

## 2017 Industrial Hemp Trials for New York State Grain and Fiber Production



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### **Introduction:**

The hemp plant (*Cannabis sativa*) is among the most ancient plants domesticated by humans. There are genetically distinct biotypes of hemp, some of which have low tetrahydrocannabinol (THC) levels. THC is the principal intoxicating agent in marijuana types of *Cannabis*. These low-THC biotypes (referred to as industrial hemp or simply hemp) are used for fiber, hempseed oil, and seed production. Commercially available cultivars from Europe and Canada have been bred for enhanced production of oil, fiber or both but have not been tested in the United States because of its prohibition of the cultivation of hemp in the 1970s. Restrictions on industrial hemp research were relaxed in 2014 (in the United States) and in 2016 (in New York).

Because many available industrial hemp cultivars were developed in environments very different than New York, it is critical to test hemp cultivars to determine which will grow well and be high yielding across and within New York's range of soil types and environments. This report presents data from industrial hemp trials

conducted by researchers from Cornell University in New York in 2017. Grain and fiber industrial hemp cultivars were tested in small plot trials in Ithaca and Geneva, NY. One fiber trial and two grain trials were planted in Ithaca and one fiber and one grain trial were planted in Geneva. An additional grain strip plot trial was planted on a certified organic site in Freeville, NY. Data consist of grain and fiber yield and grain quality. In 2018, these cultivars, as well as additional cultivars, will be tested again at a minimum of six locations representing New York's latitudinal range.

## Methods:

Industrial hemp grain trials were planted at six locations, while industrial hemp fiber trials were planted at two locations (Table 1) because of limited seed supplies. All trials consisted of replicated small plots except for the Freeville organic trial, at which one long strip was planted of each grain cultivar. Plots were six rows wide, with 7.5 inches (19.05 cm) between rows, resulting in plots that were 45 inches (114.3 cm) wide and 20 feet (6.1 m) long. Trials were planted in a randomized complete block design and were analyzed using standard ANOVA in SAS ver. XX. Seeding rates were based on pure live seed (PLS). The seeding rate for the fiber trials was 60 pounds per acre PLS (67.3 kg per ha) and the seeding rate for the grain trial was 20 pounds per acre PLS (22.4 kg per ha). Trials in Ithaca (McGowan Early, McGowan Late, and East Ithaca) and the earlier planting in Geneva (RN00A) were fertilized prior to planting with 300 lbs. per acre 10-20-20 plus zinc (336.3 kg per ha) and then, at three weeks, top dressed with 70 lbs. per acre of N (78.5 kg per ha, as ammonium sulfate) for grain trials and at least 30 lbs. per acre of N (33.6 kg per ha) for the fiber trials. The later Geneva planting (CN011) was fertilized prior to planting with 100 lbs. per acre of N (112.1 kg per ha, as 19-19-19). No additional fertilizer was applied to the Freeville strip trial.

Table 1: 2017 Trial locations, planting dates, and soil characteristics.

Location	Planting date	Soil type	Drainage	Previous Crop
Ithaca, NY (McGowan)	June 9* June 29	Niagara silt loam	Somewhat poorly drained	Alfalfa
Ithaca, NY (East Ithaca)	June 14	Arkport fine sandy loam Williamson very fine sandy loam	Well drained Moderately well drained	Squash
Geneva, NY (RN00A)	June 28*	Lima loam	Moderately well drained	Pumpkins
Geneva, NY (CN011)	July 10	Odessa silt loam	Somewhat poorly drained	Muskmellons
Freeville, NY (Org.8)	July 12	Howard gravelly loam	Well drained	Red clover

\*Fiber trial also established

Seedling counts were taken on every plot two weeks after planting. Throughout the growing season, notes were taken on weed pressure, flowering date, ratio of male to female to monoecious plants, incidence of disease and insects, and height. Within 30 days of harvest, the top 10 cm (4 inches) from 10 female plants were sampled for cannabinoids. The inflorescences were dried at 35C for 10-12 days and then ground for analysis with UV-HPLC.

**Fiber trials** consisted of four entries ('Carmagnola', 'Carmagnola Selezionata', 'Eletta Campana', and 'Fibranova', all Italian cultivars provided by Schiavi Seeds) and were harvested between flowering and seed set with sickle bar mowers, 74 days (Ithaca) or 76 days (Geneva) after planting. Yields are reported on a weight of dry stems/acre basis. Additional stems were sampled from each plot of the Ithaca trial for retting. Percent of bast and hurd are also reported.

