HEMP UPDATE LINKS

UPDATE #1 –April 26, 2019

UPDATE #2 –May 3, 2019

UPDATE #3 –May 10, 2019

UPDATE #4 – May 17, 2019

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Hemp Exec Summary and Legal Opinion

Righetti et al 2018 Not the One, but the only one

Hemp Scouting Interest Form

UPDATE #7 – June 7, 2019

LAW ENFORCEMENT REMINDER

UPDATE # 8 – June 14, 2019

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Hemp Update #9 – June 21, 2019

Longest Day - What Does it Mean For Hemp?

Since hemp is day length sensitive, for long-day varieties, the summer solstice (or shortly thereafter as days get shorter) triggers a new cycle in the plants life -flowering. Here's a good observation from NC State this year:
https://industrialhemp.ces.ncsu.edu/2019/06/early-planted-hemp/

additionally, this is selected from: https://www.hempbasics.com/hhusb/hh4bot.htm . Sections removed for brevity. See the link for full text.

Hemp Husbandry, **Robert A. Nelson**, **Internet Edition** , **Copyright 2000**

Chapter 4, Botany & Breeding

4.8 ~ Light

Cannabis' rate of growth is proportional to the intensity of the light it receives, and is inversely proportional to the length of the photoperiod.

Cannabis responds to light in accordance with the intensity, wavelength, and photoperiod. Cannabis is a "short-day" species: it flowers when the photoperiod decreases to about 8 hours. The plant requires at least 3 hours of light daily just to survive, and at least 8 hours daily to thrive. While the plant is young, up to 3 months old, it responds vigorously to increasingly longer periods of light (up to 16 hours). Daily photoperiods of 16 hours or more will cause cannabis to grow indefinitely in a vegetative phase. The plant will grow about 25% faster under 24-hour lighting. Nutrient consumption increases proportionately. **(54)**

The photoperiod must be shortened to less than 10 hours to induce flowering and complete the growth cycle. Cannabis flowers quickest with a photoperiod of 8 hours. Thus, mature plants will develop flowers within 2 weeks of short-day treatment. Immature plants require up to one month of long nights to induce flowering. A short light period usually will bring cannabis into bloom within a month after emerging from the ground, but of course the plants will be very small. Short photoperiods inhibit the growth of stems and foliage, leaves produce fewer serrations in the margins. Flowering is hastened. The number of serrations correlates well with the degree of lighttime treatment.

Erratic lighting will confuse cannabis. V. Sofinskaya studied the conditioning of hemp with lighttime, and observed the following effects:

"The decrease in day length favored the acceleration of light stage completion but was unfavorable to plant growth. A prolonged short-day treatment resulted in a greater growth delay and in stunted plants, especially when plants were grown under short-day conditions since their emergence. Sharp changes of light conditions during the light stage resulted in various morphological alterations and in the appearance of hemp forms widely differing in habitat. Changes in light conditions during the light stage caused transgression in the normal course of the stadial plant development, resulting in considerable morphological changes of infloresence development as well as in the shape and size of leaves." **(55)**

Cannabis must not be disturbed during its night; unscheduled illumination during the dark period will inhibit flowering. Total darkness is required. The flowering response of hemp is controlled by the length of the dark night, not by the length of daylight. As little as 0.03 footcandles (FC) of red light interrupting the dark period will inhibit the anthesis of hemp. A long night thus becomes two short nights separated by an extremely short day, such as 1 minute of illumination.

Very long nights cause hemp flowers to ripen more quickly. This technique is most effective after the 4th week of the flowering phase. Far red light (supplied by incandescent spotlights) can reduce the time required for the flowering phase by about one week.

Cannabis will grow with as little as 800 FC of light, but the growth will not be vigorous. A minimum of 1500 FC is required for a healthy crop. When grown in a short-day regime under low-intensity light, cannabis becomes starved for photons. The hypocotl elongates excessively during the first 2 weeks after the plant emerges. It may reach a height of 6 inches before any internode leaves develop in the plumule. If the illumination is intensified, the plants may survive, and they will develop a clockwise spiral twist in the cotyledon.

Low light levels also produce smaller, thinner leaves, elongated internodes, reduced concentrations of chlorophyll, and less dry weight. High levels of light shorten the growth period, stimulate branching and budding, and increase the production of red anthocyanin pigments. Excessive light causes dessication, bleaching due to photodestruction of chlorophyll, and then necrosis.

Laser light has similar effects. G. Krustev, *et al.*, used a He-Ne laser (632.8 nm/15 & 30 minutes) and a nitrogen laser. The sowing qualities of the seed are improved, the phases of plant development are shortened, the plants are more vigorous, and the yield of seeds and stems. **(83)**

Rejuvenation --- The growth cycle of cannabis usually lasts about 16 weeks. When cultivated indoors, however, cannabis can be rejuvenated after it has bloomed and begins to go into senile decline. Some varieties are very amenable to rejuvenation after their flowers have been harvested. The plants should be cut back to the second branching node. Let as many leaves as possible remain, and a few buds. Give the plants at least 18 hours of light daily. New meristems will develop within three weeks. Extra nutrients (especially N) must be supplied at this time, or the new flowers will be male. The process can be augmented with foliar sprays of Indole Acetic Acid (IAA) or Napthalene-AA. The soil should also be treated with the hormones. Hemp can be rejuvenated repeatedly with such treatment, thus living several times longer than usual. Even without continuous-light rejuvenation, female hemp may live several months longer after flowering if the plant remains unpollinated. If female plants become senile between rejuvenations, then sex-reversals usually occur, especially under the influence of short-day photoperiods after the continuous-light treatment. In such a case, about 90% of the females reverse to male or hermaphroditic intergrades. **(56-60)**

Rejuvenated cannabis blossoms from the terminal bud or from lateral buds below the infloresence. Usually the first few leaves on rejuvenated plants are entire (smooth edged). After several such leaves have developed, subsequent leaves again have the usual serrations. When grown under continuous light, the phyllotaxy of the branches changes from opposite to alternate at some point after the seventh node. Plants grown with normal long-days do not change their phyllotaxy until 12 internodes have developed. Rejuvenated plants are very sensitive to tobacco smoke and can be killed by it.

D. Kohler researched the effects of short and long days on hemp morphology, and found another way to rejuvenate cannabis, based on its response to light:

"In short-day and long-day hemp the first leaves are simple and comparatively broad, the later are divided, their leaflets being comparatively narrow. The size of the leaves following one another is continuously increased. Plants begin to flower (qualitatively reacting short-day hemp in short-day only). The shape of the leaves produced in the infloresence is determined in the first days of flowering: they become more and more simple and their leaflets comparatively broader. The leaf size is influenced by the length of day. The leaves of plants kept in flower-inducing daylength grow less and less due to competition between reproductive and vegetative organs, whilst the leaves of flowering plants, which are transferred into longer day, grow larger and larger. In this case the latest leaves are of the same size and shape as the earliest one; a second life-cycle starts, whilst the plants in the original daylight are dying. Considering the photoperiodic response of hemp, leaf-size is a measure of the physiological age. With monoecious hemp a certain leaf size is necessary for the formation of male flowers. If female plants are put into longer day during blossom, they do imitate the male habit." **(61)**

Ocra Wilton found a correlation of cambial activity with cannabis' flowering and regeneration:

"A study was made of cross-sections of all the internodes from the tips to the bases of the stems... When Cannabis sativa has reached an advanced stage of reproductiveness, the meristematic tissue of the stem tends to become entirely differentiated into xylem and phloem elements. This anatomical condition is a possible explanation of the death of such plants at the close of one reproductive cycle. The cessation or decline of cambial activity which accompanies the production of flowers in C. sativa progresses from the region of the infloresence toward the base of the plant, which it may or may not reach depending on the degree of reproductiveness which the plant attains. Vigorously vegetative plants have an active cambium throughout their stems... a certain amount of at least potentially meristematic tissue is necessary for a renewal of vegetative growth in stems."

Photoperiodism ---- Photoperiodic control can be very useful to the cannabis breeder. If yield is not important (as is often the case in the early stages of a breeding program), the time required for the life cycle can be greatly reduced by using short photoperiods. Thus, several generations of plants can be produced each year. Under such conditions, cannabis will flower when it is only a few inches tall. **(62)**

Photoperiodic control makes it possible to synchronize the flowering dates of male and female plants, thus making possible their cross-breeding. Most importantly, photoperiodic control enables breeders to stimulate the production of male flowers on female plants. Self-pollination can be accomplished only by means of such flowers. Male flowers on female hemp do not contain the Y (male) chromosome; they produce only female pollen. When this is used to fertilize female flowers on female plants, they will produce purely female seeds. The pollen from male flowers is of two kinds, and usually produces a ratio of males 1:1 females. A few viable seeds can be obtained from female flowers produced on male plants and self-pollinated, but such seeds are only weakly fertile and produce mostly female plants.

Report: Edible Hemp Foliar Sampling Project

http://hemp.cals.cornell.edu/2019/02/05/new-report-edible-hemp-foliar-sampling-project/

What is Sensemilla?

This is another cannabis-related word heard from time-to-time. It translates as “without seed”. The word was developed as the marijuana culture learned that unpollinated flowers produced more THC (or that, in reality, pollination reduces THC). Flower without seeds then became more valuable because oi this. “Sensemilla” as a tem became more of a brand for marijuana, suggesting higher potency. Some confuse the term Sensemilla for a variety. It is not, it just refers to a growing practice of seedless flowers by quarantining females from males.

Upcoming Events for Hemp Producers:

JUL 2 8:30 AM

2019 Seed Growers Field Day

A field tour that will highlight Cornell research on small grains, forages, biofuel species, and industrial hemp. Topics to include breeding, varieties, pathogens and pests, seed production, and…

Location**: New York Seed Improvement Project (NYSIP) Foundation Seed Barn, 791 Dryden Road (Rt. 366), Ithaca NY**

Event type: **Field Day**

JUL 31

Greenhouse IPM In-depth Hands-on Workshop

The latest in pest management methods for commercial greenhouse producers. Topics will include best practices for beneficial insects, greenhouse sanitation to prevent pests, diseases and weeds and…

Location: **Morrison Hall, Cornell Campus, Ithaca**

Event type: **Conference/Workshop**

Empire Farm Days

August 6-8 – Tuesday & Wednesday 9-5, Thursday 9-4

The Empire State Potato Growers held their first agricultural show in 1931. Over the years, the event became Empire Farm Days. Rodman Lott & Son Farms in Seneca Falls has hosted the event since 1988.

The event is the largest outdoor agricultural trade show in the Northeastern U.S., showcasing all the latest tractors, farm implements, dairy industry innovations alongside working demonstrations, live animal seminars, and more than 600 exhibits loaded with the latest agricultural information for successful farming.
https://empirefarmdays.com/

HEMP UPDATE #8 – June 14, 2019

Welcome… for those of you who are new to the list, please go here to see previous postings:

https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/38619/hempUPDATE6-12.pdf?1560461368

Tissue Culture for Propagation?

https://hempindustrydaily.com/hemp-cultivators-tissue-culture-increase-propagation-preserve-genetics/

Greenhouse Pest Management – Good Resources:

Identification of insects and general control (pesticide information may not be valid for hemp):
https://entomology.ca.uky.edu/files/efpdf4/ent60.pdf
Utilizing Insect screening:
http://www.omafra.gov.on.ca/english/crops/facts/00-021.htm
https://www.greenhousemag.com/article/insect-screening-an-important-pest-management-tool/

Focus on *Pythium*:

Pythium root and stem rot is usually noted by wilting top growth because the roots can no longer support the plant. But other symptoms can occur earlier such as plants that are stunted, low in vigor, or slow growing and wilting on warm days.

Pythium root and stem rot occurs when the disease is present and is favored by cool,

Symptoms of *Pythium* on hemp in the field. Left on seedling. Note yellowing of lower leaf. Right-symptoms on much older plant – wilt and leaf die-back. *Photos: Kevin Meyers*

wet soil conditions. Even, skillful watering, if watering by hand in a greenhouse, is essential to plant success.

The result is the appearance of brown to black, soft, rotted roots. One common symptom is that the outer portion of the root easily slides off of the inner part of the root leaving a white center that is thin and hair-like in appearance. Often this happens when removing the plant from the soil. In some plants, the disease moves up the crown and stem blackening above soil-level too.

Over fertilization can burn roots with excess salts, leaving wounds for diseases to enter. Managing fertility is key to managing *Pythium* infection rates.

But the greatest key in controlling *Pythium* is sanitation.

- Utilizing sterile potting mix only
- Using only new or properly sanitized pots/flats
- Regularly sanitize potting areas and any tools used in propagation
- Keep flying insect infestations to a minimum because they can transport spores on their bodies
- Managing cross-contamination from soil tracked in from outside. *Pythium* is everywhere in the environment outside and all it needs is the right environment to create significant losses to seedlings and cuttings.
- Keeping watering wands off the floor. They can pick up contaminated soil from the floor and then spray it on the plants.
- Sanitizing the greenhouse between crops https://ag.umass.edu/greenhouse-floriculture/fact-sheets/cleaning-disinfecting-greenhouse

Or https://www.extension.purdue.edu/extmedia/HO/HO-250-W.pdf

Pythium on Cuttings:

http://www.kyhempdisease.com/pythium-root-rot.html

What is the "Entourage Effect"?

The entourage effect is a term that is used to describe the potential interaction between THC, CBDs, terpenes (i.e. all of the plant chemistry) that may have medicinal benefits in *Cannabis*. It refers to a synergistic potential in that plant extracts are suggested to be "greater than the sum of the parts". There is mixed scientific data on each side of the possibility that this exists and whether single component medicines are more or less effective than those with mixed chemistries. However, hemp/CBD producers should be aware of the discussions and terminology, even if they are not scientifically proven, customers are applying the principals. This is the difference between a customer asking for a full-spectrum product, because it contains the wide array of components versus something produced with isolate, only containing CBD. Surely, as science and medicine move forward on analyzing these components and their effects on health, certain varieties and or growing practices will be noted for their ability to favor/discourage specific compounds. Like milk, I can imagine a component pricing

schedule in the future that is more complicated than the current (paid by %CBD only). Therefore, when testing your hemp, as you might do for THC levels through the growing season, consider testing for all of the components, that can currently be analyzed, and keep records of your results for future decision-making in comparing varieties, production practices, or even soil types.

About Testing…

These labs provide analysis for THC, other contaminants, and measure the preferred chemicals as well. Each lab is a bit different in what is offered so be sure to obtain a sample result (COA-Certificate of Analysis) and compare them to obtain the analysis you are looking for.

- East Coast Labs 172 Taunton Avenue East Providence, Rhode Island 02914 https://www.ecltesting.com Contact: matthew@ecltesting.com (401) 400-2709
- ProVerde 420 Fortune Blvd. Milford, MA 01757 http://www.proverdelabs.com Contact: Chris Hudalla (617) 221-3356
- MCR Labs, LLC 85 Speen St. Framingham, MA 01701 https://mcrlabs.com Contact: Michael Kahn (508) 872-6666
- CDX Analytics 39 Norman St. Salem, MA 01907 https://cdxanalytics.com Contact: Brian Strasnick (978) 619-2244
- Eurofins BioDiagnostics, various locations, https://www.eurofinsus.com/biodiagnostics/our-services/hemp-testing/ e-mail: EBDIHemp@eurofins.com

Also, if you have obtained your own equipment to test for THC (there are several suitcase-sized machines out these days), be sure to calibrate your results along with 2 or 3 of the above labs to be sure you are in the same range before you rely on your test completely.

