2020 HEMP FLOWER NITROGEN 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 re-emerging worldwide importance as medical providers and manufacturers seek hemp as a renewable and sustainable resource for a wide variety of consumer and industrial products. Hemp grown for all types of end-use (health supplement, fiber, and seed) contains less than 0.3% tetrahydrocannabinol (THC). Some hemp varieties intended to produce a health supplement contain relatively high concentrations of a compound called cannabidiol (CBD), potentially 10-15%. The compound CBD has purported benefits such as relief from inflammation, pain, anxiety, seizures, spasms, and other conditions. The CBD compound is the most concentrated in the female flower buds of the plant, however, it is also in the leaves and other plant parts as well.

To produce hemp for flower, the plant is generally grown intensively as a specialty crop and the flowers are cultivated for maximum growth. The various cannabinoids and terpenes concentrated in the flower buds are often extracted and

nitrogen fertility in split applications over an eight-week period starting on 26-Jun in the form of ammonium nitrate plus sulfur (URAN 28-0-0) applied directly to individual plants (Table 2).

Table 2. Weekly hemp nitrogen fertility rates (28-0-0).

Treatment	Total application rate

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 5. Hemp plant growth metrics, Alburgh, VT, 2020.

Treatment	Stem weight	Stem weight	Bud weight		Bud weight	Leaf weight	Leaf weight	Bud:stem	Leaf:stem
lbs N ac^{-1}	lbs $plant^{-1}$	% total	lbs $plant^{-1}$		% total	lbs $plant^{-1}$	% total		
Control	3.40	24.6	5.84	b	42.1	4.77	33.3	1.74	1.40
75	3.69	25.8	5.62	b	40.6	4.84	33.7	1.60	1.31
100	4.34	26.2	6.87	a	41.8	5.29	32.0	1.60	1.24
125	3.94	25.4	5.68	b	39.8	5.34	34.8	1.64	1.39
150	3.72	23.8	6.64	a	42.4	5.47	33.7	1.79	1.46
LSD (0.10) ÿ	NS¥	NS	0.667		NS	NS	NS	NS	NS
Trial Mean	3.82	25.2	6.13		41.3	5.14	33.5	1.67	1.36

Within a column treatments marked with the same letter were statistically similar (p=0.10).

ÿLSD Least significant difference at p=0.10.

¥NS No significant difference between treatments.

At harvest, a composite subsample of flower material was collected from each plot and dried down to determine flower dry matter and calculate dry matter flower yields (Table 6). Flower dry matter was not significantly different across treatments. Plants receiving the 100 lbs N ac^{-1} rate had the highest dry matter yields at 2884 lbs ac^{-1} alongside the 150 lbs N ac^{-1} rate at 2877 lbs ac^{-1}. Those rates receiving additional fertility appeared to have the lowest amounts of unmarketable flower with the highest rate having on average 0.012 lbs $plant^{-1}$ compared to the control which had the highest amount of unmarketable flower material. Unmarketable flower included any flower that had suffered from disease, rot, soil contamination, or otherwise damaged flower material. Dry matter flower yields for the Lifter cultivar within the trial averaged 2629 lbs ac^{-1} with an average flower dry matter of 24.7%.

Table 6. Hemp flower bud yield, Alburgh, VT, 2020.

Treatment	Flower dry matter	Unmarketable wet flower yield		Dry matter flower yield ú	
lbs N ac^{-1}	%	lbs $plant^{-1}$		lbs ac^{-1}	
Control	25.4	0.072	b	2586	b
75	24.4	0.038	ab	2389	b
100	24.1	0.016	ab	2884	a
125	24.4	0.050	ab	2407	b
150	25.0	0.012	a	2877	a
LSD (0.10)					

a

Dried flower samples were also analyzed for CBD and THC concentrations and a CBD:THC ratio was calculated (Table 7). Results for cannabinoids are on a dry matter basis (0% moisture). Each of the analyzed cannabinoids, with the exception of D9-THC, showed statistically significant treatment responses to nitrogen fertility rates. For both CBDA and THCA, peak concentrations were observed in the 75 lbs N ac^{-1} treatment at 18.3% and 0.597% respectively, and was statistically similar to the Control, 100, and 125 lbs N ac^{-1} treatments. The CBD concentrations were again highest in the 75 lbs N ac^{-1} at 0.738% alongside similarly high values seen in the control at 0.602%. Highest values for total CBD were observed in the 75 lbs N ac^{-1} treatments at 16.8% and were statistically similar to the Control and 100 lbs N ac^{-1} treatments at 14.4% total CBD each. The 150 lbs N ac^{-1} treatment was consistently the lowest for all tested values for each analyzed cannabinoid and total cannabinoids resulting in a nearly 4% difference in total CBD. While the concentrations appeared to be impacted by nitrogen fertility rates, the ratio of CBD:THC was not impacted, remaining fairly consistent across all treatments. As concentrations of CBD increased or decreased for a given treatment, THC followed similar trends leading to proportionally similar cannabinoid concentrations for those analyzed.

Table 7. Hemp flower concentrations, Alburgh, VT, 2020.

Treatment	CBDA	CBD	D9-THC	THCA	Total THC	Total CBD	CBD : THC
lbs N ac^{-1}	%	%	%	%	%	%	%
Control	15.8 ab	0.602 ab	0.054	0.522 ab	0.512 ab	14.4 ab	28.2

Table 8. Hemp whole plant nutrient analysis, Alburgh, VT, 2020.

Treatment	Nitrogen	Potassium		Phosphorus		Calcium		Magnesium	Carbon
lbs N ac^{-1}	%	%		%		%		%	%
Control	2.83	1.94	a	0.635	a	2.43	a		

unmarketable flower