2019 Hemp Flower Nitrogen Fertility Trial

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Environmental Testing Laboratory (Burlington, VT), no further nutrients were required for production of hemp (Table 2). The 4 week old hemp seedlings (variety T2) were transplanted on 19-Jun into a seed bed prepared with conventional tillage. A cover crop mixture of tillage radish and annual ryegrass was planted between rows on 26-Jun. Drip irrigation was setup to supply moisture as needed by the hemp plants.

Table 2. Base soil nutrient analysis for Hemp Flower Nitrogen FeETQ5eET2lls.

Irrigation was applied on a weekly basis at a rate of 8000 gallons of water per acre delivered via drip tape. Irrigation duration and amount was modified based on weekly rainfall. Prior to harvest, plant height and width was measured from all harvested plants in each plot. From each plot, flower samples were taken from the top 8” of colas and sent to ProVerde Laboratories (Milford, MA) to be analyzed for cannabinoid and terpene profiles.

For each plant harvested, the whole plant weight was recorded. On 21-Oct, all plants were harvested and were broken down into smaller branched sections and larger “fan” or “sun” leaves were removed by hand, while smaller leaves were left attached since they subtend from the flower bract. Remaining stems were then bucked using the Munch Machine Mother Bucker (Toppenish, WA)(Image 1) and remaining leaf material and buds were collected. Wet bud and leaf material was then processed through the CenturionPro Gladiator Trimmer (Maple Ridge, BC, Canada) (Image 2). Wet bud weight and unmarketable bud weight were recorded. The flower buds were then dried at 80 F or ambient temperature with airflow until dry enough for storage without molding. A subsample of flower bud from each plot was dried in a small dehydrator and wet weights and dry weights were recorded in order to calculate the percent moisture of the flower buds. The percent moisture at harvest was used to calculate dry matter yields. Metrics were collected for each of the three harvested plants within each plot and a plot average was calculated. After middle three plants were harvested and measurements collected, remaining two plants were harvested on 28-Oct and chipped to be analyzed for whole plant nutrient concentrations. A subsample of chipped plants was taken, dried, and sent to Dairy One in Ithaca, NY for nutrient analysis.

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 p-value is presented for each variable that showed statistical significance (p-value ≤ 0.10). In this case, the difference between two treatments within a column is equal to or greater than the least significant difference (LSD) value and you can be sure that for 9 out of 10 times, there is a real difference between the two treatments. In this example, treatment C is significantly different from treatment A but not from treatment B. Treatment B and treatment C have share the same letter 'a' next to their yield value, to indicate that these results are statistically similar. The difference between treatment C and treatment B is equal to 1.5, which is less than the LSD value of 2.0. This means that these treatments did not differ in yield. The difference between treatment C and treatment 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. The letter 'b' next to treatment A's yield value shows that this value is significantly different from treatment B and treatment C, which have the letter 'a' next to their value.

Treatment	Yield
A	6.0 b
B	7.5a
C	**9.0**a
LSD (p-	

Participants of State Hemp Programs intending to grow should acknowledge state and federal regulations regarding hemp production and registration. Growers must register within their intended state for production and must adhere to most current or active rules and regulations for production within a grower's given state. Regulations are subject to change from year to year with the development and approval of proposed program rules and it is important to note that regulations may vary across state lines and may be impacted by pending federal regulations. Please refer to this link for a detailed outline of proposed rules in Vermont. Additional information regarding the Vermont Agency of Agriculture, Food and Markets (VAAFM) Hemp Program can be found on the VAAFM website here:

https://agriculture.vermont.gov/public-health-agricultural-resource-management-division/hemp-program.

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 4). The month of July was hot and dry when compared to the 30-year average, followed by a slightly cooler than normal August and September. The month of October had warmer above average temperature and precipitation. Overall, there were an accumulated 2211 Growing Degree Days (GDDs) this season, approximately 197 more than the historical average, with much of the heat coming mid-season. Hemp plants received supplemental irrigation to account for precipitation deficits throughout the growing season, as needed.

Table 4. Seasonal weather data collected in Alburgh, VT, 2019.

Alburgh, VT	June	July	August	September	October
Average temperature (°F)	69.2	73.5	68.3	60.0	50.8
Departure from normal	0.84	2.84	-0.53	-0.62	0.14
Precipitation (inches)	1.71	2.34	3.50	3.87	3.85

Total bud weight, leaf weight, and stem weight were measured at harvest to further evaluate growth characteristics of each nitrogen application rate (Table 6). In general, the T2 cultivar appeared to have a very dense and compact growth habit when compared to other varieties within our trials (Image 3).