NY Hemp Exchange

Remember to post to the buy/sell board or go looking for a match to your need.
Post an ad: https://cornell.qualtrics.com/jfe/form/SV_e35Eb3pNfpWkqhv
View ads: https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/37547/hempadupdate4-24.pdf?1556201539

HEMP REMINDER – LAW ENFORCEMENT

This is a reminder as field planting is well-underway, as per your contact with NYSDAM, you must inform law enforcement of your planting locations.

(e) An authorization holder shall, no later than 15 days after having been granted authorization, notify, in writing, the applicable unit or units of law enforcement, including the unit or units of law enforcement in the political subdivision in which the registered premises is located, that it has received such authorization and shall provide such unit or units of law enforcement a copy of the security plan referred to in section 159.2(d)(5) of this Part. The authorization holder shall, no later than 15 days after having notified such unit or units of law enforcement, provide the department with a copy of such notification. An authorization holder shall adequately monitor registered premises under its control and shall notify the appropriate unit or units of law enforcement and the department regarding facts and circumstances that indicate that industrial hemp has been or may be held or possessed in violation of the provisions of this Part.

Also remember that several municipalities law enforcement may have your farm in their jurisdiction and you should contact all of them (state police, sheriff, town police, village/city police).

Information you supply should include, at least:

- Farm and permitee name/contact info (at all hours)
- the location of the field(s) GPS & street address,
- size of the fields,
- copy of authorization or least their authorization number
- copy of your security plan, if you have not already

Making personal contact with an officer in the most direct municipality would be handy too. If there is an issue, there is an officer/chief you have personally spoken to about your production and is familiar with hemp.

No, you may not have all of this information EXACTLY, as you plant but send a plan to be in compliance with your authorization. Then send updates as/if it changes.

HEMP UPDATE # 7- June 7, 2019

This week was the US Hemp Expo in Albany. Over the next few updates, information gathered will be shared with the group.

FDA PUBLIC HEARING on the Scientific Data and Information about Products Containing Cannabis or Cannabis-Derived Compounds

MAY 31, 2019

Webcast and information on public comments here: https://www.fda.gov/news-events/fda-meetings-conferences-and-workshops/scientific-data-and-information-about-products-containing-cannabis-or-cannabis-derived-compounds

Highlight on Harvesting Equipment

Check Out This site - https://formation-ag.com/
Video: https://youtu.be/gSapLLwJ4bg

Sexing Your Plants- Visual & Testing

Last week, there as an entry about identifying males, females and hermaphrodite pants in a CBD field. But plants can be DNA tested to determine when the plants are quite small. Check out these labs:
https://www.steephill.com/genkit
https://phylos.bio/plant-sex-test
https://www.medicinalgenomics.com/gender-detection/

Powdery Mildew on Hemp

Submitted by Johanna Gertin, Intern

Chances are, if you're growing hemp in a greenhouse, you have encountered powdery mildew. Powdery mildew is a disease most commonly caused by the fungus *Golovinomyces sp.* It begins on the

leaves of the plants, but can then spread to the stems and buds, contaminating the final product. The disease thrives in high available moisture/humidity and in moderate temperatures between 65 to 70 degrees F.

(https://www.alchimiaweb.com/blogen/powdery-mildew-fungus-on-marijuana-plants/)

Options for managing powdery mildew rely on manipulating either the host, pathogen or the environment. Selecting a resistant cultivar can help to decrease the chance of powdery mildew damage, but other methods focused on the pathogen and the greenhouse environment also exist. Sanitation is key for maintaining a pathogen free environment by removing discarded plant material or infected debris. Otherwise, changing the conditions to those that don't favor powdery mildew can reduce its presence. Maintain the environment at temperature and humidity levels outside of its preferred range. Proper ventilation/air movement along with plant spacing can limit the spread of powdery mildew. No fungicides are currently labeled for powdery mildew in hemp. (http://www.kyhempdisease.com/powdery-mildew-of-hemp.html)

Hemp Lingo!

Wild-Catting: Wild-catting is a term from the tobacco industry that refers to a grower growing crop outside of contract. Essentially, producing a crop without a known buyer.

Hemp Toll Processing: This is when the farmer/producer hires a processor to turn harvested crop into CBD distillates, isolates or other products. This is different than just out-right selling crop to a processor and completing the deal at field edge. In this case, the farmer may take possession of crude*, distillate*, isolate or retail-ready products to take elsewhere to transform it into a product/package that is retail-ready. If hiring such a facility, be sure they have necessary certifications from FDA, NYSDAM, or other such as GMP or organic certification, depending on the what would be required for the type of product they are producing. Also be sure both sides agree, in writing, on the kinds of testing that will be done (and by what lab) before and after processing for contaminants any other compliance test. The farmer should be sure and the processor cooperate on how lots/batches will be segregated and identified through the process so final product is traceable in accordance with the law. Will lots be homogenized (mix batches to have uniform end product)? How will traceability be managed then? Know what the

processors efficiency function is. Does their equipment extract 45% of the CBD available in the crop or 89%. If the producer is paying for that extraction the first one is worth roughly half the second.

*Note that these products are concentrated and may surpass the 0.3% and SHOULD NOT cross state lines if they need to be transported to another facility for final processing/packaging.

HEMP UPDATE #6 – May 31, 2019

Hemp Intern Started this Week

Johanna is a sophomore studying Environmental Science and Entomology at Cornell University. She is particularly interested in pest management, having taken two classes focused on it at Cornell. Pesticides, Human Health and the Environment and Integrated Pest Management introduced her to the topic, especially with its applications in agriculture. She learned about several insect, weed, and disease pests and management options through the two classes. Her prior experience with hemp comes from working with the Cornell Forage Breeding Project since August 2018 on some of the experimental plots. She had the opportunity to collect and process hemp samples and harvest the experimental plots, working outside in the fall and in the lab in the winter. She enjoys working outdoors and is excited to further her experience with hemp this summer.

Many fields have yet to be planted but we are planning her scouting route. If you have not yet filled out the request scouting form/ and-or heard from Johanna, please do ASAP. The form is attached.

What is Tobacco Mosaic Virus and Can it Harm the Crop?

Several NY growers have raised concerns about being infected with TMV. It is suspected that TMV could infect hemp.

Tobacco Mosaic Virus is a virus that infects plants through contact. Typically, it is spread from plant to plant by leaves touching, machinery, workers handling plants and, by workers who smoke tobacco cigarettes spreading it to a crop on their hands. It infects several related species of plants. Symptoms include mottling (light areas) and sometimes wrinkling or puckering of leaves. Generally, it causes stunting, reduces growth and yield. The degree of damage is related to the age at which the plant was infected. Fruit may be affected in some crops. Fun fact – TMV was the first virus ever identified in science.

However, if you are concerned about TMV infection, you can send samples to the Cornell Plant Disease Clinic: http://plantclinic.cornell.edu/ Use the site to print up a submission form and learn about how and where to send your sample. I recommend sending samples overnight and no later in the week than Wednesday to ensure they have the shortest amount of time in the package.

If you want to do your own testing, you can buy kits. These ELISA tests https://orders.agdia.com/agdia-immunostrip-for-tmv-isk-57400 are recommended . There are a couple of steps to the test but it, in general, is an easy greenhouse test that can provide easy-to-read results in less than an hour. This is a presence/absence test for TMV only.

More information on TSV identification and control:
https://www.canr.msu.edu/news/common_question_and_answers_about_tobacco_mosaic_virus
https://nysipm.cornell.edu/agriculture/vegetables/vegetable-ipm-practices/chapter-27/section-27-5-12/
https://www.growweedeasy.com/tobacco-mosaic-virus-tmv-cannabis

The mottling may just be variation in the cells ability to produce chlorophyll that is genetic, not an infection. That is called a chimera. A chimera is a plant that has different copies of genes for (in this case) chlorophyll production in different cells. Resulting in , some producing sufficient chlorophyll and others not creating the mottled appearance.

Additionally, there is a suspicion of Cannabis cryptic virus which has yet to be identified (see attached paper- Righetti et.al.) but with no testing to rely on there is no way to define presence/absence.

Worrying About Sex-Changing Plants?

Johanna put together some information:

The presence of males in a field of female hemp leads to seed production and decreased cannabinoid yields. As such, CBD growers must be on the lookout for males, although feminized seed decreases the chances of such an occurrence. Yet even with only females, hemp still runs the risk of pollination and seed production with its hermaphroditism. Female plants may develop both male and female reproductive organs, whether as a result of genetics or environmental factors. Environmental stresses influence the appearance of hermaphrodites because it decreases the length of the reproductive period, an advantageous strategy in difficult conditions. Common causes include changes in the photoperiod, excessive heat, late harvesting, mechanical stressors, pest infestations, irrigation issues, and the use or overuse of phytotoxic products (https://www.alchimiaweb.com/blogen/marijuana-hermaphroditism/). The best solution for minimizing hermaphrodites is optimizing environmental conditions for hemp growth and preventing and managing difficulties like pest activity. If hermaphrodites are found, they should probably be removed before pollination occurs and the crop is compromised.

Photo 3a: Hemp female plant
Photo 3b: Hemp hermaphroditic plant
Photo 3c: Hemp Male plant

Source:https://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/crop15539/$file/HempHarvestStorage.pdf?OpenElement

Source: “Cannabis Male Female Hermaphrodite” https://thehighco.co.za/how-to-grow-high-quality-cannabis/

A: all female inflorescence B: male and female combination C: all male

Source: http://vp5qw4uf5x.search.serialssolutions.com/?url_ver=Z39.88-2004&url_ctx_fmt=info:ofi/fmt:kev:mtx:ctx&rft.atitle=Foliar+Sprays+of+Silver+Thiosulfate+Produce+Male+Flowers+on+Female+Hemp+Plants&rft.aufirst=Jessica+D.&rft.aulast=Lubell&rft.date=2018&rft_id=info:doi/10.21273%2FHORTTECH04188-18&rft.eissn=1943-7714&rft.epage=747&rft.genre=article&rft.issn=1063-

0198&rft.issue=6&rft.jtitle=HORTTECHNOLOGY&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&rft.pages=743-747&rfr_id=info:sid/webofscience.com:WOS:WOS&rft.spage=743&rft.stitle=HORTTECHNOLOGY&rft.volume=28&rft.au=Brand%2C+Mark+H.

Do Bees Pollinate Hemp?

The short answer is no. They do utilize the pollen of the male plants as a food source but do not visit female flowers because it does not make nectar. Cornell has been researching this and more information is available here:
https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/a/7491/files/2017/04/Hemp-and-Bees-Field-Day-2018-Handout_HG-1uas2lq.pdf

Hemp History Week June 3-9 …Check It Out

https://www.hemphistoryweek.com/

Updated Guidance/Input on 2018 Farm Bill Hemp Implementation

According to AMS' website on Hemp Production - Comments and questions about the 2018 Farm Bill implementation of Hemp Production may be submitted to farmbill.hemp@usda.gov.
https://www.ams.usda.gov/rules-regulations/farmbill-hemp See the attached pdf, (Hemp Exec Sum…) It may be a handy item, especially to have in vehicles during crop transportation.

Missed a Hemp Update?

New to the list or looking for something you know you read about? Prior hemp updates can be found here:
https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/38248/hemp_update_5-24.pdf?1559077671

Reminder: This Update is for producers in the lower Hudson Valley, primarily. All of the information/services offered may not be available/useful for you if you are outside of Colombia, Green, Ulster, Orange, Sullivan, Dutchess, Rockland, Putnam, & Westchester counties

HEMP UPDATE #5 – May 24, 2019

Last Call for Crop Scouting!!

If you have not yet, please fill out attached application and return via e-mail. The scout will be organizing visits starting next week. I know planting has just begun, but we need to develop a seasonal scouting route.

Some Good Greenhouse Pest Management Sites:

Whiteflies: http://sfyl.ifas.ufl.edu/agriculture/whiteflies/
http://ipm.ucanr.edu/PMG/PESTNOTES/pn7401.html

Root Diseases (hemp appears to be quite susceptible to Pythium and Rhizoctonia):
https://ag.umass.edu/greenhouse-floriculture/fact-sheets/root-diseases-of-greenhouse-crops

Sanitation/Cleaning between crops: https://www.extension.purdue.edu/extmedia/ho/ho-250-w.pdf

Powdery Mildew: https://kentuckypestnews.wordpress.com/2018/06/19/powdery-mildew-of-hemp/

Article on Cannabis Uses for Animals

From the Journal of the American Veterinary Medical Association
https://www.avma.org/News/JAVMANews/Pages/190601f.aspx

Sign Up for Larry Smart's Hemp Twitter Feed

https://twitter.com/Cornell_U_Hemp?ref_src=twsrc%5Etfw%7Ctwcamp%5Eembeddedtimeline%7Ctwterm%5Eprofile%3ACornell_U_Hemp&ref_url=https%3A%2F%2Fhemp.cals.cornell.edu%2F

US Hemp Expo in Albany Coming Up June 2-4:

https://www.ushempexpos.com/about-eastern

Mark Your Calendars -Other Future Educational Meetings with Cornell:

- Willsboro Farm Field Day – July 10
- Aurora Farm Field Crops Field Day – July 11
- Freeville Organic Farm Field Day – July 31
- Long Island Hort Res Ext Center Plant Science Day – July 31
- Hemp Workshop – Empire Farm Days – Aug 6-8

- Cornell Hemp Field Day – Geneva – Aug. 13
- Cornell CBD Hemp Field Day – Bluegrass Lane, Ithaca – Sept. 10?

NY Hemp Exchange/Buy and Sell Board:

It's not fancy but its effective!
Current Buy/Sell Listings:
https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/37547/hempadupdate4-24.pdf?1556201539
To post your own listing (updated ~ weekly):
https://cornell.qualtrics.com/jfe/form/SV_e35Eb3pNfpWkqhv

If you have a posting but it is no longer valid, please let Maire mru2@cornell.edu or Kathy kal64@cornell.edu know and it will be removed/changed.

Did You Miss a Previous Update:

See them here:
https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/38094/hempupdate5-17.pdf?1558456477

hemp update #4 - 5/17/19

What is Crop Scouting?

Crop scouting is the process of assessing pest pressure and crop performance to evaluate economic risk from pest infestations as well as to determine the potential effectiveness of pest and disease control interventions.

This year, for hemp, scouting will focus more on identifying and assessing actual threats to the crop. Since there are no pesticides available for use, controls are limited but our data may help "make a case" for pesticide labeling.

It is an opportunity to have contact with Cornell Faculty and staff on current production issues and solutions as we develop this new industry.

The scout will visit weekly or bi-weekly, your choice (mostly), from early June through early August. Please see attached enrollment from. So I can gather more information on who, where, and how much in each area. This is so I can develop a schedule for the scout that is efficient.

If you are interested in scouting, and in the lower Hudson Valley, please be sure to contact Maire and or fill out the attached form and return. Scouting will begin in early June. She has responses on the interest and now needs this information.

What is Farm Bureau, Should I belong?