**Grain trials** consisted of 13 grain or dual purpose entries (Table 2) and, at all locations except East Ithaca, were harvested with an Almaco SPC20 plot combine when all cultivars had at least 60% mature seed. Mature seed heads from the East Ithaca trial were harvested by hand when each cultivar was determined to be sufficiently mature. Harvested grain was tested for percent moisture and then dried in forced air ovens at 40°C until a stable moisture was achieved (6-8% moisture). Data collected include: clean grain yield, test weight, and thousand kernel weight (TKW). Composite samples of each cultivar at each location were sent to Dairy One (<http://dairyone.com/>) for analysis of quality components including crude protein, fiber (as NDF), and fatty acid profile.

Table 2: 2017 Industrial hemp grain trial variety information

Varieties	Origin	Seed Company	Days to Maturity	Use
Anka	Canada	Valley Bio Limited	~110	dual purpose
Bialobrzeshire	Poland	Schiavi Seeds LLC	<135	dual purpose
Felina 32	France	Schiavi Seeds LLC	<135	dual purpose
Futura 75	France	Schiavi Seeds LLC	<145	dual purpose
Tygra	Poland	Schiavi Seeds LLC	<135	dual purpose
USO-31	Ukraine	Schiavi Seeds LLC	90-100	dual purpose
Wojko	Poland	Schiavi Seeds LLC	n/a	dual purpose
CFX-1	Canada	Hemp Genetics International	105+	grain
CFX-2	Canada	Hemp Genetics International	103+	grain
CRS-1	Canada	Hemp Genetics International	~110	grain
Grandi	Canada	Hemp Genetics International	100-110	grain
Katani	Canada	Hemp Genetics International	100-110	grain
Piccolo	Canada	Hemp Genetics International	100-110	grain

## Results:

### Fiber Trials:

Germination rates for the four cultivars in the fiber trials ranged from 14-68%. Seeding rates were corrected so that the same number of viable seeds were planted in each plot. Even with this correction, there were significant differences in seedling density in the trials due to cultivar. ‘Carmagnola’ and ‘Carmagnola Selezionata’ were very sparse (9.1-12.3 seedling/ft<sup>2</sup> in Ithaca and 2.5-4.1 seedlings/ft<sup>2</sup> in Geneva) and ‘Eletta Campana’ and ‘Fibranova’ seedlings were much denser (25.3-32.5 seedling/ft<sup>2</sup> in Ithaca and 35.9-40.3 seedlings/ft<sup>2</sup> in Geneva).



Harvesting Ithaca fiber trial with sickle bar mower

At harvest, cultivars in the Ithaca fiber trials were 250-264 cm tall (8-8.5 feet) and male plants were in full flower. In the Geneva fiber trial, harvested three weeks later, cultivars were 111-250 cm tall (3.5-5 feet) and male plants had finished shedding pollen and were beginning to dry down. Plots were cut, weighed, and sampled for dry matter. Plot weight times percent dry matter was used to estimate yield (Figure 1). In the Ithaca trial, ‘Carmagnola’ and ‘Eletta Campana’ were not significantly different in dry stem yield, even though the stand density was significantly different. However, there was a difference in fiber quality. ‘Eletta Campana’ was 28% bast fiber while ‘Carmagnola’ was 24% bast fiber, equivalent to a difference of over 550 lbs. of bast fiber per acre.

