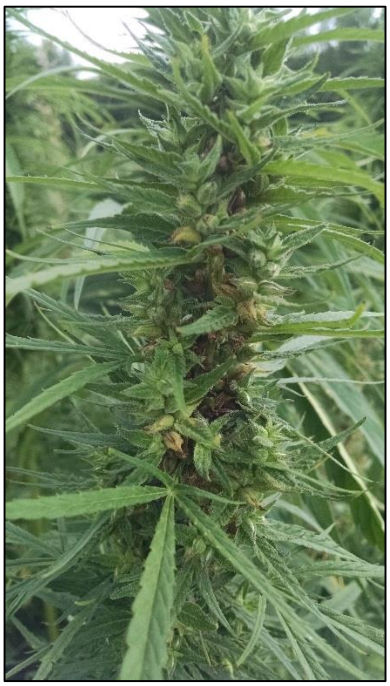
2018 Industrial Grain Hemp Planting Date Trial



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THE UNIVERSITY OF VERMONT EXTENSION

2018 INDUSTRIAL GRAIN HEMP PLANTING DATE 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, 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 historical production knowledge for the region has been lost. In this trial, we evaluated three hemp grain varieties over three planting dates to determine optimum planting dates for the region.

MATERIALS AND METHODS

Table 1. Agronomic information for the industrial hemp grain planting date trial 2018, Alburgh, VT.

Location	**Borderview Research Farm Alburgh, VT**
Soil type	Benson rocky silt loam, 8-15% slope
Previous crop	Corn silage
Plot size (ft)	5 x 20
Planting dates	7-Jun, 15-Jun, 22-Jun
Emergence dates	15-Jun, 22-Jun, 29-Jun
Row spacing	7”
Planting equipment	Great Plains NT60 Cone Seeder
Planting rate (live seeds m^{-2})	125
Harvest dates	7-Sep and 10-Sep

The trial was conducted at Borderview Research Farm in Alburgh, Vermont (Table 1) to evaluate the impact of planting date on yield for three hemp grain varieties. The experimental design was a randomized complete block with four replications. Seeding rates were adjusted after accounting for germination rates and a mortality rate of 30% to a target of 125 live seeds m^{-2}. The typical seeding rate used by hemp grain growers is approximately 25 lbs ac^{-1}. The trial was planted on 7-Jun, 15-Jun, and 22-Jun.

Table 2. Hemp grain varieties evaluated in the planting date trial 2018, Alburgh, VT.

Variety	Seed company	Days to maturity
Anka USO-31	UniSeeds, Inc. Cobden, Ontario (613) 646-9737 orders@uniseeds.ca	110 122-127
CFX-2	Hemp Genetics International Jeff Kostuik Saskatoon, Saskatchewan (204) 821-0522 jeff.kostuik@hempgenetics.com	100-110

There were three hemp grain varieties evaluated, each with differing days to maturity (Table 2). The trial was planted into 5'x 20' plots. On 9-Jul, the trial was fertilized with 150 lbs ac^{-1} of nitrogen, 30 lbs ac^{-1} of phosphorus, and 40 lbs ac^{-1} of potassium. Fertility amendments were based on soil test results. All fertility amendments were approved for use in organic systems.

A few days before harvest, plant populations were recorded by counting the number of plants in three one-foot sections of a row per plot. At that time, data was collected on plant heights by measuring three randomly selected plants per plot. Infection rates from the disease, *Sclerotinia sclerotiorum,* were recorded 1.5 months after planting, at female flowering stage, and just before harvest by counting the number of infected plants per plot. Pest pressure from arthropods was recorded at those times as well, by counting the number and variety of each arthropod present on two leaves from five plants per plot. On 7-Sep and 10-Sep, the grain plots were harvested using an Almaco SPC50 small plot combine. Test weight was also measured using a Berckes Test Weight Scale, which weighs a known volume of grain. Harvest moisture was calculated by using an OHaus (Parsippany, New Jersey) MB 23 moisture analyzer.

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

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.

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

RESULTS

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 (Table 3).

Table 3. Seasonal weather data collected in Alburgh, VT, 2018.

Alburgh, VT	June	July	August	September
Average temperature (°F)	64.4	74.1	72.8	63.4
Departure from normal	-1.38	3.51	3.96	2.76
Precipitation (inches)	3.70	2.40	3.00	3.50
Departure from normal	0.05	-1.72	-0.95	-0.16
Growing Degree Days (base 50°F)	447	728	696	427
Departure from normal	-27	88	115	109

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.

The summer months were hot and dry. July through September were an average of 3.41° F warmer than historical averages and received an average of 0.94 inches less precipitation than historical averages. June received an expected amount of precipitation, however, it was cooler than historical averages. Overall, there were an accumulated 2298 Growing Degree Days (GDDs) from June to September, approximately 285 more than the historical average.

Results by Planting Date x Variety

There were no significant planting date by variety interactions in this study. This indicates that the varieties responded similarly in each of the planting dates.