Farm Bureau is a lobbying organization that works, collectively on the issues of farmers. They have been active in the area of hemp, supporting the economic opportunity for farmers all along. Belonging is a statement (and they have a good monthly newsletter) but it also has tangible benefits such as reduced insurances (including workers comp). For more info: https://www.nyfb.org/

Resources Available from Cornell:

If you have not had the opportunity to see this resource on successful production in NYS, please review it as it is fill of links and other info. on hemp: https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/36391/beginning_hemp.pdf?1551806063

The Cornell Hemp Website: http://hemp.cals.cornell.edu/about/extension/

Upcoming Educational Event:

Consumer Educational Event on CBD

https://www.morningagclips.com/cbd-consumer-educational-event/

Building Codes:

Several of you plan on building buildings to accommodate drying or processing. Not all activities are considered agricultural and qualify for exemptions. Please read codes and consult with your building inspector/code enforcement officer.

Building Code Exemptions

by Lisa A. Ovitt, Paralegal

lovitt@nyfb.org

The Division of Building Standards and Codes (BSC) administers the mandatory statewide Uniform Fire Prevention and Building Code (Uniform Code) and State Energy Conservation Construction Code (Energy Code). The Division provides a variety of services related to the Uniform Code and Energy Code. It provides technical assistance, administers variances, delivers educational programming, oversees the enforcement practices of local governments and serves as secretariat to the State Fire Prevention and Building Code Council. The Albany Central Office and eleven regional offices throughout the state provide regional service to elected officials and local code enforcement personnel regarding general requirements for code enforcement. The Division program was created by Chapter 707 of the Laws of 1981.

The New York Legislature enacted Article 18 of the Executive Law, directing the formulation of a Uniform Fire Prevention and Building Code (Uniform Code), which became effective January 1, 1984. The Uniform Code is designed to cover new construction, building rehabilitation, fire safety, and housing maintenance. In addition, there are several exemptions scattered throughout the Uniform Code that exempt certain types of buildings and structures. Below is a partial list of structures that are exempt, either in whole or in part, from the Uniform Code. Please note that every structure must be carefully evaluated based on its **actual use** to determine if it meets the requirements for any exemptions.

Section 372 of Article 18 of the Executive Law defines a building as “a combination of any materials, whether portable or fixed, having a roof, to form a structure affording shelter for persons, animals or property.”

The following types of structures common to agriculture are specifically mentioned in either Executive Law or the Uniform Code as being exempt, either whole or in part:

- **Temporary Greenhouses** – Exempt from the Uniform Code per the definition of a "building" provided above. "Temporary greenhouse" means specialized agricultural equipment having a framework covered with demountable polyurethane materials or materials of polyurethane nature and lacking a permanent and continuous foundation which is specifically designed, constructed and used for the culture and propagation of horticultural commodities. A "temporary greenhouse" may include, but is not limited to, the use of heating devices, water and electrical utilities, and supporting poles embedded in non-continuous concrete. A temporary greenhouse cannot be used for the retail sale of any farm or non-farm products.

  In general, the Uniform Code prescribes "standards for the construction of all buildings or classes of buildings including factory manufactured homes, consonant with accepted standards of engineering and fire prevention practices." Therefore, as a "temporary greenhouse" does not meet the definition of a "building," the Uniform Code does not regulate the construction of structures that meet the definition of a "temporary greenhouse."

  A "temporary greenhouse" does not have to be located on a farm, nor in an agricultural district defined by the New York State Agriculture and Markets Law. A "temporary greenhouse" may be for personal use or for commercial use; however, it cannot be "used for the retail sale of any farm or non-farm products."

- **Agriculture Buildings** – "Nothing in the rules shall require or be construed to require regular, periodic inspections of (A) owner-occupied one and two-family dwellings, or (B) agricultural buildings used directly and solely for agricultural purposes, provided, however that this shall not be a limitation on inspections conducted at the invitation of the owner or where conditions on the premises threaten or present a hazard to public health, safety, or welfare." An agriculture building is defined as a structure designed and constructed to house farm implements, hay, grain, poultry, livestock, or other horticultural products, **excluding** any structure designed, constructed or used, in whole or in part, for human habitation, or a place of employment, where agricultural products are processed, treated, or packaged, or as a place used by the public. This means that barns where there are workers, for example, milking cows, **are not exempt from the building code.**

  Generally, inspections of agricultural buildings would only be triggered by either a change in use or occupancy (e.g. if an agricultural building once used solely to house poultry became a

place used by the public), at the invitation of the owner, or by the presence of a hazardous condition.

The following types of structures are not specifically mentioned in either Executive Law or the Uniform Code as being exempt or partially exempt; however, based on the language provided in Executive Law and the Uniform Code, these structures can be characterized as being exempt as described below:

- Solar Farms – Solar farms that are not associated with a building or other structure regulated by the Uniform Code do not meet the definition of a "building" provided above. Only when the solar farm can be considered equipment and/or a system that is an appurtenance to a building are they subject to the Uniform Code requirements (see other sections such as 605.11 of the 2015 International Fire Code).

- Ponds – The Uniform Code does not contain a definition for "Ponds" and subsequently does not contain construction provisions for them. The 2017 Uniform Code Supplement contains the definition of a swimming pool, which does not include "structures, basins, or chambers" which are not intended for "swimming, diving or recreational bathing" (i.e. koi ponds or drainage and irrigation ponds).

Note: Agricultural Buildings are not exempt from the "administrative, operational, and maintenance provisions" of the 2015 International Fire Code or the 2015 International Property Maintenance Code. The 2015 International Fire Code as adopted by New York State may be found at https://codes.iccsafe.org/content/IFC2015/toc. The Code is designed to address conditions hazardous to life and property from fire, explosion, handling or use of hazardous materials and the use and occupancy of buildings and premises. The 2015 International Property Maintenance Code as adopted by New York State may be found at https://codes.iccsafe.org/content/IPMC2015NY-1/toc. This Code applies to all existing residential and non-residential structures and premises and constitutes minimum requirements and standards for such things as light, ventilation, heating, sanitation, etc.

Look for Technical Bulletins to be posted soon at https://www.dos.ny.gov/DCEA/tech_bull2016.html regarding NYS agencies with permitting authority.

Note: The above referenced information/exemptions are not intended to apply to any other ordinance, law, or regulation. Being exempt from the Uniform Code does not exempt these structures from other potential provisions outside of the Uniform Code, including **local** zoning and building requirements. Therefore, code users should review all relevant ordinances, laws, or other regulations that may be applicable.

For more information:

NYS Department of State, Division of Building Standards and Codes (BSC)
https://www.dos.ny.gov/dcea/.

Building Standards and Codes Fire Prevention and Control

https://www.dos.ny.gov/DCEA/pdf/2018-09%20-UC%20Exceptions%20Final.pdf

The information contained in this article is provided for informational purposes only. It is not intended to be, nor should it be considered, a substitute for legal advice rendered by a competent attorney. If you have any questions about the application of the issues raised in this article to your particular situation, seek the advice of a competent attorney.

Source: Grassroots, Compliance Corner, May 2019

Hemp Update #3 - 5/10/19

Summer Scout/Intern:

In the first update I put a call out for those interested in field scouting. It will be reasonable ($100-200/farm for the season) – yes THAT inexpensive. The scout will start in early June and collect data into August. She will report to you and collect samples/consult with Cornell as needed. But, shortly I need to know who is interested in scouting so I can start building a schedule of visits. And, not just interest – how many fields/acres you would like scouted. In all likelihood, we will not be able to scout all the acreage but this will help me plan her week. It's first-come-first serve (within reason) Please let me know your interest ASAP in this. Maire 845-344-1234 or mru2@cornell.edu.

This Week - Transplant Management:

This week we will focus on transplants…there are few scientific sources for hemp transplant production but, using general advice for tomato transplant production is a good place to start…

Excellent General article on transplant production:

http://extension.uga.edu/publications/detail.html?number=B1144&title=Commercial%20Production%20of%20Vegetable%20Transplants

Good Resource for organic substrates & fertilizer and production:

http://www.greenhouse.cornell.edu/crops/organic.html

Probably one of the biggest problems with hemp transplants, because they can grow too rapidly, is managing their height for the transplanter. Height or "stretching" is a combination of differences between night temperature and day temperature, levels of light in the greenhouse, water stress, and fertility. It is a complex mix of all of these factors that can make the difference between nice 4-6" transplants and 10" ones. Brushing, known to work on tomatoes to manage height, has not been studied in hemp. Although, Faculty growing transplants have been using brushing thus far in production. They suspect many of the tomato techniques are useful for hemp.

Good tomato height management factsheet:

https://nevegetable.org/vegetable-transplant-production/plant-culture-and-height-management

Watering enough but not too much is as much an art as a science for transplants. Most utilize hand watering. Good website to start:

https://ag.umass.edu/greenhouse-floriculture/fact-sheets/hand-watering-greenhouse-crops-resources

Another area of concern is water quality. In Orange County (and I suspect more of SENY) well water with high to very high pH and alkalinity are common. Over weeks of watering into flat cells (compared to the large quantities of soil in the field or even a much larger container), you can drive the pH of your mix high enough that it is limiting uptake of nutrients and possibly allowing some nutrients to become toxic. Well water for greenhouse use should be checked and possibly amended to counteract this effect. pH testing is good but alkalinity tests are necessary for accurate assessment of potential/current problems. Many water testing labs do this but be sure that what they are testing for is what you want, not just pH. Those who specialize in greenhouse management surely know what you are looking for and will often recommend solution to amend with the testing.

http://www.greenhouse.cornell.edu/crops/factsheets/pHGreenhouseCrops.pdf

Have You Seen This?

(if photo does not display, it's an attachment for you)

Faculty are testing plants with these symptoms but this could be 2 things:

Normal (not really, but not harmful/contagious) variegation. It seems as some varieties seem to express these mottled leaves more than others. Think freckles and families… If this is the case, these are merely anomalies that can be ignored. They may not grow as well since they are missing some of the chlorophyll to feed them but they are harmless to a producer who is not planning on saving seed from the crop for the next generation.

Mosaic virus. If it is, it was likely transmitted by insects, and in turn, could be transmitted from this plant to another. The insects we are familiar with that transmit viruses in plants are thrips, aphids, leafhoppers, and whiteflies. If you see plants like this, it is probably best to have them tested but most importantly, unless you KNOW it is NOT a virus, quarantine the few that show the symptoms until you have a diagnosis and evaluate the greenhouse or field for potential vectors. Insects can carry the virus in their systems for days leading to additional infections after quarantine/destruction.

Wonderful Website of the Week:

North Carolina State Extension too has an excellent website for hemp. Most notably they have quite a list of seed and transplant suppliers.

https://industrialhemp.ces.ncsu.edu/

Previous Hemp Updates can be found here:

https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/37835/Hemp_Updates.pdf?1557432417

most recent are on first pages.

NY Hemp Exchange/Buy and Sell Board:

It's not fancy but its effective!

Current Buy/Sell Listings:
https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/37547/hempadupdate4-24.pdf?1556201539

To post your own listing (updated ~ weekly):
https://cornell.qualtrics.com/jfe/form/SV_e35Eb3pNfpWkqhv

HV Hemp Update #2, 5/3/19

Applications for CBD Growing Re-opened

New York State is accepting grower applications from individuals and businesses for the Industrial Hemp Agricultural Research Pilot Program. Applications for future research partners can be submitted in the areas of grain, fiber, and Cannabidiol (CBD). The Department is not accepting CBD processor applications at this time. https://www.agriculture.ny.gov/pi/pihome.html

My recommendation: For not-yet-permitted CBD growers, given the lateness of the season and the scarcity quality of seed that is not already "spoken-for" for CBD production, it is best to apply for 2020 production. Take the season to prepare/submit a quality application and be ready (permitted) by end of 2019 so acquiring seeds or plants is seamless.

For those who already are permitted, this is an opportunity to add acreage /locations if you have the plant matter to fill it.

NYSDAM Seeks Letters of Interest from Hemp Cooperatives

The request for Research Letter of Interest from Agricultural Cooperatives New York has an opportunity to lead industry development by creating more opportunities for farm businesses to grow, process, produce, and market industrial hemp and industrial hemp products. Agricultural Cooperatives may be an advantageous business structure under which growers may consider entering the industrial hemp marketplace. Agricultural Cooperatives may be formed under Article 6 of the New York State Cooperative Corporations Law (https://codes.findlaw.com/ny/cooperative-corporations-law/#!tid=N210D7380BFCA48E5B2233EEF1AF5E923) for the production and merchandising of agricultural commodities. Agricultural Cooperatives provide the means by which farmers may act together in manufacturing, processing, preparing for market, handling and/or marketing their farm products. Farmers are also able to act together in purchasing, testing, grading, processing, distributing and/or furnishing farm supplies and/or farm business services. These cooperatives are owned and operated by and for the mutual benefit of its farmer members. To learn more about the potential for New York farmers to pool resources, spread risk, and share in the benefits with respect to industrial hemp, the Department would like to work with agricultural cooperatives or growers interested in exploring the feasibility of a cooperative business structure in the industrial hemp sector.

LETTERS OF INTEREST MUST BE SUBMITTED IN WRITING AND POSTMARKED OR EMAILED ON OR BEFORE JUNE 6, 2019. Letters of Interest and any questions must be submitted in writing to ag.dev@agriculture.ny.gov or through the U.S. mail to: NYS Department of Agricultural and Markets Agricultural Development Division Industrial Hemp Agricultural Cooperative Letter of Interest 10B Airline Drive Albany, NY 12235

Hemp Crop Insurance?

Crop Insurance through USDA/RMA is not available yet and a reasonable prediction is that it would not be available for 4-5 years for a crop-specific policy and I suspect, that would be for grain and fiber. It may be longer for CBD if the costs of production stay where they are today as that complicates matters quite a bit. Then, it may not be available in every county, even after policy is designed, because volume of production in a county determines inclusion. Here is an article that was in Progressive Farmer that addresses that and a few other Farm Bill tid-bits related to insurance.
https://www.dtnpf.com/agriculture/web/ag/news/business-inputs/article/2019/02/19/rma-administrator-hemp-coverage-new-2

As for Whole Farm Revenue Protection coverage, it is not available for 2019 since the 2019 policy was defined before the 2018 farm Bill passed. But for 2019, growing hemp does NOT preclude you from having Whole Farm for the other-than-hemp farm income in 2019 (previously that had been the case). This RMA statement suggests that Whole Farm may be available for 2020. Keeping exceptional records of costs and income, separate for hemp if you have other crops, will help you, when Whole Farm is available, to include hemp as an income stream that can be insured. However, I'm not sure how Whole Farm will work, and when it would be available, if it is your only farm income and you do not have a farm income history prior to hemp.
https://www.rma.usda.gov/en/Policy-and-Procedure/Bulletins-and-Memos/2019/MGR-19-002

However, several private agencies are offering crop insurance. From my e-review, they seem to vary widely in what they cover and not and several do not give a lot of specifics. Well, at least for me on their website without asking for a direct quote as a farmer. For those of you new to crop insurance, I would be happy to walk through any quote you have to troubleshoot.

Other insurance: Some of those companies offering crop insurance also offer other types of farm/product insurance such as liability. Of course, having proper business insurance to protect you all along the way is vital, especially if your business is a sole-proprietorship or partnership to protect private assets. Because of that it is recommended that you form an S-corp or LLC for your business to insulate you and your personal assets from any accident/suit that might befall you.

Cornell Interested in Feral Hemp

If you happen to have a feral hemp population on your farm (a patch that has survived the many years since hemp was cultivated on your farm or from seeds that fell out of rope etc.), Cornell Plant Breeding would like some of these live plants to use in the breeding program. Utilizing the genetics from plants that have survived this long, outside of cultivation, would be an asset in developing vigorous New York varieties. If you have such a stand (they are probably just up and identifiable now) please contact us to collect plants or seeds later in the year.