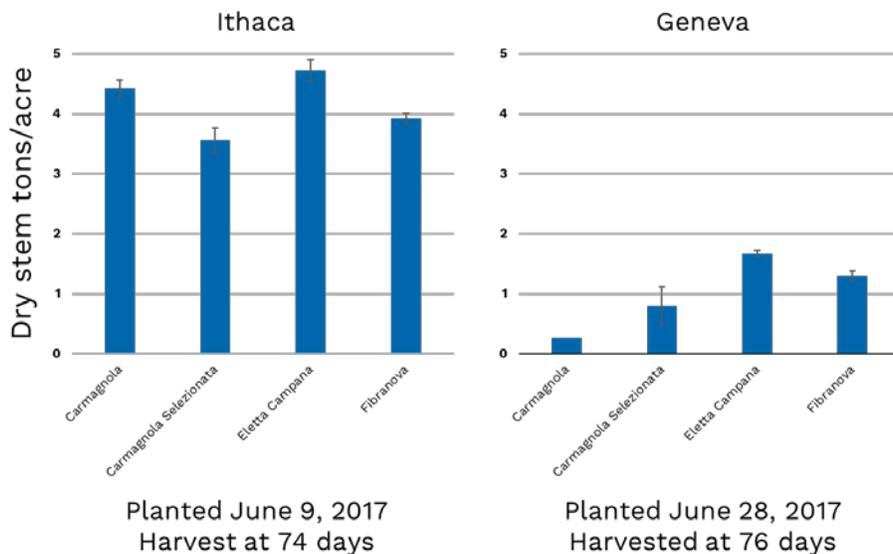


Figure 1: 2017 NY Industrial hemp fiber yields

## Grain Trials:



*Freeville organic strip trial harvested with Almaco combine*

The grain trials were planted with the intention of managing them as dual purpose trials. Since the cutter bar on our plot combine could only be raised to around 100 cm, trials were managed for optimal grain yield instead of balancing the harvest for both grain and fiber yields.

Grain yields were greatest in the McGowan trials in Ithaca, NY (Figure 2). These trials had good establishment, no weed pressure, and excellent growth throughout the

growing season. The McGowan Early trial was on average 49 cm taller than the McGowan Late trial, but did not yield significantly more grain. In the earlier trial, the earliest maturing cultivar was ready to be harvested four weeks before the latest maturing cultivar. In the four weeks between maturity and harvest, the early cultivars were susceptible to shattering and bird feeding, so that yield potentials for early maturing cultivars are underestimated. In the later planted trials, there were two weeks or less between when the earliest and latest maturing cultivars were ready for harvest. The second trial, planted in East Ithaca, had very poor establishment due to a cold rain between planting and emergence. This trial also had severe weed pressure. The East Ithaca trial had the lowest plant density and the lowest yields of all the trials. The third trial, planted in Geneva on June 28 (RN00A) had good establishment, but quickly became nitrogen deficient. Seedlings were yellow and stunted before supplemental nitrogen was applied and, even after nitrogen was applied, did not fully outgrow the stunting. The final replicated trial (CN011), was planted at the latest date, on the most poorly drained field, and had the second poorest seedling establishment. Even with these disadvantages, this trial had an average height equal to that the McGowan Late trial. The difference in yield could be almost completely explained by the lower plant density.

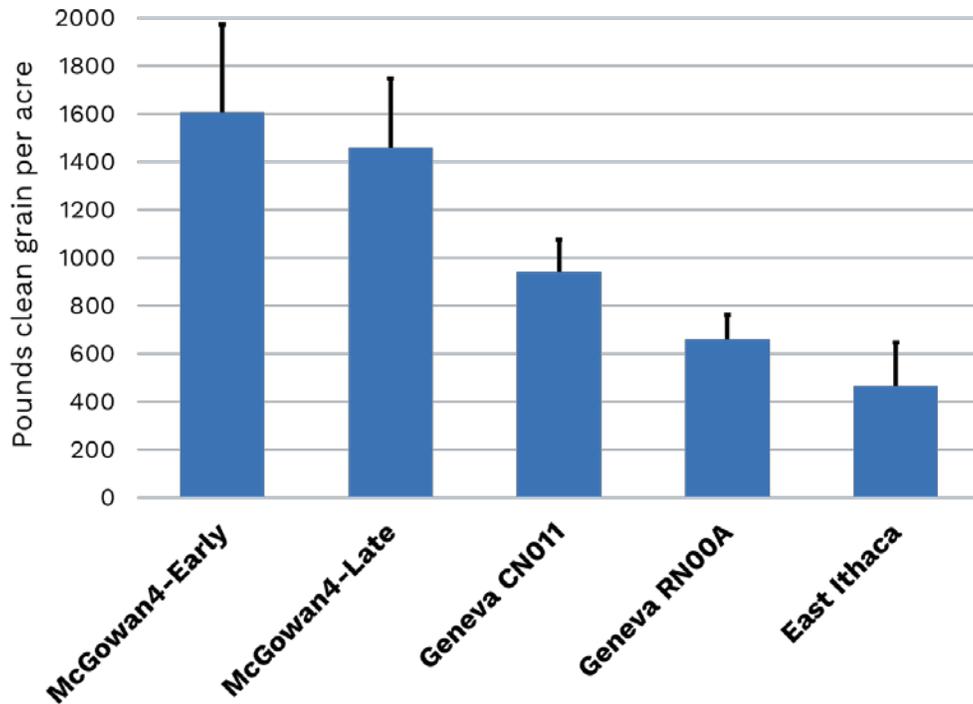


Figure 1: Average yields at five locations

There were also differences among cultivars (Figure 3). Later maturing cultivars tended to be higher yielding than the earlier maturing cultivars, though the degree of these differences may be due to the length of time between cultivars reaching maturity and harvest. The highest yielding cultivar in the highest yielding trial, yielded over 2300 pounds/acre, confirming that New York has enormous potential for hemp production.