Results by Planting Date

Table 4. The impact of planting date across all varieties on plot characteristics and harvest yield of industrial hemp, Alburgh, VT, 2018.

Planting date	Height @ harvest	Population	Yield	Test weight	Moisture @ harvest	Seed oil
	cm	plants ac^{-1}	lbs ac^{-1}	lbs bu^{-1}	%	%
7-Jun	**133**	423,500	**1414**	**39.8**	17.8	20.1
15-Jun	118	410,983	1366*	37.0	18.1	22.1
22-Jun	108	461,052	1251	35.6	17.2	21.4
LSD (0.10)	12.4	NS	162	1.74	NS	NS
Trial mean	120.	431,845	1343	37.5	17.7	21.2

*Treatments marked with an asterisk performed statistically similar to the top performing treatment (p=0.10) shown in **bold**.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Across all varieties, planting date had a significant impact on plant height, yield, and test weight (Table 4). The 7-Jun planting date was the top performer for yield at 1414 lbs ac^{-1}. The 15-Jun planting date had a comparable yield to the first planting date.

Table 5. The impact of planting date on disease and arthropod presence in industrial hemp at female flowering across all varieties, Alburgh, VT, 2018.

Variety	Aphids	Leafhoppers	Flea beetles	Japanese beetles	Tarnished plant bugs	Minute pirate bugs	Soldier bugs	Physical damage
	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$†
7-Jun	0.050	0.0333	0.050	0.0833	**0.033**	0.000	0.000	0.933
15-Jun	0.167	0.0333	0.033	0.000	0.117*	0.033	0.233	0.700
22-Jun	0.117	0.0333	0.083	0.0667	0.233	0.000	0.000	0.667
LSD (0.10)	NS	NS	NS	NS	0.128	NS	NS	NS
Trial mean	0.111	0.033	0.056	0.050	0.128	0.011	0.078	0.767

†Physical damage from insect pests was recorded as the average number of damaged leaves per plant.
*Treatments marked with an asterisk performed statistically similar to the top performing treatment (p=0.10) shown in **bold**.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Low levels of aphids, leafhoppers, flea beetles, Japanese beetles, tarnished plant bugs, minute pirate bugs, and insect damage were present at the female flowering stage (Table 5). There were no significant differences for insect presence between planting dates.

Table 6. The impact of planting date on disease and arthropod presence in industrial hemp at harvest across all varieties, Alburgh, VT, 2018.

Variety	Sclerotinia infection	Aphids	Ladybugs	Spiders	Physical damage
	% of plants	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}†
7-Jun	0.015	0.083	**0.050**	0.000	1.08*
15-Jun	0.000	0.083	0.000	0.000	1.57
22-Jun	0.012	0.016	0.000	0.0168	**0.917**
LSD (0.10)	NS	NS	0.0361	NS	0.387
Trial mean	0.009	0.061	0.0167	0.006	1.19

†Physical damage from insect pests was recorded as the average number of damaged leaves per plant.
*Treatments marked with an asterisk performed statistically similar to the top performing treatment (p=0.10) shown in **bold**.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

When evaluating arthropod insect presence just prior to harvest across varieties, low levels of sclerotinia, aphids, ladybugs, spiders, and pest damage were present (Table 6). The disease, *Sclerotinia sclerotiorum* (Table 6, Image 1), had infected a minimal number of plants and no significant difference was seen between planting dates. Surprisingly, there was a lower aphid presence at harvest than at flowering, whereas previous observations had noted that aphid presence increased during the season. Ladybug presence was highest in the first planting date and this beneficial insect likely came to prey upon the aphid population. Physical damage was highest in the 7-Jun and 22-Jun planting dates, however, the damage was low, overall.

Image 1. *Sclerotinia sclerotium* infection on industrial hemp, Alburgh, VT, 2016.

Field Results by Variety

Table 7. The impact of variety across all planting dates on plot characteristics and harvest yield of industrial hemp, Alburgh, VT, 2018.

Variety	Height @ harvest	Population	Yield	Test weight	Moisture @ harvest	Seed oil
	cm	plants ac^{-1}	lbs ac^{-1}	lbs bu^{-1}	%	%
Anka	**138**	452,707	**1417**	31.5	16.8	21.7
CFX-2	93.9	417,241	1371*	31.5	17.8	21.3
USO-31	127*	425,586	1243	**39.5**	18.6	20.7
LSD (0.10)	12.4	NS	163	1.74	NS	NS
Trial mean	120	431,845	1343	34.1	17.7	21.2

*Treatments marked with an asterisk performed statistically similar to the top performing treatment (p=0.10) shown in **bold**.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Across all planting dates, the variety Anka was the top performer for yield (1417 lbs ac^{-1}) (Table 7). CFX-2 yielded comparably.

Table 8. The impact of variety on disease and arthropod presence in industrial hemp at female flowering across all planting dates, Alburgh, VT, 2018.