USDA Now Accepting Applications of Seed-Propagated Hemp for Plant Variety Protection

The U.S. Department of Agriculture (USDA) today announced that the Plant Variety Protection Office (PVPO) will start accepting applications of seed-propagated hemp for plant variety protection.

PVPO provides intellectual property protection to breeders of new varieties of seeds and tubers. Implementing the Plant Variety Protection Act, PVPO examines new applications and grants certificates that protect varieties for 20 years (25 years for vines and trees). Certificate owners have rights to exclude others from marketing and selling their varieties, manage the use of their varieties by other breeders, and enjoy legal protection of their work.

Applicants can submit their applications through the electronic application filing system, choosing hemp in the Crop Kind Dropdown box. The ePVP System provides an efficient and secure way to 1) file new plant variety protection applications, 2) amend existing applications, 3) pay fees, 4) check the status of an application, and 5) correspond directly with PVPO staff.

All new ePVP System users must be e-authenticated before being able to use the system. Click on http://www.eauth.usda.gov/ to apply for a USDA eAuthentication Account.

- Domestic users: Request level 2 access and follow the instructions to establish the account.
- International users: Request level 1 access only; and upon creating the account, email name and contact information to pvpomail@ams.usda.gov to finalize the account authorization.
- Once e-Authentication has been completed, applicants can proceed to establish an ePVP

For questions on e-Authentication, logging into the ePVP System and PVPO operation, please e-mail pvpomail@ams.usda.gov or call (202) 260-8983. Information on program requirements, fees and forms is also provided on the PVPO website.

Upcoming Educational Opportunities:

More info to follow…. but mark your calendars!

- Eastern NY Hemp Conf & Expo - Albany- June 3-4 https://www.ushempexpos.com/about-eastern
- Willsboro Farm Field Day – July 10
- Aurora Farm Field Crops Field Day – July 11
- Freeville Organic Farm Field Day – July 31
- Long Island Hort Res Ext Center Plant Science Day – July 31
- Hemp Workshop – Empire Farm Days – Aug 6-8
- Cornell Hemp Field Day – Geneva – Aug. 13
- Cornell CBD Hemp Field Day – Bluegrass Lane, Ithaca – Sept. 10?

HV Hemp Update #1

Welcome to Hemp production! Some of you are new, some are not, to either hemp production and/or commercial agriculture and processing.

Cornell Cooperative Extension in New York State is actively reaching out to producers and processors to help further the industry. In the Hudson Valley, CCE is working across county lines to deliver critical information and services to the industry…hence this list serve.

Here to Hemp… *ooops… I mean* HeLp….

If you are unfamiliar with Cornell Cooperative Extension you can learn more about it here: http://cce.cornell.edu/
In your County you can reach out to:
Orange - http://cceorangecounty.org/ – Maire Ullrich mru2@cornell.edu
Ulster – http://ulster.cce.cornell.edu/ - Christian Malsatzki cpm78@cornell.edu
Columbia/Greene - http://ccecolumbiagreene.org/- Margaret Smith mms426@cornell.edu or Aaron D. Gabriel adg12@cornell.edu
Dutchess - http://ccedutchess.org/ - Stephanie Radin sradin@cornell.edu or Jennifer Fimbel jlf20@cornell.edu
Putnam - http://putnam.cce.cornell.edu/ - Jennifer Lerner jjs95@cornell.edu
Sullivan - http://sullivancce.org/ - Michelle Proscia mml249@cornell.edu

This growing season we hope to provide timely updates about the state of the crop, educational and marketing opportunities, answers to common production or regulatory questions, and much more!

Resources Available from Cornell:

Firstly, if you have not had the opportunity to see this resource on successful production in NYS, please review it as it is fill of links and other info. on hemp: https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/36391/beginning_hemp.pdf?1551806063
The Cornell Hemp Website: http://hemp.cals.cornell.edu/about/extension/

2019 Hemp Intern:

CCE Orange will be hosting a Cornell Student Intern this summer to do hemp crop pest evaluations as well as collect as much data as possible on production practices and costs for developing academic budgets. This intern will be like a field scout (or greenhouse) and do scouting on a certain number of fields/locations each week. There may be a bi-weekly schedule to visit the same fields/locations every other fields/locations to increase the number of fields she can get to – but all numbers depend on interest. So…. who is interested? (contact Maire at mru2@cornell.edu) Likely, there will be nominal fee to offset mileage costs as she will be travelling through several counties. Expressing interest in not binding. Also, if you do not "sign-up" for the scout, emergency visits will still be possible if you have an urgent matter with your hemp crop.

Crop Production Notes from Cornell Faculty:

Weed management for Hemp 2019

There are no selective herbicides yet registered specifically for use in hemp. Weed control in hemp might best achieved with a combination of different cultural. One method to try might be to start with the stale seed bed technique. This practice allows weed seedlings to emerge for several days to 4 weeks after the field has been finally fitted for seeding. After significant weed emergence and before they are too large, the weed cover is removed. The method of removal is somewhat limited for hemp. The post emergence herbicide SUPPRESS is labeled for this type of use generally for all food and fiber crops. SUPPRESS is OMRI approved as an organic herbicide. However, it will only work well on small broadleaf weeds and its cost may be prohibitive. Propane flaming or even light surface cultivation are other possible means of removed the emerged weed cover. This operation should then be followed with direct seeding of the crop without further soil disturbance. Even in the best of circumstances this will not provide 100% weed control, but it can reduce the initial weed growth so that a vigorous crop can outpace the weeds. (A. Senesac)

Disease management for Hemp 2019

Sil-MATRIX (EPA Reg. No. 82100-1) is a fungicide/miticide/insecticide that contains 29% potassium silicate, the active ingredient. It is labeled for use on numerous crops including industrial hemp. It is described as a broad spectrum, preventative fungicide. Powdery mildew is the only labeled disease for vegetables, fruits, nuts, vine crops, agronomic crops, and ornamentals. Labeled insect pests are aphids, spider mites, and whiteflies. It is approved for use in organic production (OMRI listed). Based on my experience testing organic fungicides for powdery mildew in vegetable crops, I would expect Sil-MATRIX to provide moderately good control of this disease in hemp when applied on a regular (weekly) basis starting before or at start of disease development, especially if this powdery mildew occurs predominantly on the upper leaf surface or it is possible to achieve good spray coverage on the underside of leaves. (M. McGrath)

Alternative Pest Management:

Also consider products from here as some are not pesticides but fertilizers or soil inoculants that can be used to improve plant health so they can better fend off pests.
http://www.biosafesystems.com/

Labs for Plant Testing for Sex via Leaf Material:

https://www.steephill.com/genkit and https://phylos.bio/plant-sex-test and https://www.medicinalgenomics.com/gender-detection/

Details on Setting up Testing Labs can be found from NYSDOH:

https://www.wadsworth.org/regulatory/elap/medical-marijuana

NY Hemp Exchange/Buy and Sell Board:

It's not fancy but its effective!
Current Buy/Sell Listings:
https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/37547/hempadupdate4-24.pdf?1556201539
To post your own listing (updated ~ weekly):
https://cornell.qualtrics.com/jfe/form/SV_e35Eb3pNfpWkqhv

Educational Opportunities:

US Eastern Hemp Expo June 2-4, Albany, NY https://www.ushempexpos.com/about-eastern
Hemp Breeding and Seed Production: A new course developed by the UC Davis. The first course offering is scheduled for October 29-30, 2019 in Davis,
CA http://sbc.ucdavis.edu/Courses/Hemp_Breeding_and_Seed_Production/

Additional NYS/Cornell Events here: https://hemp.cals.cornell.edu/category/events/

In the News:

Farm Journal has done several pieces on hemp in the past few months
https://www.agweb.com/cannabis/

Eur J Plant Pathol (2018) 150:575–588
DOI 10.1007/s10658-017-1301-y

Not the one, but the only one: about *Cannabis cryptic virus* in plants showing 'hemp streak' disease symptoms

Laura Righetti · Roberta Paris · Claudio Ratti · Matteo Calassanzio · Chiara Onofri · Davide Calzolari · Wulf Menzel · Dennis Knierim · Gianmaria Magagnini · Daniela Pacifico · Gianpaolo Grassi

Accepted: 13 July 2017 / Published online: 22 July 2017

Abstract Interveinal chlorosis and leaf margin wrinkling are widespread symptoms of *Cannabis sativa*. They are traditionally attributed to the so-called hemp streak virus (HSV), but its existence has not been demonstrated yet. To our knowledge, no molecular investigation has so far been performed in order to identify the causal agent of this symptomatology, we therefore decided to use traditional and molecular virology techniques to better characterize symptoms and pursue the etiological agent. No pathogenic virus was found by using targeted PCR reactions and by RNA sequencing, whereas we were able to detect the *Cannabis cryptic virus* (CanCV) with both techniques. We, therefore, developed an RT-qPCR assay based on a CanCV-specific TaqMan probe and applied it to a wide range of symptomatic and symptomless plants, using a two-step (for quantification), or a one-step (for fast detection) protocol. Both symptoms and the virus were only shown to be transmitted vertically and did not pass via mechanical inoculation or grafting, though we could not find any cause-effect correlation between them. In fact, the virus was found in all the tested hemp samples, and its abundance varied greatly between different accessions and individuals, independently from the presence and severity of symptoms. The suggestion that hemp streak is caused by a virus is therefore questioned. Some abiotic stresses seem to play a role in triggering the symptoms but this aspect needs further investigation. For breeding purposes, a selection of parental plants based on the absence of symptoms proved to be efficient in containment of the disease.

Keywords *Partitiviridae* · *Cannabis sativa* · HSV · RNA-Seq · RT-qPCR

Electronic supplementary material The online version of this article (doi:10.1007/s10658-017-1301-y) contains supplementary material, which is available to authorized users.

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Introduction

Cannabis sativa L. (Cannabaceae), commonly known as hemp, is an important herbaceous species and a uniquely versatile plant that has been grown for at least 5000 years (McPartland et al. 2000). This plant offers raw material for many industrial uses, including textiles, paper, rope and innovative biomaterials, as well as

foodstuffs, cosmetics and fuel. It is also a source of bioactive molecules of interest to the pharmaceutical industry, but its use for human health has experienced ups and downs throughout history, and nowadays it is regulated differently in many countries.

Hemp is well adapted to most European agricultural and environmental conditions but, despite a reputation for being quite resistant, it can host several pathogens and suffer from diseases and pests (McPartland 1996). A number of known bacterial and fungal pathogens are responsible for different stress symptoms and diseases (Kusari et al. 2013), whilst limited literature on the subject reports only a dozen common plant viruses able to infect *Cannabis* plants (McPartland et al. 2000) and only five viral syndromes. Among these, three are caused by known agents, all with a worldwide distribution and a wide host range: *Alfalfa mosaic virus* (AMV), *Cucumber mosaic virus* (CMV) and *Arabis mosaic virus* (ArMV), whereas the causal agents of the syndromes observed and described under the names of Hemp streak virus (HSV) and Hemp mosaic virus (HMV) have yet to be isolated and characterized. In particular, symptoms attributed to HSV were originally described in 1941 (Röder 1941) and caused serious losses also in Italy (Ferri 1963). According to these references, foliar symptoms appear as interveinal yellow streaks; eventually, leaf margins become wrinkled, leaf tips roll upward and leaflets curl into spirals, and such syndrome is still widely observed among hemp accessions, as reported by farmers and amateur growers.

More recently, another virus was found in hemp plants and characterized by molecular tools. The *Cannabis cryptic virus* (CanCV) was accidentally isolated by Ziegler et al. (2012) while using hemp as host to propagate a hop virus. The CanCV genome consists of two linear molecules of monocistronic double-stranded RNA (dsRNA) 2420 and 2346 nucleotides in length, which code for a putative RNA-dependent RNA polymerase (RdRp) and a coat protein (CP), respectively. Following phylogenetic analysis, the virus has been included in the new *Betapartitivirus* genus, within the *Partitiviridae* family, whose members are known to infect plants, fungi, and protozoa generally without causing obvious symptoms (Nibert et al. 2014). Ziegler et al. (2012) found that five out of six hemp varieties tested were positive for the presence of CanCV by using *CP* specific primers in RT-PCR, suggesting that this virus is widespread among hemp varieties. Nonetheless, no other information is reported in literature about the role and effects of CanCV in *Cannabis* plants.

The recent resurgence of interest in both medical and food uses of *C. sativa* is demanding plants that are suitable for vegetative propagation and free from pathogens, like viruses, that can affect plant metabolism and production. Up to date, little is known about hemp diseases and very little research has been done, probably also due to regulatory constraints in its cultivation. However, a better understanding of mechanisms triggering recurring symptoms, like those of hemp streak, is essential for disease management and breeding of resistant varieties.

During this project, we studied expression and transmissibility of hemp streak symptoms and looked for the possible viral agent by means of both traditional and molecular techniques; these were applied according to each result achieved as work progressed. Corroborating evidence obtained by different techniques (for example RT-PCR and NGS) is included to strengthen our results, describing methods that can be readily used by other researchers. We also focused on CanCV, investigating its spread and transmissibility, therefore offering a new contribution to the controversial question on the attribution of an etiological role of 'cryptoviruses' in plants.

Materials and methods

Plant material

Different varieties of *Cannabis sativa* were used, as specified in the following paragraphs. Most experiments were carried out on the Dutch cultivar (cv.) 'Chamaeleon' and on the Italian variety 'Codimono' because, based on our experience, these varieties showed severe HSV associated symptoms (as defined in the following paragraph) starting from very early stages of growing. Also many other European and Asian accessions were assessed to investigate the diffusion of CanCV.

Plants were grown in three different environments. Most experiments were performed in a glasshouse where plants received natural photoperiod and lighting; a second environment consisted of a growth chamber equipped with high-pressure sodium lamps, with a photoperiod of 16 h of light and a temperature of 22–26 °C. The third environment was the open field in the

experimental station of Rovigo, Italy (Latitude: 45° 4′ 41.912″ N; longitude: 11° 45′ 56.988″ E; altitude: 0 m asl).

Nicotiana benthamiana and *Chenopodium quinoa* plants were used as common viral hosts for transmission tests by mechanical inoculation.

Hemp streak symptom description

Early foliar symptoms attributed to HSV, as described by McPartland et al. (2000), were considered. These are typically interveinal yellow streaks (later called interveinal chlorosis) and leaf margin wrinkling upward (later referred to as leaf wrinkling). Severity scales for interveinal chlorosis and leaf wrinkling were defined from 1 (no symptoms) to 4 (symptoms spread on the whole leaf surface) (Fig. 1). In all experiments, plant phenotyping was performed independently by three different operators and average scores were calculated. The severity index (SI) of symptoms was given as the product of the values obtained for interveinal chlorosis and leaf wrinkling, ranging from 1 (no symptoms) to 16.

Screening for plant viruses

Leaves from 6 highly symptomatic (SI = 16) and 6 symptomless (SI = 1) plants of the cv. 'Chamaeleon' were tested for the presence of the most common viruses by PCR. The species or genus-specific primer pairs and relative references are listed in Table 1. DNA or cDNA were used as templates for amplification, according to the virus type. DNA was extracted from 50 to 100 mg of frozen leaf material with Nucleospin® Plant II (Macherey-Nagel) and 5 ng were used for subsequent applications.