The grain harvested from different cultivars had different quality as well. The thousand kernel weights ranged from 12.2-15.2 grams (Figure 4). Crude protein ranged from 25-27.2 % of the dry weight, with the grain types tending to have higher protein than those classified as dual purpose (Figure 5). Total fatty acids ranged from 34.6-37.0 % of the dry weight with Omega-3s averaging 6.1 % and Omega-6s averaging 20.9% of the dry weight (Figure 6). Fiber content in the grain averaged 34.9 % with no significant differences among cultivars.

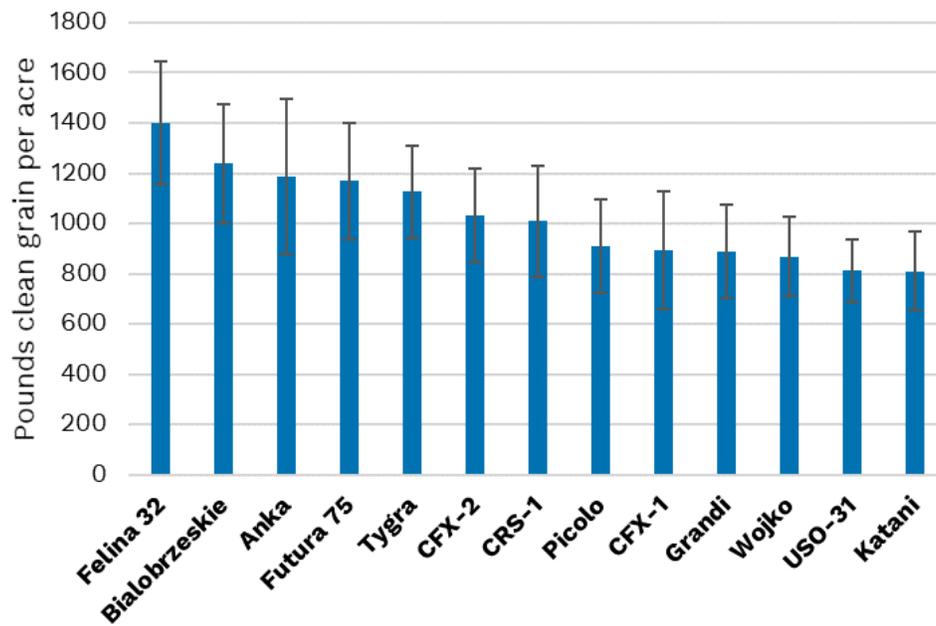


Figure 2: Yield of all cultivars averaged over five locations

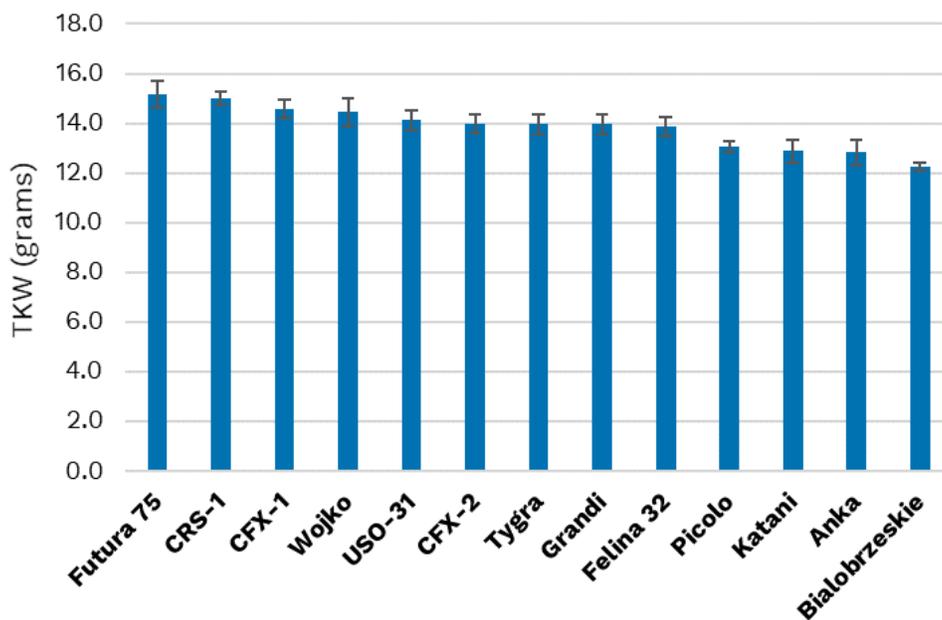


Figure 3: Weight of one thousand kernels of hemp grain by cultivar, averaged over locations