Plants grown at 150, 125, and 75 lbs N ac^{-1} had the highest overall wet flower bud weight. Plants grown with 150 lbs N ac^{-1} had the highest proportion of buds compared to other plant components (leaves and stems). The 150 N ac^{-1} treatment also had the highest ratio of bud:stem material per plant at 1.08:1. The 125 lb ac^{-1} rate had the highest leaf weight and percentage with 150 lb ac^{-1} and 75 lb ac^{-1} having comparable weights. The amount of total leaf or stem material can influence a number of factors such as harvest time to remove excess leaf material for trimmed flower or harvestable plant material in a biomass production system. Amount of time required to harvest plants could vary drastically depending on desired end-product and intricacy of trimming, influenced largely by overall plant size and proportions of bud, leaf, and stem material.

Table 6. Hemp plant growth metrics, Alburgh, VT, 2019.

Treatment	Wet bud weight	Wet bud weight	Leaf weight	Leaf weight	Stem weight	Stem weight	Bud:stem	Leaf:stem
lbs N ac^{-1}	lbs plant-1	% total	lbs $plant^{-1}$	% total	lbs $plant^{-1}$	% total		
0	2.41 b †	29.5 ab	3.13 b	38.9	2.55 b	31.6 bc	0.935 ab	1.24 ab
75	2.93 ab	26.1 b	4.26 a	38.1	**3.98 a**	**35.8 a**	0.731 c	1.07 b
100	2.35 b	29.8 ab	3.07 b	37.2	2.73 b	33.0 ab	0.922 abc	1.13 b
125	3.02 a	27.5 ab	**4.31 a**	39.6	3.58 a	32.9 ab	0.842 bc	1.20 ab
150	**3.07 a**	**31.4 a**	3.85 ab	39.2	2.90 b	29.4 c	**1.08 a**	**1.34 a**
LSD (0.10) ‡	**.599**	**4.67**	**.888**	**NS ¥**	**0.558**	**2.90**	**.193**	**.196**
Trial Mean	2.76	28.8	3.73					

Table 7. Hemp flower bud yield, Alburgh, VT, 2019.

Treatment	Flower dry matter	Dry matter flower yield €	Yield at 8% moisture	Unmarketable flower yield
lbs N ac^{-1}	%	lbs ac^{-1}	lbs ac^{-1}	lbs ac^{-1}
0	20.6	861	936	7.05 †
75	20.1	1021	1110	7.29
100	20.8	846	919	9.12
125	20.1	1052	1144	4.99
150	19.9	1056	1148	78.4
LSD (0.10) ‡				

Table 8 cont. Hemp whole plant nutrient analysis, Alburgh, VT, 2019.

Treatment lbs N ac^{-1}	Iron ppm	Zinc ppm	Copper ppm	Manganese ppm	Molybdenum ppm	Sulfur %	Chloride %	Cobalt ppm
0	416	57.3	16.3	73.0 b †	0.700	0.240 bc	**0.243 a**	0.208
75	376	55.0	16.3	77.5 b	0.575	0.233 c	0.220 ab	0.250
100	343	56.8	14.8	101 ab	0.850	0.243 bc	0.195 bc	0.208
125	391	56.8	15.3	120 a	0.925	**0.285 a**	0.195 bc	0.215
150	405	56.5	15.5	**126 a**	0.750	0.268 ab	0.175c	0.190
LSD (<0.10) ‡	NS ¥	NS	NS	36.5	NS	0.032	0.034	NS
Trial mean	386	56.5	15.6	99.5	0.760	0.254	0.206	0.214

†Within a column treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold.**

‡LSD – Least significant difference at p=0.10.

¥NS – No significant difference between treatments.

Results for cannabinoids are on a dry matter basis (0% moisture). Total potential CBD was highest at the 100 lbs N ac^{-1} rate at 8.54% and was statistically similar to 150, 125, and 0 lbs N ac^{-1} rates (Table 9). Total potential THC did not appear to be impacted by the N application rates. Under this year's growing conditions each of the tested nitrogen application rates was compliant with Vermont State regulations for THC limits in the 2019 growing season

The Cannabis plant contains a wide array of non-cannabinoids that contribute to aromatic profiles and may potentially have similar health benefits to some cannabinoids. Terpenes are one of many types of compounds found in hemp. Terpene profiles were analyzed for each plot within the fertility trial (Table 10). Results are included for 18 analyzed, unique terpenes, which have distinct chemical compositions and associated aromas that contribute to individual plant characteristics. Some terpenes may have medicinal uses as anti-irritants, anti-inflammatories, anti-microbials, or pain relievers, however the medicinal effects of many known compounds remains to be unseen. As highly volatile compounds, many of these terpenes can be subject to high levels of loss as a result of various harvest, drying, processing, or storage methods. Each of these factors should be carefully considered when evaluating and determining your growing practices, as well as desired end-product.