Total RNA was extracted from 50 to 100 mg frozen leaf material by Spectrum™ Plant Total RNA kit (Sigma-Aldrich) and treated with DNAse I (Sigma-Aldrich). For cDNA synthesis, 500 ng of RNA were denatured at 80 °C for 2 min, then reverse transcribed in 10 μL reaction, using High-Capacity RNA-to-cDNA Kit (Life Technologies). For PCR detection of members of the genus *Carlavirus* and *Potyvirus*, the cDNA was synthesized using the M4T primer (Table 1) and the enzyme Superscript III (Invitrogen).

Positive controls (Table 1) were nucleic acids extracted from virus-infected plants. Fragments of the expected sizes were obtained by (RT)-PCR with all primer pairs used on the respective positive controls, supporting the reliability of the results obtained.

The presence of virus particles in symptomatic hemp leaves was further tested by electronic microscopy. Purification was performed as published elsewhere (Turina et al. 2007) from 60 g of symptomatic leaves collected from 2-month-old hemp plants. Purified particles were adsorbed to two different carbon-coated (polyvinyl formal) 300 mesh-grids and observed by Philips CM 10 transmission electron microscope (TEM) after negative staining with 2% uranyl acetate (pH 4.3).

Next generation sequencing approach

Total RNA from highly symptomatic cv. 'Codimono' was used as template for an RNA sequencing approach. The nucleic acid was extracted using QIAGEN RNeasy kit, followed by selective depletion of ribosomal RNA (Invitrogen RiboMinus™ Plant Kit). A paired-end library was created from double stranded cDNA (Illumina Nextera XT Library Preparation Kit) and sequenced on an Illumina MiSeq platform. De novo assembly of the reads was done using the Geneious software (ver. 9.2.3). The assembled contigs were analyzed for similarities to known viruses by NCBI nucleotide BLAST (http://blast.ncbi.nlm.nih.gov/Blast.cgi) to identify putative (partial) genomes of viruses present in the sample.

CanCV re-sequencing and sequence analysis

The entire genome of the CanCV isolate from the hemp cv. 'Chamaeleon' was re-sequenced as follows: the dsRNA was isolated from symptomatic leaves as described by Tzanetakis and Martin (2008), run on 1% agarose gel, and used as template for a random RT-PCR approach (Froussard 1992) and RACE reactions for the determination of 5′ and 3′-ends; remaining gaps were amplified using sequence specific primers. With the exception of RACE PCR products, which were sequenced directly, obtained fragments were cloned (pGEM-T vector, Promega) before sequencing (Helmholtz Centre for Infection Research, Braunschweig). Sequence analysis and alignments were carried out using BLAST, SMART (http://smart.embl-heidelberg.de) and EMBL-EBI Clustal Omega (http://www.ebi.ac.uk/Tools/msa/clustalo/) tools. The sequences obtained from the two genomic dsRNAs were submitted to GenBank (accession no. KX709964 and KX709965).

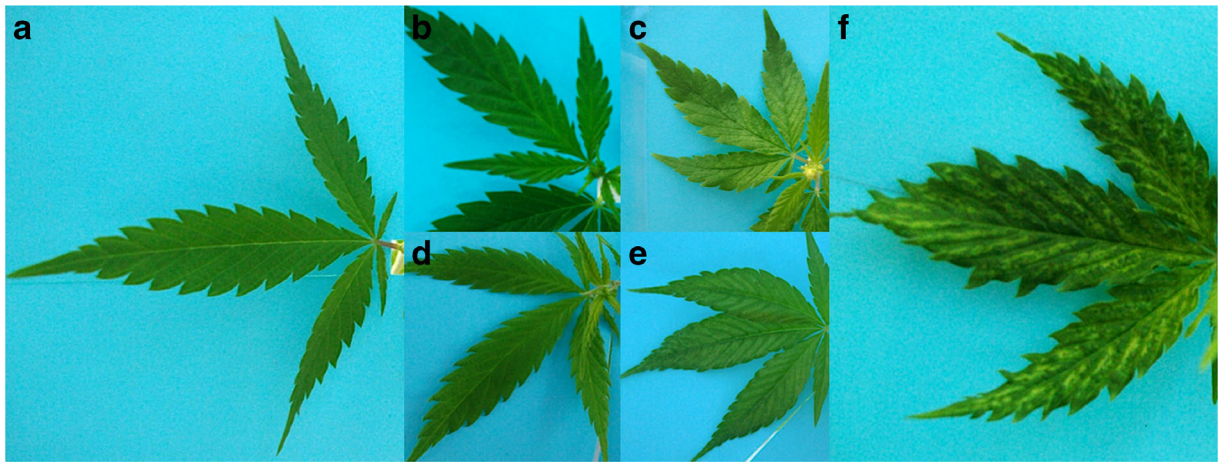

Fig. 1 Scale of symptoms of interveinal chlorosis (IC) and leaf wrinkling (LW) ranging from 1 (no symptoms) to 4 (symptoms spread on the whole leaf surface). **a** healthy leaf (IC 1; LW 1); **b** (IC 2; LW 1); **c** (IC 3; LW 1); **d** (IC 1; LW 2); **e** (IC 1; LW 3); **f** (IC 4; LW 4)

The *CP* complete coding sequence (cds) was aligned to that of the CanCV isolate from the French variety Fedora 17 (GenBank ID: JN196537). The portion of *CP* gene between primers CP_F and CP_R (Table 2) was amplified by PCR from the cDNA of 5 accessions from different countries and sequenced in order to verify the level of conservation. Sequencing was performed by BioFab Research s.r.l (http://www.biofabresearch.it/). Sequence alignments were performed with EMBL-EBI Clustal Omega. CanCV *CP* and *RdRp* cds were blasted against the 'Purple Kush' and 'Finola' genome and transcriptome (van Bakel et al. 2011) and all the *Cannabis* ESTs available on NCBI (http://www.ncbi.nlm.nih.gov), in order to verify whether CanCV sequences were already present in these databases. Attempts of amplifications from genomic DNA of 'Chamaeleon' and 'Codimono' were also performed to exclude integration events into the plant genome.

All primer and probe sequences used in this work are listed in Table 2.

CanCV relative quantification

CanCV relative quantification was performed through two-step RT-qPCR using the Rotor-Gene 6000 Instrument (Corbett Life Science). TaqMan primers and probe (Table 2) were designed on a conserved region of CanCV *CP* by using PRIMER EXPRESS Software version 2.0 (Life Technologies) and blasted against the non-redundant nucleotide and EST collections (NCBI), and the *Cannabis* genome (http://genome.ccbr.utoronto.ca) to further confirm their specificity.

Each reaction was performed in a total volume of 15 μL, containing 7.5 μL of Rotor-Gene probe PCR kit 2X (Qiagen), 0.75 μL of TaqMan probe 20X (1X contains 900 nM of each unlabeled primer and 250 nM of the 6-FAM dye-labeled MGB probe) and 1.5 μL of cDNA as the template, obtained as described above. Amplifications were carried out with an initial activation step of 3 min at 95 °C, then 40 two-step cycles of 3 s at 95 °C and 10 s at 60 °C for annealing/extension.

Relative quantification was performed using *beta tubulin TUB* (Marks et al. 2009) as the reference gene in an independent 6-FAM labelled TaqMan reaction performed in the same run (Table 2). The absence of DNA in cDNA samples, obtained through DNase treatment of the starting RNAs before reverse transcription to cDNA, was further confirmed by PCR with intron-spanning primers targeting the *TUB* gene (Table 2) and agarose gel electrophoresis. Two standard curves were also generated to determine the amplification efficiency of both assays (*CP* and *TUB*). As templates, we used the PCR products of 525 bp (for *CP*) and of 293 bp (for *TUB*) obtained using primers as in Table 2, and purified on column by QIAquick PCR Purification Kit (Qiagen). The Ct values of 4 serial 1:100 dilutions of the templates were plotted versus the log of the dilution factors and the slopes of the linear regression curves were used to calculate efficiencies according to the eq. $E = 10^{\wedge(-1/\text{slope})}-1$. Both efficiencies of amplification were close to 1 (1.01 for *CP* assay and 1.09 for *TUB* assay), data are thus presented as

Table 1 Target, primers, references and positive controls of the viruses tested for this study

Target	Name	Sequence (5′-3′)	Amplicon length (bp)	Reference	Positive control
Species *Alfalfa mosaic virus*	AMVCP_F2 AMVCP_R2	GCTGGTGGGAAAGCTGGTAAAC GGCTACGGCATAGGAATGCTTG	483	(Koziel 2010)	*Alfalfa mosaic virus*
Species *Cucumber mosaic virus*	CMV_F2 CMV_R2	AGAGTCTTGTCGCAGCAGCTTTCG ACTGATAAACCAGTACCGGTGAGG	367	(Koziel 2010)	*Cucumber mosaic virus*
Genus *Tobamovirus*	Tob-Uni 1 Tob-Uni 2	ATTTAAGTGGASGGAAAAVCACT GTYGTTGATGAGTTCRTGGA	804	(Letschert et al. 2002)	*Tobacco mosaic virus*
Genera *Trichovirus/ Capillovirus/ Foveavirus*	PDO-Fli PDO-R3i	TITTYATKAARWSICARYWITGIAC GCRCACATRTCRTCICCIGCRAAIIA	362	(Foissac et al. 2005)	*Cherry virus A*
	PDO-R4i	ARIYICCATCCRCARAAMITIGG			
	PDO-F2i	GCYAARGCIGGICARACIYTKGCITG			
	PDO-Rli	TCHCCWGTRAAICKSATIAIIGC			
Genus *Carlavirus*	M4T Carla-Uni	GTTTTCCCAGTCACGAC$(T)_{15}$ GGAGTAACYGAGGTGATACC	150	(Badge et al. 1996)	*Potato virus M*
	M4	GTTTTCCCAGTCACGAC			
Genus *Potyvirus*	M4T Sprimer	GTTTTCCCAGTCACGAC$(T)_{15}$ GGNAAYAAYAGYGGNCARCC	1500–1800	(Chen et al. 2001)	*Plum pox virus*
	M4	GTTTTCCCAGTCACGAC			
Genus *Nepovirus* species *Arabis mosaic virus*	ArMV_F2 ArMV_R2	ACACTGTCTGTCCCTCATTGG CCTCGACCCTATCACATACTC	843	(Koziel 2010)	*Arabis mosaic virus*
Genus *Nepovirus subgroups A and B*	NepoA-F NepoA-R	ACDTCWGARGGITAYCC RATDCCYACYTGRCWIGGCA	340	(Wei and Clover 2008)	*Arabis mosaic virus*
	NepoB-F NepoB-R	TCTGGITTTGCYTTRACRGT CTTRTCACTVCCATCRGTAA	250		*Tomato black ring virus*
Genus *Nepovirus subgroup C*	Nepo-C-s Nepo-C-a	TTRKDYTGGYKAAMYYCCA TMATCSWASCRHGTGSKKGCCA	640	(Digiaro et al. 2007)	*Tomato ringspot virus*
Genus *Luteovirus*	Luteo-C1F1 Luteo-C1F2	GGGGTMMTCAAATTCGGKCC TCGCAATGYCCAGCRCTTTCAG	129/156	(Chomič et al. 2010)	*Barley yellow dwarf virus*
	Luteo-C1R1	GAGTTCAATAAAKATWGCGCC			
	Luteo-C1R2	GTCGAGTTCAATAA AGAKWGCGCC			
Genus *Caulimovirus*	Caulimo3'cpF	GAARRHCATTATGC MAAYGARTGTCCW	840	(Pappu and Druffel 2009)	*Cauliflower mosaic virus*
	C4281	WWGGRTTTTCWRAACWWACT			
Genus *Badnavirus*	HafF HafR	ATGCCITTYGGIITIAARAAYGCICC CCAYTTRCAIACISCICCCCAICC	530	(Lyttle et al. 2011)	*Canna yellow mottle virus*

mean of ddCt ± standard error, calculated according to the rules of error propagation. For the *CP* assay, the standard curve loses linearity at Ct > 32, we therefore considered this Ct value as a threshold for a reliable relative quantification. Samples with Ct < 32 were CanCV positive (CanCV+) while CanCV was considered not quantifiable (CanCV_nq) if Ct ≥ 32 or when no amplification could be detected. These latter samples were double checked with an additional primer pair, targeting the *RdRp* cds of CanCV, designed by software Primer 3 (http://biotools.umassmed.edu/bioapps/primer3_www.cgi), and used with SYBR Green chemistry. Reactions were performed in 15 μL, containing 1X SYBR Select Master Mix (Life Technologies), 100 nM of specific primer pairs and 1.5 μL of cDNA template. Amplification conditions consisted of an initial denaturation at 95 °C for 2 min, followed by 45 cycles as follows: 95 °C for 15 s, 60 °C for 60 s. The absence of dimer formation was checked in

Table 2 Primers and probes used in this study

Target gene[a]	Application	Name	Sequence (5′-3′)	Amplicon length (bp)
CP	Sequencing	CP_ F	CAATGCCATGAAATCACTCG	525
GenBank ID JN196537	Standard curve analysis	CP_R	TAGGGATGCTTGGC TTGAAC	
	RT-qPCR TaqMan	CP_TaqMan_F	TCTCGAGCTACTCCCAATTC CA	65
		CP_TaqMan_R	CGCAGTCGATTGTATAGGAA CGA	
		CP_MGB_probe-FAM	CTCCTCGCCTGCCTGC	
TUB	cDNA evaluation/ Standard curve analysis	TUB_F	GGCGCTGAGTTGATCGATTC G	gDNA[b] ~1916
GenBank ID GR222117.1		TUB_R	GCTTCATTATCAAGAACCAT GCAC	cDNA 293
	RT-qPCR TaqMan	TUB_TaqMan_F	CTCTGACACAGTTG TGGAACCAT	93
		TUB_TaqMan_R	GCGTTTTCAACCAGTTGATG CA	
		TUB_MGB_probe-FAM	ACAACGCCACCCTCT	
RdRp	RT-qPCR	RdRp_F	ATCGCATCTCCCAATTCATC	202
GenBank ID JN196536.1	SYBR Green	RdRp_R	GGCTTGAGTCCATTTTCAGG	

[a] *CP*: Coat Protein; *TUB:* beta tubulin; *RdRp*: RNA-dependent RNA polymerase

[b] gDNA: genomic DNA, matching with Finola genomic sequence 14487376:503–2760, from the *C. sativa* genome browser

no-template samples by product dissociation analysis and electrophoretic separation in agarose gel. Each analysis was repeated twice. In the event of a difference between the two replicates of 0.5 Ct or more the reactions were repeated.

For fast detection of CanCV, a spot one-step RT-qPCR method was also developed and used in the experiments on symptom and CanCV transmissibility. Templates prepared as in Minguzzi et al. (2016) were used in TaqMan reactions as described above, with the addition of 4 U of M-MLV Reverse Transcriptase (Promega) and 0.25 μL of RNasin Ribonuclease Inhibitor (Promega). The program was 30 min at 48 °C, 10 min at 95 °C, 40 cycles of 10 s at 95 °C and 1 min at 60 °C.