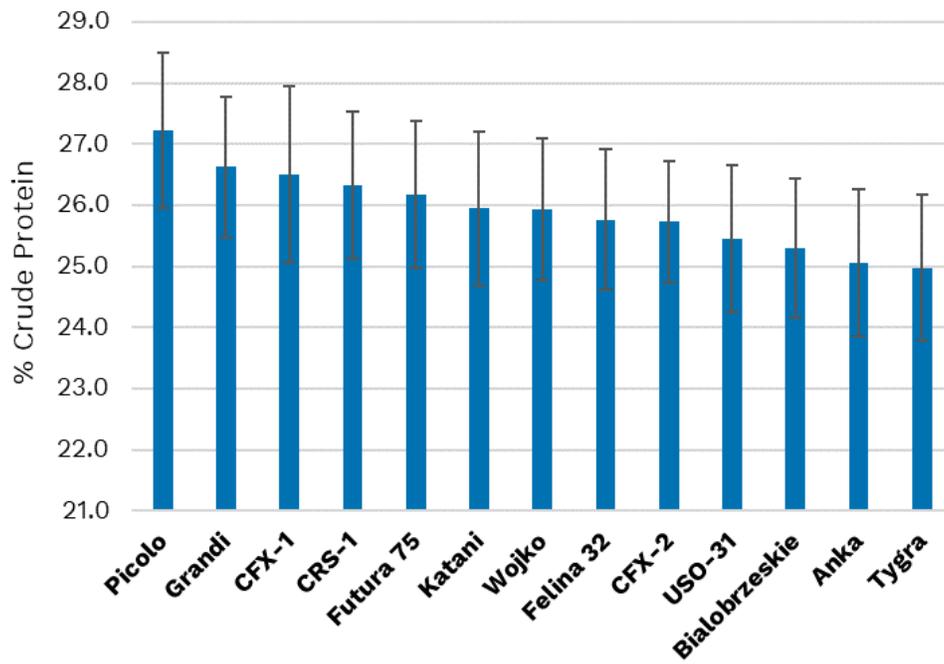


Figure 4: Percent crude protein by cultivar, averaged over locations

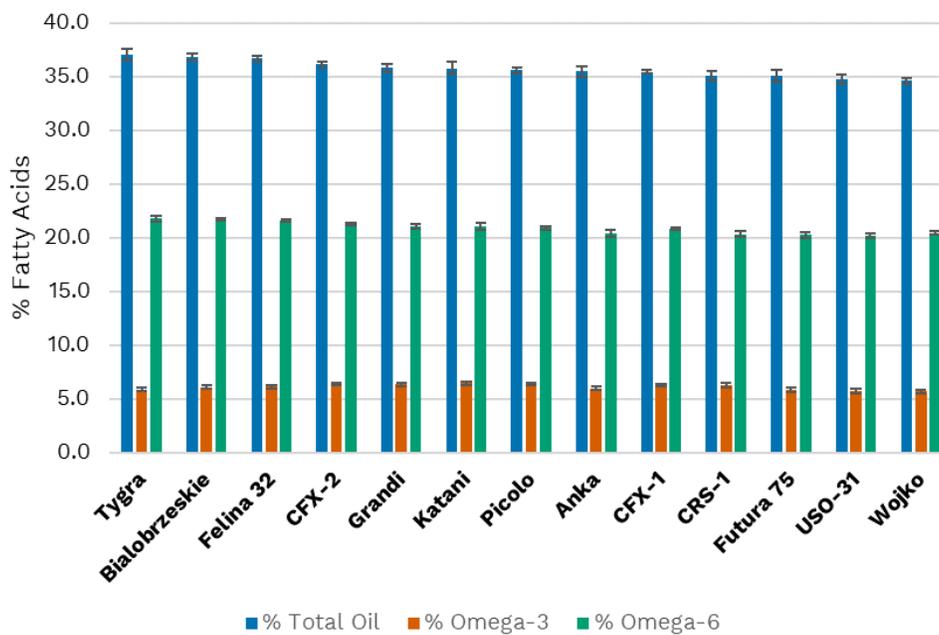


Figure 5: Percent fatty acids by cultivar, averaged over locations

Analysis of cannabinoids was conducted on female flower shoots from four grain trials (Figs. 7, 8) and two fiber trials (Fig. 9). The greatest mean total THC content (d9THC+0.88\*THCA) of a cultivar in any grain trial was 'Picolo' at CN011, which was still under 0.2%. Total THC was fairly high in 'Carmagola' at RN00A with a mean of 0.3%. Based on this analysis, all cultivars met regulatory compliance for total THC content using the