Variety	Aphids	Leafhoppers	Flea beetles	Japanese beetles	Tarnished plant bugs	Minute pirate bugs	Soldier bugs	Physical damage
	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$	# $plant^{-1}$†
Anka	0.100	0.050	0.050	**0.000**	0.117	0.033	0.233	0.733
CFX-2	0.100	0.033	0.033	0.017*	0.133	0.000	0.000	0.700
USO-31	0.133	0.017	0.083	0.133	0.133	0.000	0.000	0.867
LSD (0.10)	NS	NS	NS	0.077	NS	NS	NS	NS
Trial mean	0.111	0.033	0.056	0.050	0.128	0.011	0.078	0.767

†Physical damage from insect pests was recorded as the average number of damaged leaves per plant.
*Treatments marked with an asterisk performed statistically similar to the top performing treatment (p=0.10) shown in **bold**.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Across all planting dates, several arthropod insects were present in very low populations on hemp plants during the female flower development stage, including aphids, leafhoppers, flea beetles, Japanese beetles, tarnished plant bugs, minute pirate bugs, and soldier bugs (Table 8). Japanese beetles showed a significantly higher incidence on USO-31, however, its presence overall was low. Physical damage due to insect pests was also low.

Table 9. The impact of variety on disease and arthropod presence in industrial hemp at harvest across all planting dates, Alburgh, VT, 2018.

Variety	Sclerotinia infection	Aphids	Ladybugs	Spiders	Physical damage
	% of plants	# plant^{-1}	# plant^{-1}	# plant^{-1}	# plant^{-1}†
Anka	0.007	0.033	0.017	0.000	1.12
CFX-2	0.009	0.050	0.033	0.000	1.15
USO-31	0.012	0.100	0.000	0.017	1.30
LSD (0.10)	NS	NS	NS	NS	NS
Trial mean	0.009	0.061	0.017	0.006	1.19

†Physical damage from insect pests was recorded as the average number of damaged leaves per plant.
NS – There was no statistical difference between treatments in a particular column (p=0.10).

Prior to harvest, aphid populations surprisingly decreased and *Sclerotinia sclerotiorum* infection had appeared in all varieties (Table 9). Ladybugs and spiders were also present. All pest pressure was low.

DISCUSSION

Yield and Quality

All hemp varieties and all planting dates reached full plant maturity. Generally, the male flowers (pollen source) appeared after 40 days and late season varieties matured by 50 days after planting. Seed development began after 65 days and up to 75 days after planting, for the late season varieties.

The hemp was harvested on time, when plants were still young and green and seed was 50 to 70% ripe and seed moisture was within the acceptable range of 10-20% moisture. As recommended from growing hemp in Saskatchewan, Canada, hemp harvest can begin when field moisture is at 20% and plants are relatively pliable and less likely to get wrapped in the combine. However, seed would need to start drying within 4 hours as it otherwise will heat up. Seed should be dried to 8-10% moisture for long term storage. Ideally, hemp is harvested in the 12-15% range.

Average yield across all three planting dates was 1343 lbs ac^{-1} and was slightly above average yields from Canada, which range from 500-1200 lbs ac^{-1}. The last planting date (22-Jun) yielded less than the early June planting dates. It is possible that this planting had a disadvantage from experiencing a shorter season. Clearly, if conditions are optimal for planting in early June, this can result in higher yields. However, planting of hemp should more likely be based on field conditions and hence, slightly delaying planting into mid or late June are acceptable and will still allow hemp to reach maturity in our growing region.

Pest Pressure in Hemp: Disease, insects, weeds

Hemp has the potential to host a number of diseases and insects. For the most part, hemp growing regions have not indicated that disease and arthropod pests are of economic significance. During the growing season, a survey of pest incidence was conducted to gain a better understanding of any pressures that exist on hemp in the region. Early in the season, lesions on hemp leaves were noticed and later identified as being *Alternaria* spp., *Aspergillus* spp., and *Cladosporium* spp. These diseases did not appear to negatively affect yields. *Sclerotinia sclerotiorum* infection increased later in the season, but did not seem to affect yields.

During the early growth stages of hemp, plants were small, weak, and had poor root development while weeds quickly grew. In the 2016 hemp trials, about one month after planting, the hemp grew rapidly and successfully overtook the weeds without any weed control. However, due to low populations and stand establishment in 2017, the hemp was a poor competitor against weeds. In 2018, the stand appeared better than in 2017, however, not as robust as in 2016. This was likely due to the cool start to the season and then the dry, very hot summer months. The primary weeds present in the hemp trials were lamb's quarter, ragweed, and foxtail. 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.

It is important to remember that these data represent only one year of research, and in only one location. More data should be considered before making agronomic management decisions. It was clear that due to unseasonably cool, wet, early season conditions, all planting dates underperformed. Additional research needs to be conducted to evaluate varieties in more growing conditions.

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 John Bruce, Catherine Davidson, Hillary Emick, Amanda Gervais, Haley Jean, and Rory Malone 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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