Inter and intra-accession analysis of CanCV

Seeds of 125 different hemp accessions were sown in the field in April 2013 and grown until maturity. Foliar symptoms were evaluated at pre-flowering (June 2013) and 35 single plants, derived from 12 different countries across Europe and Asia, with symptom severity ranging from SI = 1 to 16 were chosen to investigate the presence and the abundance of CanCV. A sample of the youngest fully expanded leaf (about 1 g, fresh weight) was collected at pre-flowering (June 2013), full flowering (July 2013) and end of flowering (August 2013), frozen immediately in liquid nitrogen and stored at −80 °C until RNA extraction. Two independent homogenization, RNA extractions and reverse transcriptions were performed on each leaf sample. Every cDNA was used as a template for two reactions of two step RT-qPCR as described above. Pairwise t-test and correlation coefficient were calculated with R.

In order to verify the reliability of the assay, data were analyzed with both the ddCt method, using *TUB* as the reference gene, and by absolute quantification, with the *CP* standard curve described above. In this case, the log of the viral copy number was estimated as in Olmos et al. (2005), which was modified to take into account that, in our case, the template is dsDNA, and normalized to the total RNA used in the RT-qPCR reaction. The two

sets of results were rescaled and compared with the Two Sample Kolmogorov-Smirnov Test using R.

For intra-accession analyses, five different accessions were selected from the 35 field-collected accessions, covering a wide range of symptom severity and CanCV abundance. Five seeds per accession were sown in peat fertilized with 1X Hoagland's solution 1 (Hoagland and Arnon 1950) and grown in a growth chamber with 16 h photoperiod, 430 μmol PAR, 23/19 °C day/night temperature and 65 ± 5% day/night relative humidity for 3 weeks. For each plant, the youngest fully expanded leaves were sampled and processed as described above.

Transmission tests

Symptoms were tentatively transmitted to plants of *N. benthamiana* and *C. quinoa* grown in a greenhouse for 3 weeks before mechanical inoculation. Leaf tissues from 'Codimono' plants showing severe symptoms were homogenized in a mortar with the addition of 0.1 M Na-phosphate buffer, pH 7.5 containing 0.12% sodium sulfite and 5% polyvinylpyrrolidone (Clover et al. 2003). The homogenate was mixed with carborundum powder and mechanically inoculated on herbaceous indicators (at least 10 plants for each species). The appearance of local or systemic symptoms was evaluated until 4 weeks after inoculation. This experiment was performed twice.

The same protocol was followed with the leaves of plants that were positive to CanCV. Local and systemic presence of CanCV in inoculated *N. benthamiana* and *C. quinoa* plants was evaluated by one-step RT-qPCR assay.

Cross grafting between rootstocks and scions from twelve symptomatic and twelve symptomless *C. sativa* (cv. Codimono) plants and from twelve plants that were positive to CanCV (CanCV+) and twelve others in which CanCV was not quantifiable (CanCV_nq) was also performed. All plants were grown in a growth chamber under the conditions described above and the symptoms, as well as the presence of CanCV, were monitored until 3 months after grafting.

The transmission of symptoms and CanCV was also evaluated in 'Codimono' progenies deriving from crosses of one symptomatic (SI =16) female CanCV_nq plant partially subjected to sex reversion with silver thiosulfate solution (STS) (Mohan Ram and Sett 1982) that was self-pollinated and used for pollinating three other female plants with the following characteristics: 1) symptomatic and CanCV+; 2) symptomless and CanCV+ and; 3) symptomless and CanCV_nq. Seeds were collected separately from each plant. Seed production, seed germinability, symptom rate in 40 plants, and CanCV presence in 3 symptomatic and 3 symptomless plants from the offspring were evaluated.

Finally, plants of the same 'Codimono' variety used in the previous test were rated for symptoms and then, at an early stage (17 days after sowing), divided into two groups consisting of 24 symptomatic (SI > =9) and 24 symptomless plants. These groups of plants were kept separate in grow boxes (1.2 m × 1.2 × 2.0 m) until seed production and the rate of symptoms was evaluated in 160 plants of the two progenies.

Effect of nutrition and growth conditions on symptoms

In order to verify the effect of nutrients upon the appearance of symptoms, seeds of 'Chamaeleon' were sown in February 2014 on coco coir or peat substrate. Plants were supplemented daily with the complete fertilizer Coco A & B (5% NO^{3-}, 0.1% NH^{4+}, 4% P_2O_5, 3% K_2O, 7% CaO, 3% MgO, 2% SO_3, 0.007% B, 0.001% Cu, 0.02% Fe DTPA, 0.0003% Fe EDTA, 0.01% Mn, 0.002% Mo, 0.007% Zn, 0.5% fulvic and humic acid, CANNA International BV, Oosterhout, Netherlands). Four different electrical conductivity (EC) levels of nutrient solution (0.3; 1; 2 and 3 mS/cm) were compared, approximately corresponding to a dilution of the complete fertilizer at 0, 1:500, 1:250, and 1:170 (*v*/v), respectively. Half of these were grown in a glasshouse with a natural photoperiod of approximately 14 h, and temperatures and humidity ranging as in Online Resource 1. The remaining plants were grown in the growth chamber with a 16-h photoperiod, 26/22 °C day/night temperature and 72/55% day/night relative humidity, and moved to the glasshouse 3 weeks after sowing. Five weeks after sowing, symptoms were rated and plant heights were measured.

Analysis of variance and the Tukey's test post-hoc comparisons were performed with R.

Results

Screening for plant viruses

Different approaches were used to identify possible viral agents. Firstly, an approach based on PCR and specific

primer pairs was attempted, comparing symptomatic and symptomless plants. The result was that no amplification was obtained with primers that are specific to viruses known for infecting *Cannabis* (CMV, AMV, ArMV). Negative results were also obtained using specific primers for both viruses with RNA (genera *Trichovirus*, *Capillovirus* and *Foveavirus* within the family *Flexiviridae*, *Nepovirus* group A, B and C, *Tobamovirus*, *Potyvirus*, *Carlavirus* and *Luteovirus*) and DNA (genera *Caulimovirus* and *Badnavirus*) genomes. Positive results were only obtained for CanCV that was detectable in both symptomatic and symptomless plants.

Subsequently, as a universal method to identify plant viruses, we performed an RNA-Seq analysis on a highly symptomatic sample, and again only CanCV was identified. In detail, chloroplast and mitochondrion DNA sequences were subtracted (accession nos. KR059940, KR779995, NC_026562, NC_027223 and NC_029855) from the 4,491,006 reads obtained from the Illumina MiSeq run. De novo assembly of the remaining 2,131,126 reads resulted in a total of 1000 assembled contigs, ranging from 232 up to 5949 bases. Only two contigs of 2380 and 2258 bases assembled from 18,975 and 11,475 reads, respectively, were identified as the putative genome (lacking the extreme 5′- and 3′-ends) of a Partitivirus, with the highest nucleotide sequence identity of 99% versus *Cannabis cryptic virus* RNA1 and RNA2 (isolate Fedora 17). No other contigs with similarities to known viruses or viroids could be identified.

Finally, TEM observation of the virus purification product identified isometric virus-like particles of approximately 34–36 nm in diameter, corresponding to the CanCV particles observed by Ziegler et al. (2012). No other type of virus-like structure was observed in any of the analyzed specimens.

CanCV database search and sequence analysis

A total of 20 CanCV *CP* sequences similar to *CP* cds from ‘Fedora 17’ were retrieved in the NCBI EST collection (EW700746, EW700777, EW700979, EW700980, EW701078, EW701242, EW701378, EW701434, EW701404, EW701449, EW701446, EW701462, EW701504, EW701513, EW701558, EW701651, EW701661, EW701691, EW701706), all derived from different cDNA libraries obtained from healthy, symptomless plants of the fiber hemp ‘Chamaeleon’ (van den Broeck et al. 2008).

No sequence similar to CanCV was retrieved from the *Cannabis* genome or amplified starting from hemp genomic DNA, suggesting the absence of integration events.

As expected, a single band of about 2.4 kbp resulted from agarose gel electrophoresis of the viral dsRNA extracted from the cv. ‘Chamaeleon’, which provided further evidence of the absence of other viruses with ssRNA or dsRNA genomes. Sequence analysis of the two genomic RNAs clearly identified the virus as an isolate of CanCV. The complete nucleotide sequences encoding the putative *CP* and *RdRp* genes were 99% identical to both the ‘Fedora 17’ isolate described by Ziegler et al. (2012), and the sequences obtained by deep sequencing of the hemp variety ‘Codimono’. This suggests a low sequence variability in all isolates for which sequence information is available.

The partial re-sequencing of CanCV *CP* from 5 different accessions further confirmed the presence of a highly-conserved portion which was therefore selected for the design of primers and probes for the TaqMan assay. The 65 bp region of the CanCV *CP* cds amplified with the TaqMan assay primers showed no similarity with other sequences. This supports the CanCV specificity of the assay.

CanCV relative quantification

Among the 125 phenotyped hemp accessions, approximately 74% were completely symptomless and 26% showed hemp streak symptoms on at least one plant. The CanCV relative quantification was performed on 35 single plants from different accessions, chosen on the basis of the SI. Nine were symptomless, 10 showed mild symptoms ($2 < SI < 4$) and the remaining plants showed more severe symptoms, with a SI ranging from 6 to 16. The results in Fig. 2 clearly showed and confirmed that CanCV is ubiquitous, with wide ranging quantities (the highest ddCt is about 24). The standard error is more or less constant across observations regardless of the mean, therefore for low ddCt the measurement is notably less precise. In our dataset, a difference in ddCt of 5 usually corresponds to a statistically significant difference according to pairwise t-test (p-value < 0.05), but the discrimination could be improved by increasing the number of replicates. The 35 accessions are displayed from left to right according to an increasing level of symptom

severity (expressed as SI), making it clear that there is no direct correlation between CanCV relative quantity and symptoms (correlation coefficient = 0.14). Nor did the time of sampling influence the viral RNA quantity in hemp leaves (data not shown). Using the TaqMan assay, CanCV was found not quantifiable in two symptomless plants only, for which, however, the *RdRp* based SYBR Green assay revealed positivity to CanCV.

These data were analyzed also by absolute quantification using the standard curve method and the distributions of the two sets of results were compared. The Two Sample Kolmogorov-Smirnov Test *p*-value of 0.9995 indicated that there is no significant difference between the two distributions, supporting the choice of using *TUB* as reference gene to estimate the relative quantification of the virus.

We also observed that the variability of CanCV quantification among plants of the same accession was generally very high (Table 3); a low variability of measures, associated to very high Ct values, was found only in one accession out of five (No. 15). Three plants of three different accessions were excluded from the analysis because their Ct was higher than the TaqMan assay quantification limit; however, for all three SYBR Green analysis unequivocally confirmed positivity to CanCV.

Transmission of symptoms and CanCV

No symptoms were observed on *C. quinoa* or *N. benthamiana* plants 4 weeks after mechanical inoculation, nor was CanCV detected in any plant inoculated with CanCV positive sap. Between 1 and 2 weeks after grafting, all scions were successfully grafted onto rootstocks, allowing translocation of nutrients and, if present, pathogens invading the vascular system. Despite symptomatic and CanCV-positive scions and rootstocks preserving their symptoms and viral infection, they transmitted neither of these to the symptomless or CanCV_nq scions and rootstocks up to 3 months after grafting.

Phenotyping and molecular analysis of progenies derived from vertical transmission experiments are shown in Table 4. Pollen was obtained from a symptomatic and CanCV_nq plant subjected to partial chemical-induced sex reversion. The highest rate of symptoms (52.5%) was registered in the self-pollinated progeny, whereas in the progenies derived from the other crosses symptoms did not seem to be clearly influenced by the presence or absence of symptoms on the female plants. Interestingly, CanCV was not quantifiable in the sexually reverted (symptomatic) plant, and progenies were clearly positive to CanCV when the female parental was positive, while Ct was higher than 32 (nq) when the female parental was nq too. Seed production of the symptomatic female was slightly lower than that of the symptomless ones (12 g vs 16 g and 19 g), while seed germinability was not clearly influenced by CanCV or by symptoms in the parents.

In the experiment where 'Codimono' plants were separated according to the presence or absence of symptoms at day 17, the selection of symptomatic plants provided highly symptomatic offspring (36.3%), while the selection of symptomless parents provided offspring with very low rate of symptoms (6.3%).

Effect of nutrition and growth condition on symptoms

The appearance and severity of symptoms were not triggered by nutritional deficiencies. Plants without fertirrigation (EC of 0.3 mS/cm) were strongly affected in their development, with an average height below 7 cm and presenting severe symptoms of nutrient deficiencies. At EC from 1 to 3 mS/cm, increasing levels of fertilization positively affected plant growth, but did not prevent the appearance of symptoms (Fig. 3) or decrease their severity (data not shown). On the other hand, the stress imposed by moving a batch of plants from a controlled environment to the glasshouse with no temperature, humidity or light control, where the difference between the lowest and highest temperatures often exceeded 20 °C and the photoperiod was reduced, triggered symptoms on about 20% of the plants (Fig. 3).

Discussion

Despite the traditional description of hemp streak as a viral disease, in our set of experiments it was not possible to identify any viral causal agent correlated to the symptoms.

Different approaches, based on both conventional and novel virology techniques, were consequently used, based on, and as confirmation of, the results obtained with previous methods. The initial approach was to test the presence of known viruses on symptomatic hemp plants, using PCR with specific primer pairs for as many viruses as possible, including, but not limited to those transmitted by pollen or seeds. By PCR analysis, we

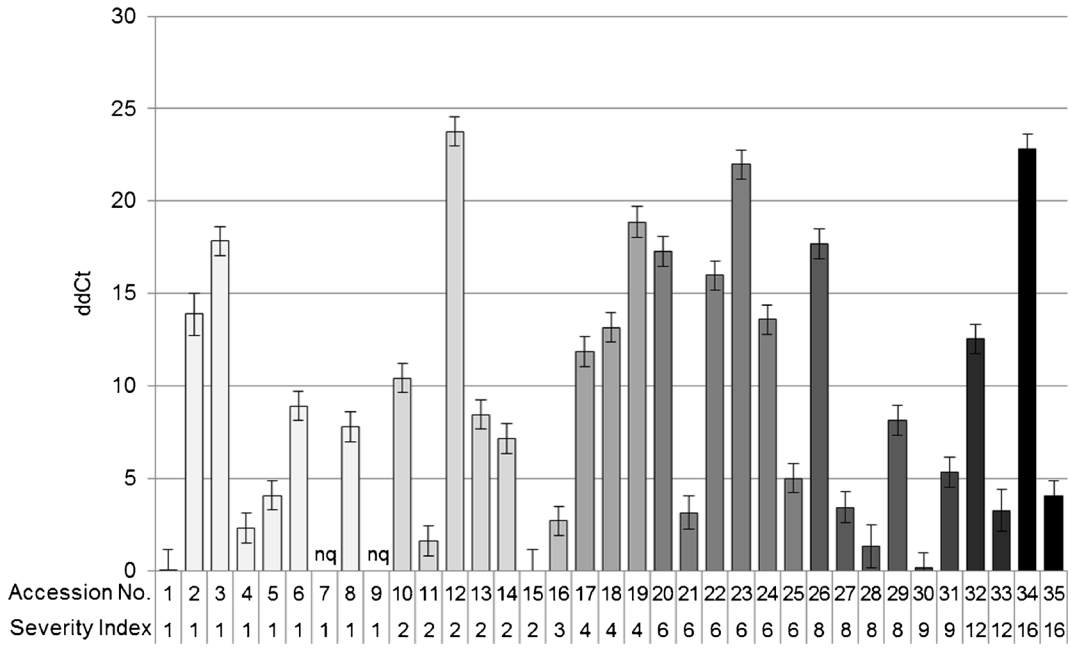

Fig. 2 CanCV relative quantification in 35 plants of 35 different accessions. Plants, identified with a number from 1 to 35, are displayed from left to right according to increasing level of symptom severity, highlighted with different shades of *gray*. Accession 15 was used as the calibrator for ddCt calculation. Results are expressed as means of ddCt and *error bars* represent the standard errors. nq: accessions with non-quantifiable *CP* (Ct > 32)

excluded the presence of viruses known to be pathogenic for *C. sativa* (AMV, CMV and ArMV) and of some other common plant viruses with RNA genomes (genera *Trichovirus*, *Capillovirus*, *Foveavirus*, *Nepovirus*, *Potyvirus*, *Tobamovirus*, *Carlavirus*, *Luteovirus)*. Our analyses also failed to retrieve DNA viruses of the *Caulimovirus* and *Badnavirus* genera, which, to the contrary, can give consistent symptoms in other hosts. As a further attempt to identify never-before-seen viruses or other pathogens putatively involved in triggering symptoms, we therefore moved to an RNA next-generation sequencing approach, which offers a powerful alternative solution to conventional targeted methods (Adams et al. 2013). RNA virus genomes or pathogen transcripts are sequenced on a background of host nucleic acid, and identified by similarity to known pathogens using bioinformatic approaches. These innovative technologies are also a powerful tool in understanding the implications of one or more microorganisms in plant disease occurrence. In this research, we sequenced the transcriptome of highly symptomatic hemp leaves with Illumina MiSeq and the only match was with the *Cannabis cryptic virus*, which was also revealed by TEM. Indeed, CanCV was the only detectable virus in the accessions of *Cannabis sativa* we analyzed and therefore we investigated its spread and possible role in the syndrome under study. We started with a partial re-sequencing of the *CP* gene of CanCV isolated from