formula above. Total CBD (CBD+0.88CBDA) varied significantly by cultivar, with 'Futura 75', 'Felina 32', and 'Wojko' producing between ~1.5-2.0% in most of the grain trials. All four cultivars in the fiber trial at RN00A produced between ~1.5-2.0% total CBD, but the levels were lower (~1.0-1.5%) in the fiber trial at McGowan. The levels of CBD are promising for either dual purpose fiber and CBD harvest from 'Carmagnola' or 'Eletta Campana' or a possible triple purpose harvest of grain, fiber, and CBD from 'Futura 75', 'Felina 32', or 'Wojko'.

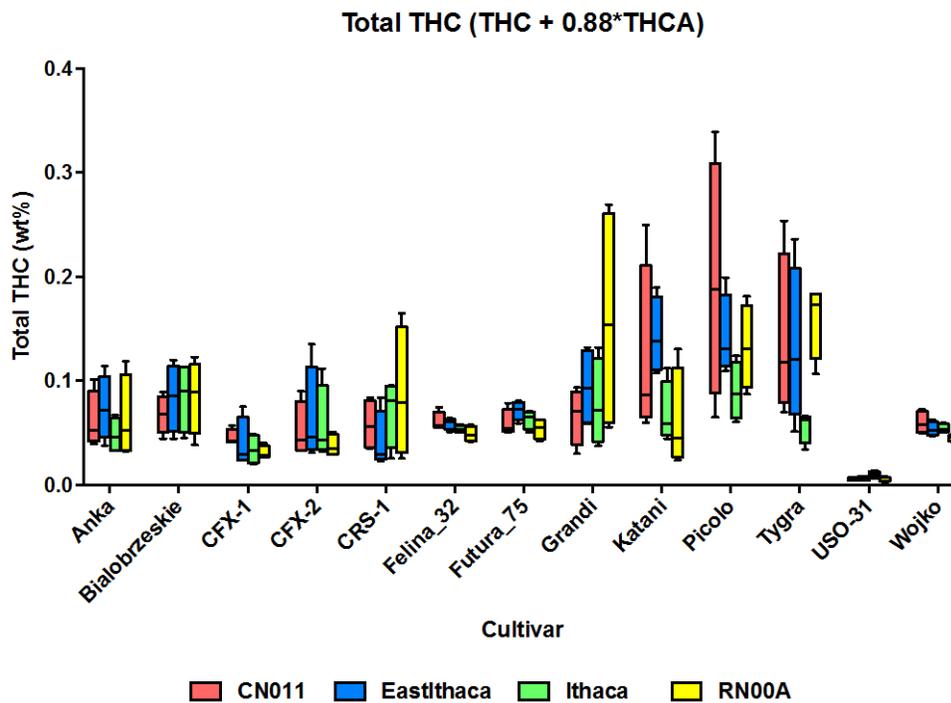


Figure 7: Total THC by % dry weight by cultivar, averaged over locations.

