lbs ac^{-1} sodium nitrate (16-0-0). These products were all approved for use in certified organic systems.

Table 1. Agronomic information for industrial hemp weed control trial 2016, Alburgh, VT.

Location	**Borderview Research Farm, Alburgh, VT**
Soil type	Covington silty clay loam, 0-3% slope
Previous crop	Winter barley and heirloom winter wheat
Replications	4
Plot size (ft)	10 x 50
Industrial hemp variety	Anka, dual purpose variety
Planting date	24-May
Emergence date	29-May
Row spacing	STANDARD: 7.0” WIDE: 9.0” BAND: 5.0” seed spread, 6.0” between rows
Planting equipment	STANDARD : Sunflower seeder WIDE: Kverneland seeder BAND: Custom made air seeder, mounted with precision Dutch openers
Planting rate (lbs ac^{-1})	25
Harvest date	13-Sep

On 9-Sep, plant heights were measured by randomly taking the height of 3 plants per plot. On 13-Sep, the hemp was harvested using an Almaco SPC50 small plot combine, after adjusting the head height, reel height, and concave, plots were harvested. Percent moisture was calculated by taking a 100g subsample of harvested seed and drying it at 105^{o} F till it reached a stable weight. Test weight was measured using a Berckes Test Weight Scale, which weighs a known volume of grain.

Shortly after harvest, populations were measured by counting the number of plants in a 0.25 ft^2 quadrant, twice per plot.

Data were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and soil amendment treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Treatment	Yield
A	6.0
B	7.5*
C	**9.0***
LSD	2.0

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the 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, except where analyzed by pairwise comparison (t-test). Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two treatments. Treatments that were not significantly lower in performance than the top-performing treatment in a particular column are indicated with an asterisk. In this example, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did not differ 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 hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

RESULTS AND DISCUSSION

Weather Summary

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT. The growing season was dryer than normal with May-September receiving 7.27 fewer inches of precipitation as compared to historical averages (Table 2). Temperatures in June-July were comparable to normal averages, while May and August-September were at least 1.8 degrees warmer than normal, per month. Overall, there were an accumulated 2562 Growing Degree Days (GDDs) at base 50° F this season, approximately 268 more than the historical average. Hemp seed has been shown to produce well with 1460 GDDs at base 50° F in Saskatchewan, Canada.

Table 2. Seasonal weather data collected in Alburgh, VT, 2016.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	58.1	65.8	70.7	71.6	63.4
Departure from normal	1.80	0.00	0.10	2.90	2.90
Precipitation (inches)	1.5	2.8	1.8	3.0	2.5
Departure from normal	-1.92	-0.88	-2.37	-0.93	-1.17
Growing Degree Days (base 41°F)	543	745	919	942	681
Departure from normal	68	1	1	82	95

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Alburgh precipitation data from August-October was provided by the NOAA data for Highgate, VT.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Yield, Weed Pressure, and Quality

Table 3. Plot characteristics and harvest yield of industrial hemp, Alburgh, VT, 2016.

Treatment	Weed cover	Height	Population	Yield	Test weight	Moisture
	%	cm	plants ft^{-2}	lbs ac^{-1}	lbs bu^{-1}	%
Banded row	17.1	199	5.77	1120	**43.4***	23.5
Standard row	7.03	**177***	5.95	1080	43.3*	24.0
Wide row	7.59	211	4.23	1150	42.6	**26.8***
LSD (0.10)	NS	28.0	NS	NS	0.40	1.70
Trial mean	10.6	196	5.32	1120	43.1	24.8

Treatments in bold were top performers for the given variable.
NS – There was no statistical difference between treatments in a particular column (p=0.10).
*Treatments marked with an asterisk did not perform statistically different than the top performing treatment (p=0.10).

Weed cover in the treatments ranged from 7.03 to 17.1 percent and there was no significant difference between treatments (Table 3). Hence, row spacing did not appear to impact weed biomass and cultivation did not appear to improve weed control. During the early growth stages of hemp, weed pressure appeared to be problematic. The hemp plants were small, weak, and had poor root development while weeds seemed to be growing much quicker. On 16-Jun plots were cultivated, which appeared to reduce weed cover or plant populations. It was certainly plausible to think that cultivating would help with weed control, however the cultivation also seemed to pull-out the tiny hemp seedlings. When the hemp was 8-10" tall, it grew rapidly past the weeds and became far more competitive and clearly could grow past the weed pressure. Future research needs to further evaluate early season weed control.

Currently there are no pesticides (herbicides, insecticides, fungicides, nematicides, etc.) registered for hemp in the U.S, so growers must follow best practices to reduce the impact of pests, especially weeds.

Overall, harvest went smoothly for this trial, which in large part may have been attributed to harvesting at the proper moisture. At harvest, plants were still green and approximately 70% of the seed was ripe. Row spacing did not significantly impact hemp yields. The WIDE row treatment yielded the highest, at 1150 lbs ac^{-1}, although it was not significantly different from the STANDARD or BANDED treatments. Yields from this trial were well within Canadian yield averages of 500-1200 lbs ac^{-1}. The BANDED row treatment had the highest test weight, at 43.4 lbs bu^{-1}, however this was comparable to the STANDARD row treatment. This was slightly lower than the average test weight from Canada, at 44 lbs bu^{-1}.

The STANDARD row treatment had an average height of 177 cm, which was significantly lower than other treatments. This would likely be advantageous for grain production, where taller plants increase the likelihood of lodging and also tend to be more difficult to harvest.

The WIDE row treatment had the highest percent moisture, at 26.8%, which was significantly different from the other treatments. Higher moisture at harvest may be more advantageous during harvest, as the plants may be more flexible and less likely to get caught in the combine. As recommended from growing hemp in Saskatchewan, Canada, hemp harvest can begin when field moisture is at 20%, however, seed would need to start drying within 4 hours of harvest, as it otherwise will heat up. Seed should be dried to 8-10% moisture for long-term storage.

It is important to remember that these data represent only one year of research and in only one location. Additional years of data need to be completed to determine optimal row spacing and weed control methods for hemp in the Northeast region.

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils Program would like to thank the United Natural Foods Incorporated grant program, our supporters through our crowdfunding effort, and Dr. Bronner's company for funding this research. We would also like to thank Roger Rainville and his staff at Borderview Research Farm for their help with the research trials. We would like to acknowledge Nate Brigham, Kelly Drollette, and Xiaohe "Danny" Yang 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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