Table 3 Descriptive statistics of RT-qPCR results in 5 plants of 5 accessions

Accession No.	min dCt	max dCt	mean dCt	95% confidence interval	median dCt
9	−7.0	11.2	1.2	±10.9	−2.3
15[a]	−7.7	−5.0	−6.2	±1.8	−6.1
20	−4.0	10.0	4.7	±6.6	6.0
25 [a]	−0.9	12.1	7.5	±9.2	9.3
29[a]	−5.0	−1.0	−3.5	±2.7	−3.9

[a] One plant out of five had a non-quantifiable amount of CanCV and was omitted from this analysis

Table 4 Results of transmission tests in progenies derived from crossing between symptomatic (S) and symptomless (SL) plants

Cross	Not germinated seeds	Symptomatic plants	CanCV in S plants		CanCV in SL plants	
			nq	+	nq	+
♀S CanCV_nq x ♂S CanCV_nq (self pollination)	3/40 (7.5%)	21/40 (52.5%)	3/3	0/3	3/3	0/3
♀S CanCV+ x ♂S CanCV_nq	4/40 (10.0%)	12/40 (30.0%)	0/3	3/3	0/3	3/3
♀SL CanCV_nq x ♂S CanCV_nq	9/40 (22.5%)	9/40 (22.5%)	3/3	0/3	3/3	0/3
♀SL CanCV+ x ♂S CanCV_nq	4/40 (10.0%)	15/40 (37.5%)	0/3	3/3	0/3	3/3

nq: plants with non-quantifiable *CP* (Ct > 32)

+: plants positive to CanCV

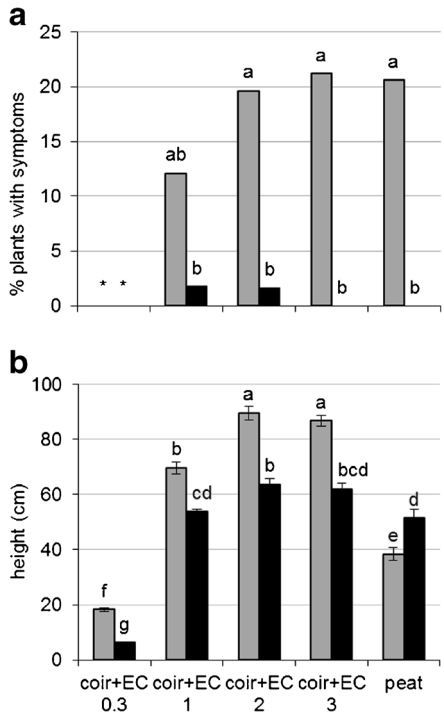

Fig. 3 Fertilization and environmental effects upon symptoms. **a** percentage of symptomatic plants; **b** average height and standard errors of the mean (19 degrees of freedom). In *gray*: plants that were moved from the growth chamber to the glasshouse 3 weeks after germination; in *black*: plants that were in the glasshouse for the whole experiment. The electrical conductivity (EC) of the tested nutrient solutions was 0.3, 1, 2 and 3 mS/cm; peat was used as control. *: symptoms were not evaluated due to unsuitable plant growth. *Different letters* correspond to statistical difference according to Tukey's post-hoc test ($p < 0.05$). No symptoms were observed at EC 2, 3 and on peat under glasshouse conditions

different accessions to verify the conservation of its genome and, based on this, designed specific real-time PCR assays. We report two variants of the method of detection: the first enables measurement of the CanCV relative abundance in relation to that of the plant *beta tubulin* gene using RT-qPCR and TaqMan probes; the second is aimed at a non-quantitative fast diagnostic screening and it is based on the same *CP* primers and probes but in a single one-step Real Time RT-PCR using leaf juice as a template. CanCV was detected in all tested plants and our results demonstrated for the first time that CanCV abundance is extremely variable in both different accessions and different individuals of the same accession, but in a completely independent manner from hemp streak symptom appearance and severity.

Ziegler et al. (2012) had already reported a wide distribution of CanCV in hemp varieties, with only one accession (Uso 31) being tested negative. However, they used semi-quantitative PCR for detection, which is less sensitive than RT-qPCR with hydrolysis probes. We could not find any unequivocally negative samples, even though for some individuals the results were close to the limit of our detection techniques. Since partitiviridae sequences encoding for CPs have been found integrated into plant genomes (Chiba et al. 2011), we tested whether this event also occurred for CanCV in hemp, as a possible explanation of its ubiquitous presence. *CP*-like sequences were not found by searching in public genomic databases or by direct molecular analyses on plant DNA. Conversely, 20 ESTs similar to CanCV *CP* were retrieved from the cDNA libraries constructed by van den Broeck et al. (2008) from healthy plants, suggesting that the virus was present in the host plant at the time of sampling.

Since we did not find a cause-effect relationship between this virus and streak symptoms, further experiments would be necessary to unveil if and how CanCV affects the fitness of hemp plants. In our experimental conditions, the presence alone of CanCV did not trigger any symptoms and, at least in the tested genotypes, we can exclude the co-existence of more viral agents, that in

other biological systems can cause a severe symptomatology, as reported in strawberry (Tzanetakis et al. 2008) and in many other species (Lamichhane and Venturi 2015). Ubiquitous presence and latent behavior are expected for these types of viruses that have been called cryptic precisely because they usually mediate persistent infections of their hosts, usually plants or fungi, with few or no effects on host cells. In some cases, they can negatively affect growth and virulence of some fungal hosts (Potgieter et al. 2013; Xiao et al. 2014), whereas, in other cases the same virus might be harmful, cryptic or beneficial to its host depending on the complexity of the ecological interaction (Hyder et al. 2013). The effect on plant pathogenic fungi can indirectly affect their interaction with the host plant. Some direct negative effects have been reported on host plants, i.e. on raphanus and beet (Chen et al. 2006; Xie et al. 1994), while other observations suggest positive mutualistic relationships, as in the interaction between *White clover cryptic virus 1* and *Trifolium repens* or between *Lolium perenne* and a probable deltapartitivirus (Nibert et al. 2014; Roossinck 2011). In fact, plant viruses might positively impact response to both abiotic and biotic stresses (Roossinck 2015), but these relationships bring costs and benefits to the plant and the ability to understand and modulate these could be a powerful resource for breeders and growers. For all these reasons, monitoring the presence and abundance of CanCV in hemp could be of great interest. The availability of the TaqMan assays may be useful to underpin the biology and epidemiology of CanCV, which remain largely unknown, and in breeding programs in the attempt to identify virus-free selections. Our results also gave new evidence that CanCV is transmitted vertically at least by seeds, while it does not pass between scion and rootstock in the case of grafting.

Concerning the hemp streak symptoms, our results, according to the new Koch postulates (Fredricks and Relman 1996), suggested that leaf chlorosis and wrinkling are most likely not caused by a virus. Hemp streak symptoms were observed in many genotypes both in open field and in controlled conditions (growth chamber, glasshouse) since the appearance of the first mature leaves. We observed that in general leaf chlorosis and wrinkling appeared more intensely in young plantlets grown in stressful conditions (for example in rockwool pads). Abiotic factors like imbalances of soil nutrients and climatic stress can provoke symptoms that resemble those of diseases caused by living organisms or can predispose plants to infectious diseases caused by other agents (McPartland et al. 2000). Deficiency of Mg, Zn, Fe and Mn can provoke yellowing between veins but the association of this to the typical upward curling of leaf edges is difficult to attribute to a specific imbalance (lack or excess) of nutrients. Deficiency symptoms from mobile nutrients (like N, P, K, Mg, Mo) generally begin in larger leaves at the bottom of plants, while symptoms from less mobile elements (Mn, Zn, Ca, S, B, Fe and Cu) usually begin in younger leaves; however, we observed the appearance of symptoms at the same time on younger and older leaves. Moreover, the results obtained by our experiments excluded the possibility that nutritional deficiency alone could enhance symptom appearance and severity. Finally, we observed that sudden application of abiotic stresses, such as big changes in light, humidity and temperature, caused an outbreak of symptoms, while plants that germinated and grew in the same stressful environment seemed to adapt and barely showed symptoms; therefore the exact trigger still remains unknown. Controlled application of abiotic stresses could clarify their involvement, and this aspect would certainly merit further studies. Our results also confirmed that symptoms of leaf chlorosis and wrinkling are vertically transmitted as reported by McPartland et al. (2000), while they did not pass to herbaceous test plants or to symptomless *C. sativa* plants by grafting.

To conclude, the Hemp Streak syndrome has been observed for many years now, but the identification of its cause is still problematic. The presence of CanCV is not in itself synonymous with the disease, but we cannot exclude its interaction with other biotic or most likely abiotic stresses in triggering the symptomatology. Also the possible effect of other vertically transmitted characteristics, perhaps also of a genetic nature, would need further investigation. A better understanding of what initiates this syndrome would be helpful to deploy more appropriate control and management measures. However, since it is transmitted vertically, a selection of parental plants before crossing and, if possible, the control of environmental conditions, are effective in decreasing the rate of symptoms spreading to offspring.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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Hemp Scouting Interest Form

Name of Farm_____

Name of Hemp Business (if different from farm name)_____

Mailing Address_____City_____State_____ZIP_____

Contact Person_____

Contact Person Phone(s)_____

Contact/crop manager e-mail(s)_____

Address of Farm/Main Location for Hemp_____

*Number of Fields for scouting_____ *Number of Acres_____

☐ Greenhouse scouting ◯ alone ◯ in addition to field Square footage_____

**Field(s) are located in these Town(s)_____

In these county(ies)_____

Looking for ☐ weekly ($200 total/season) ☐ bi-weekly ($100 total/season) scouting

☐ I agree to provide the scout/CCE with any crop management information needed to comply with Worker Protection Standard Safety regulations.

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* Note that as much acreage will be accommodated as possible, depending in interest across several counties. Please give is the MAXIMUM you would like scouted and we will reduce if we must to accomodate.

** This is to plan efficient scouting schedule

United States Department of Agriculture

Office of the General Counsel

Washington, D.C. 20250-1400

STEPHEN ALEXANDER VADEN
GENERAL COUNSEL

May 28, 2019

MEMORANDUM

SUBJECT: EXECUTIVE SUMMARY OF NEW HEMP AUTHORITIES

On December 20, 2018, President Trump signed into law the Agriculture Improvement Act of 2018, Pub. L. 115-334 (2018 Farm Bill). The 2018 Farm Bill legalized hemp production for all purposes within the parameters laid out in the statute.

The Office of the General Counsel (OGC) has issued the attached legal opinion to address questions regarding several of the hemp-related provisions of the 2018 Farm Bill, including: a phase-out of the industrial hemp pilot authority in the Agricultural Act of 2014 (2014 Farm Bill) **(Section 7605)**; an amendment to the Agricultural Marketing Act of 1946 to allow States and Indian tribes to regulate hemp production or follow a Department of Agriculture (USDA) plan regulating hemp production **(Section 10113)**; a provision ensuring the free flow of hemp in interstate commerce **(Section 10114)**; and the removal of hemp from the Controlled Substances Act **(Section 12619)**.

The key conclusions of the OGC legal opinion are the following:

1. As of the enactment of the 2018 Farm Bill on December 20, 2018, hemp has been removed from schedule I of the Controlled Substances Act and is no longer a controlled substance.

2. After USDA publishes regulations implementing the new hemp production provisions of the 2018 Farm Bill contained in the Agricultural Marketing Act of 1946, States and Indian tribes may not prohibit the interstate transportation or shipment of hemp lawfully produced under a State or Tribal plan or under a license issued under the USDA plan.

3. States and Indian tribes also may not prohibit the interstate transportation or shipment of hemp lawfully produced under the 2014 Farm Bill.

4. A person with a State or Federal felony conviction relating to a controlled substance is subject to a 10-year ineligibility restriction on producing hemp under the Agricultural Marketing Act of 1946. An exception applies to a person who was lawfully growing hemp under the 2014 Farm Bill **before December 20, 2018**, and whose conviction also occurred before that date.

With the enactment of the 2018 Farm Bill, hemp may be grown only (1) with a valid USDA-issued license, (2) under a USDA-approved State or Tribal plan, or (3) under the 2014 Farm Bill industrial hemp pilot authority. That pilot authority will expire one year after USDA establishes a plan for issuing USDA licenses under the provisions of the 2018 Farm Bill.

It is important for the public to recognize that the 2018 Farm Bill preserves the authority of States and Indian tribes to enact and enforce laws regulating the **production** of hemp that are more stringent than Federal law. Thus, while a State or an Indian tribe cannot block the shipment of hemp through that State or Tribal territory, it may continue to enforce State or Tribal laws prohibiting the growing of hemp in that State or Tribal territory.

It is also important to emphasize that the 2018 Farm Bill does not affect or modify the authority of the Secretary of Health and Human Services or Commissioner of Food and Drugs to regulate hemp under applicable U.S. Food and Drug Administration (FDA) laws.

USDA expects to issue regulations implementing the new hemp production authorities in 2019.

Attachment

United States Department of Agriculture

Office of the General Counsel

Washington, D.C. 20250-1400

STEPHEN ALEXANDER VADEN
GENERAL COUNSEL

May 28, 2019

MEMORANDUM FOR SONNY PERDUE
SECRETARY OF AGRICULTURE

SUBJECT: LEGAL OPINION ON CERTAIN PROVISIONS OF THE AGRICULTURE IMPROVEMENT ACT OF 2018 RELATING TO HEMP

This memorandum provides my legal opinion on certain provisions of the Agriculture Improvement Act of 2018 ("2018 Farm Bill"), Pub. L. No. 115-334, relating to hemp.