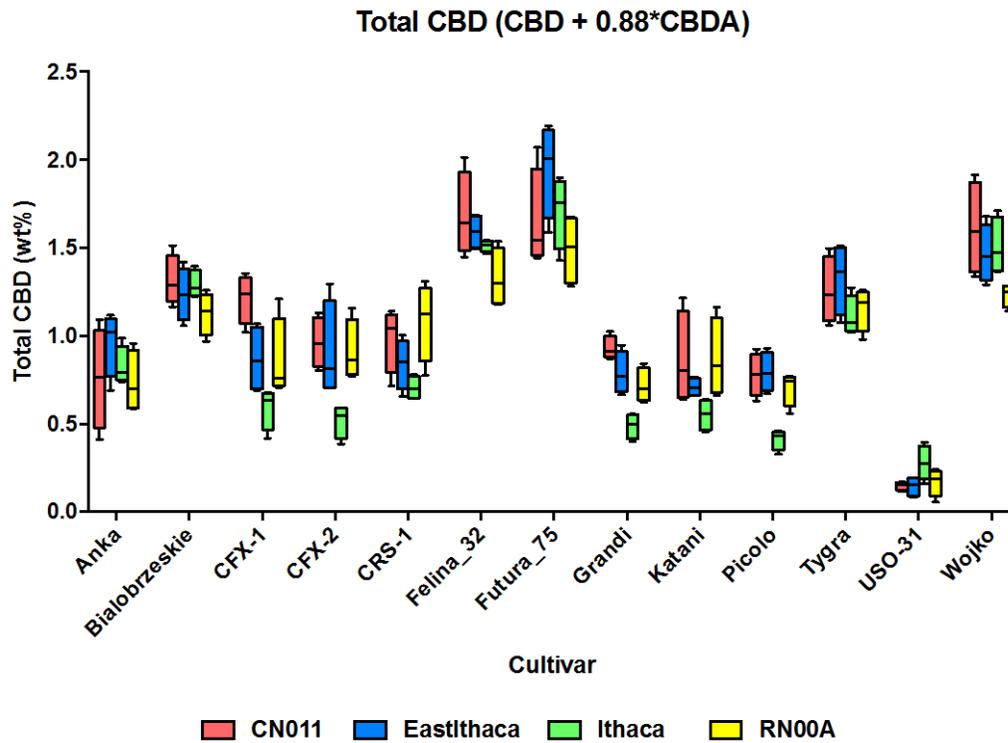


Figure 8: Total CBD by % dry weight by cultivar, averaged over locations.

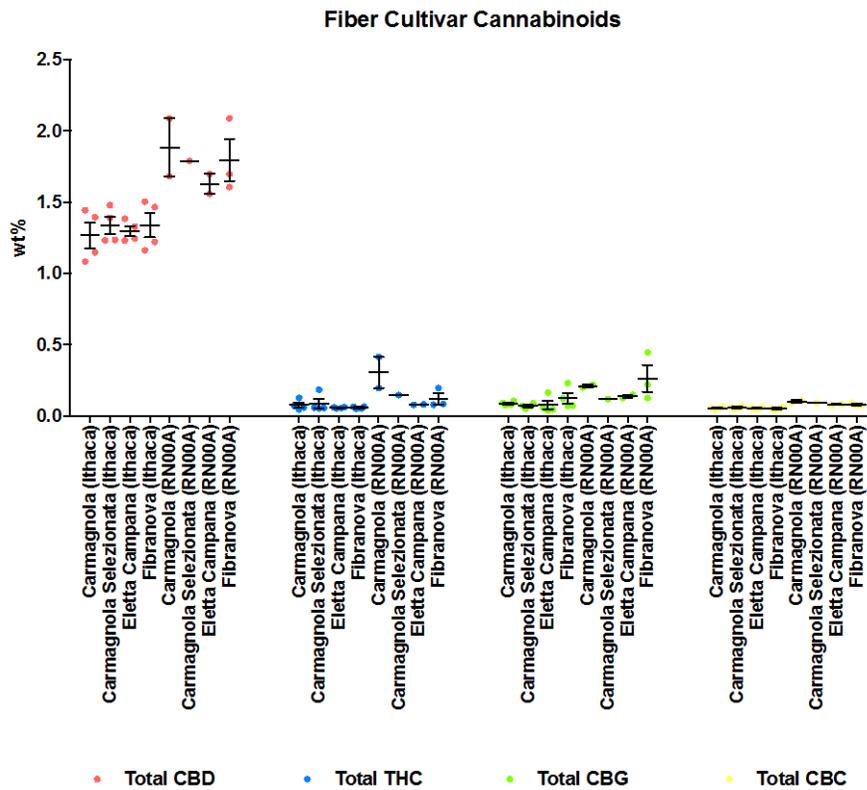


Figure 9: Total select cannabinoids by % dry weight by cultivar, averaged over locations.

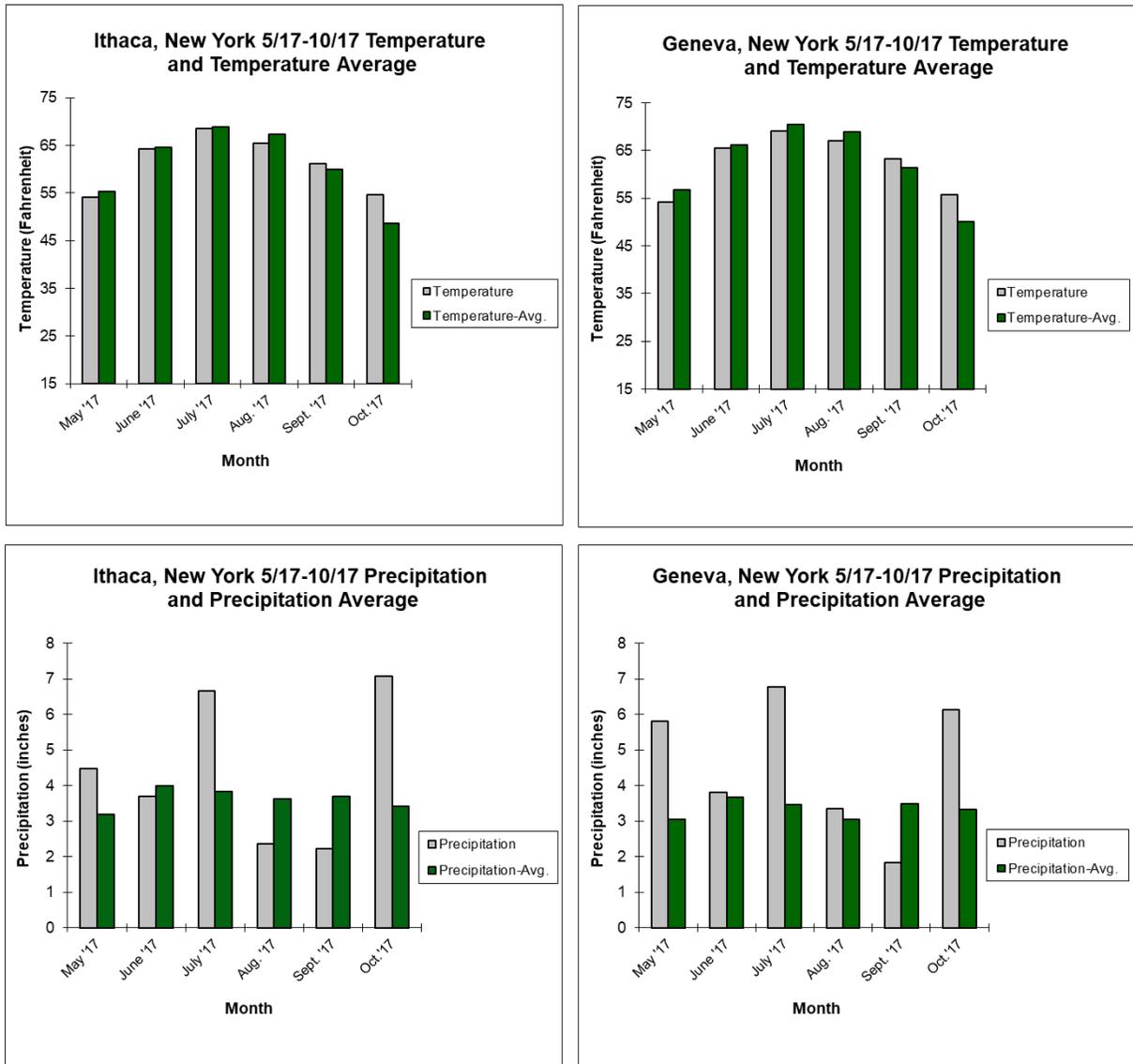


Figure 10: Growing season temperature and precipitation for growing locations. Ithaca, NY and Geneva, NY May 2017–October 2017 temperature and precipitation. Weather data from the Northeast Regional Climate Center at Cornell University: <http://www.nrcc.cornell.edu/>

**Discussion:**

In 2017, all trials were planted later than would have been ideal. The main reason for this departure from recommended planting time was the weather. May was very wet in both Ithaca and Geneva, and in Geneva, the above-average precipitation continued into June (Fig. 10). The somewhat poorly drained site in Geneva (CN011) was planted as soon as the field was dry enough to be worked, and that was the second week in July.



*Mature industrial hemp at harvest*

Field crop history also had a significant effect on the yields. In the fields that were planted to legumes in previous years, seedlings were just starting to show nutrient deficiency at three weeks when the additional fertilizer was added. At the Geneva site (RN00A), which was previously planted to pumpkins, seedlings were already slightly yellow and stunted before the fertilizer was applied at three weeks.

Trials planted in 2018 will test all of the entries from 2017 with at least six additional cultivars at six locations spanning the full latitudinal range of New York State. Multiple high CBD cultivars will also be tested.

**Acknowledgements:**

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