As explained below, this memorandum concludes the following:

1. As of the enactment of the 2018 Farm Bill on December 20, 2018, hemp has been removed from schedule I of the Controlled Substances Act ("CSA") and is no longer a controlled substance. Hemp is defined under the 2018 Farm Bill to include any cannabis plant, or derivative thereof, that contains not more than 0.3 percent delta-9 tetrahydrocannabinol ("THC") on a dry-weight basis.

2. After the Department of Agriculture ("USDA" or "Department") publishes regulations implementing the hemp production provisions of the 2018 Farm Bill contained in subtitle G of the Agricultural Marketing Act of 1946 ("AMA"), States and Indian tribes may not prohibit the interstate transportation or shipment of hemp lawfully produced under a State or Tribal plan or under a license issued under the Departmental plan.

3. States and Indian tribes may not prohibit the interstate transportation or shipment of hemp lawfully produced under the Agricultural Act of 2014 ("2014 Farm Bill").

4. A person with a State or Federal felony conviction relating to a controlled substance is subject to a 10-year ineligibility restriction on producing hemp under subtitle G of the AMA. An exception applies to a person who was lawfully growing hemp under the 2014 Farm Bill before December 20, 2018, and whose conviction also occurred before that date.

This memorandum also emphasizes two important aspects of the 2018 Farm Bill provisions relating to hemp. First, the 2018 Farm Bill preserves the authority of States and Indian tribes to enact and enforce laws regulating the **production** (but not the interstate transportation or shipment) of hemp that are more stringent than Federal law. For example, a State law prohibiting the growth or cultivation of hemp may continue to be enforced by that State. Second, the 2018 Farm Bill does not affect or modify the authority of the Secretary of Health and Human Services or Commissioner of Food and Drugs under applicable U.S. Food and Drug Administration laws.

I. BACKGROUND

The 2018 Farm Bill, Pub. L. No. 115-334, enacted on December 20, 2018, includes several provisions relating to hemp.[1] This legal opinion focuses on sections 7605, 10113, 10114, and 12619, summarized below.

- **Section 7605** amends section 7606 of the 2014 Farm Bill (7 U.S.C. § 5940), which authorizes institutions of higher education or State departments of agriculture to grow or cultivate industrial hemp under certain conditions — namely, if the hemp is grown or cultivated for research purposes in a State that allows hemp production. Among other things, section 7605 amends 2014 Farm Bill § 7606 to require the Secretary of Agriculture ("Secretary") to conduct a study of these hemp research programs and submit a report to Congress. Section 7605 also repeals 2014 Farm Bill § 7606, effective one year after the date on which the Secretary establishes a plan under section 297C of the AMA.[2]

- **Section 10113** amends the AMA by adding a new subtitle G (sections 297A through 297E) (7 U.S.C. §§ 1639o – 1639s) relating to hemp production. Under this new authority, a State or Indian tribe that wishes to have primary regulatory authority over the production of hemp in that State or territory of that Indian tribe may submit, for the approval of the Secretary, a plan concerning the monitoring and regulation of such hemp production. *See* AMA § 297B. For States or Indian tribes that do not have approved plans, the Secretary is directed to establish a Departmental plan concerning the monitoring and regulation of hemp production in those areas. *See* AMA § 297C. The

[1] The 2014 Farm Bill defines **"industrial hemp"** as "the plant Cannabis sativa L. and any part of such plant, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis." 7 U.S.C. § 5940(a)(2). The 2018 Farm Bill added a new, slightly different definition of **"hemp"** in section 297A of the AMA, defined as "the plant Cannabis sativa L. and any part of that plant, including the seeds thereof and all derivatives, extracts, cannabinoids, isomers, acids, salts, and salts of isomers, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis." 7 U.S.C. § 1639o(1). Both definitions require a THC concentration of not more than 0.3 percent for a Cannabis sativa L. plant to be considered hemp versus marijuana. For purposes of this legal opinion, I use the terms **"hemp"** and **"industrial hemp"** interchangeably.

[2] The Conference Report accompanying the 2018 Farm Bill explains the effect of the repeal as follows: "The provision also repeals the hemp research pilot programs one year after the Secretary publishes a final regulation allowing for full-scale commercial production of hemp as provided in section 297C of the [AMA]." H.R. REP. NO. 115-1072, at 699 (2018).

Secretary is also required to promulgate regulations and guidelines implementing subtitle G. *See* AMA § 297D. The new authority also provides definitions (*see* AMA § 297A) and an authorization of appropriations (*see* AMA § 297E).

- **Section 10114** (7 U.S.C. § 1639o note) is a freestanding provision stating that nothing in title X of the 2018 Farm Bill prohibits the interstate commerce of hemp or hemp products. Section 10114 also provides that States and Indian tribes shall not prohibit the interstate transportation or shipment of hemp or hemp products produced in accordance with subtitle G through the State or territory of the Indian tribe.

- **Section 12619** amends the CSA to exclude hemp from the CSA definition of marijuana. Section 12619 also amends the CSA to exclude THC in hemp from Schedule I.[3]

In passing the 2018 Farm Bill, Congress legalized hemp production for all purposes within the parameters of the statute but reserved to the States and Indian tribes authority to enact and enforce more stringent laws regulating production of hemp.

II. ANALYSIS

A. As of the Enactment of the 2018 Farm Bill on December 20, 2018, Hemp Has Been Removed from Schedule I of the Controlled Substances Act and Is No Longer a Controlled Substance.

CSA § 102(6) defines "controlled substance" to mean "a drug or other substance, or immediate precursor, included in schedule I, II, III, IV, or V of part B of this title. . . ." 21 U.S.C. § 802(6). Marijuana[4] is a controlled substance listed in schedule I of the CSA. *See* CSA § 202(c)(10), schedule I (21 U.S.C. § 812(c), Schedule I (c)(10)); 21 C.F.R. § 1308.11(d)(23).

The 2018 Farm Bill amended the CSA in two ways.

- First, 2018 Farm Bill § 12619(a) amended the CSA definition of marijuana to exclude hemp. Before enactment of the 2018 Farm Bill, CSA § 102(16) (21 U.S.C. § 802(16)) defined marijuana as follows:

> (16) The term 'marihuana' means all parts of the plant Cannabis sativa L., whether growing or not; the seeds thereof; the resin extracted from any part of such plant; and every compound, manufacture, salt, derivative, mixture, or preparation of such plant, its seeds or resin. Such term does not include the mature stalks of such plant, fiber produced from such stalks, oil or cake made from the seeds of such plant, any other compound, manufacture, salt, derivative, mixture, or preparation of such mature stalks (except the resin extracted therefrom), fiber, oil, or cake,

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[3] For additional background on hemp production prior to enactment of the 2018 Farm Bill, *see* Congressional Research Service, "Hemp as an Agricultural Commodity" (RL32725) (updated July 9, 2018), *available at* https://crsreports.congress.gov/product/pdf/RL/RL32725.

[4] This opinion uses the common spelling of "marijuana" except when quoting the CSA, which uses the "marihuana" spelling.

> or the sterilized seed of such plant which is incapable of germination.

As amended by the 2018 Farm Bill, the CSA definition of marijuana now reads:

> (A) Subject to subparagraph (B), the term 'marihuana' means all parts of the plant Cannabis sativa L., whether growing or not; the seeds thereof; the resin extracted from any part of such plant; and every compound, manufacture, salt, derivative, mixture, or preparation of such plant, its seeds or resin.
>
> (B) The term 'marihuana' does not include—
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> (i) hemp, as defined in section 297A of the Agricultural Marketing Act of 1946; or
>
> (ii) the mature stalks of such plant, fiber produced from such stalks, oil or cake made from the seeds of such plant, any other compound, manufacture, salt, derivative, mixture, or preparation of such mature stalks (except the resin extracted therefrom), fiber, oil, or cake, or the sterilized seed of such plant which is incapable of germination.

- Second, 2018 Farm Bill § 12619(b) amended the CSA to exclude THC in hemp from the term "tetrahydrocannabinols" in schedule I. As amended by the 2018 Farm Bill, CSA § 202(c)(17), schedule I (21 U.S.C. § 812(c)(17), schedule I) now reads:

> Tetrahydrocannabinols, except for tetrahydrocannabinols in hemp (as defined under section 297A of the Agricultural Marketing Act of 1946).

By amending the definition of marijuana to exclude hemp as defined in AMA § 297A, Congress has removed hemp from schedule I and removed it entirely from the CSA. In other words, hemp is no longer a controlled substance. Also, by amending schedule I to exclude THC in hemp, Congress has likewise removed THC in hemp from the CSA.

It is important to note that this decontrolling of hemp (and THC in hemp) is self-executing. Although the CSA implementing regulations must be updated to reflect the 2018 Farm Bill amendments to the CSA, neither the publication of those updated regulations nor any other action is necessary to execute this removal.

I address here two principal objections to the view that the decontrolling of hemp is self-executing. The first objection is that, because regulations have not been published under CSA § 201, the legislative changes to schedule I regarding hemp are not effective. This objection is not valid.

The typical process for amending the CSA schedules is through rulemaking. Under CSA § 201(a), the Attorney General "may by rule" add to, remove from, or transfer between the schedules, any drugs or other substances upon the making of certain findings. 21 U.S.C. § 811(a). However, the schedules also can be amended directly by Congress through changes to the statute; and Congress has done so several times.[5]

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[5] *See, e.g.*, Pub. L. 112-144, § 1152 (amending schedule I to add cannabimimetic agents); Pub. L. 101-647, § 1902(a) (amending schedule III to add anabolic steroids).

The second objection is that, because the legislative changes to schedule I regarding hemp are not yet reflected in 21 C.F.R. § 1308.11, the removal is not yet effective. This objection also is not valid.

It is axiomatic that statutes trump regulations. *See Nat'l Family Planning & Reprod. Health Ass'n, Inc. v. Gonzales*, 468 F.3d 826, 829 (D.C. Cir. 2006) ("[A] valid statute always prevails over a conflicting regulation[.]"). Congress established the five CSA schedules in statute, providing that "[s]uch schedules shall initially consist of the substances listed in this section." 21 U.S.C. § 812(a).[6] Congress further provided that "[t]he schedules established by this section shall be updated and republished on a semiannual basis during the two-year period beginning one year after October 27, 1970, and shall be updated and republished on an annual basis thereafter." 21 U.S.C. § 812(a). The requirement to update and republish the schedules, however, is not a prerequisite to the effectiveness of the schedules "established by [the statute]." *Id.* In other words, where Congress itself amends the schedules to add or remove a controlled substance, the addition or removal of that controlled substance is effective immediately on enactment (absent some other effective date in the legislation); its addition to or removal from a schedule is not dependent on rulemaking.[7]

To illustrate, Congress amended the CSA in 2012 to add "cannabimimetic agents" to schedule I. That amendment was enacted as part of the Synthetic Drug Abuse Prevention Act of 2012 (Pub. L. 112-144, title XI, subtitle D), which was signed into law on July 9, 2012. Almost six months later, the Drug Enforcement Administration ("DEA") published a final rule establishing the drug codes for the cannabimimetic agents added to schedule I by Congress and making other conforming changes to schedule I as codified in 21 C.F.R. § 1308.11. *See* 78 Fed. Reg. 664 (Jan. 4, 2013). In explaining why notice-and-comment rulemaking was unnecessary, DEA noted that "the placement of these 26 substances in Schedule I **has already been in effect since July 9, 2012**." *Id.* at 665 (emphasis added). In other words, the legislative changes to schedule I were effective immediately upon enactment. The reflection of those changes in 21 C.F.R. § 1308.11, although required by 21 U.S.C. § 812(a), was not necessary for the execution of those changes to schedule I.

Accordingly, enactment of the 2018 Farm Bill accomplished the removal of hemp (and THC in hemp[8]) from the CSA. Conforming amendments to 21 C.F.R. § 1308.11, while required as part

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[6] "Marihuana" and "Tetrahydrocannabinols" were both included in the initial schedule I established by Congress in 1970.

[7] *Cf. United States v. Huerta*, 547 F.2d 545, 547 (10th Cir. 1977) ("[F]ailure to publish the 'updated' schedules as required by Section 812(a) had no effect upon the validity of those substances initially listed in the five schedules."); *United States v. Monroe*, 408 F. Supp. 270, 274 (N.D. Cal. 1976) ("Thus, while section 812(a) clearly orders the controlled substance schedules to be republished, it is clear that Congress did not intend republication to serve as a reissuance of the schedules, which if done improperly would cause those schedules to lapse and expire. . . . [T]he requirement that the schedules, once 'updated,' be 'republished' was solely for the purpose of establishing one list which would reflect all substances which were currently subject to the Act's provisions. . . .").

[8] Schedule I, as published in 21 C.F.R. § 1308.11, includes a definition of "tetrahydrocannabinols" in paragraph (d)(31) that does not appear in the CSA. Notwithstanding the presence of that definition in the current regulations, I

of DEA's continuing obligation to publish updated schedules, are not necessary to execute the 2018 Farm Bill changes to schedule I.[9]

B. <u>After the Department of Agriculture Publishes Regulations Implementing the Hemp Production Provisions of the 2018 Farm Bill Contained in Subtitle G of the Agricultural Marketing Act of 1946, States and Indian Tribes May Not Prohibit the Interstate Transportation or Shipment of Hemp Lawfully Produced Under a State or Tribal Plan or Under a License Issued Under the Departmental Plan.</u>

AMA § 297D(a)(1)(A) directs the Secretary to issue regulations and guidelines "as expeditiously as possible" to implement subtitle G of the AMA. 7 U.S.C. § 1639r(a)(1)(A). These regulations will address the approval of State and Tribal plans under AMA § 297B and the issuance of licenses under the Departmental plan under AMA § 297C. As explained below, once these regulations are published, States and Indian tribes may not prohibit the transportation or shipment of hemp (including hemp products) produced in accordance with an approved State or Tribal plan or produced under a license issued under the Departmental plan.

Transportation of hemp is addressed in 2018 Farm Bill § 10114.[10] Subsection (a) provides:

> (a) RULE OF CONSTRUCTION.—Nothing in this title or an amendment made by this title prohibits the interstate commerce of hemp (as defined in section 297A of the Agricultural Marketing Act of 1946 (as added by section 10113)) or hemp products.

7 U.S.C. § 1639o note. This provision states that nothing in title X of the 2018 Farm Bill

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am of the opinion that THC in hemp is excluded from THC as a schedule I controlled substance under the CSA by virtue of the 2018 Farm Bill amendments.

[9] Schedule I, as reflected in 21 C.F.R. § 1308.11, includes a separate listing of "marihuana extract" in paragraph (d)(58). Marijuana extract is not reflected in schedule I in the statute because it was added after 1970 by regulation under CSA § 201. The term "marihuana extract" is defined in regulation as "an extract containing one or more cannabinoids that has been derived from any plant of the genus Cannabis, other than the separated resin (whether crude or purified) obtained from the plant." The 2018 Farm Bill amended the definition of "marihuana" to exclude hemp, but because the regulatory definition of "marihuana extract" in schedule I does not use the words "marihuana" or "tetrahydrocannabinols" to define the term, a question arises whether **hemp extract** is still considered to be listed as a schedule I controlled substance. While the issue is not further addressed in this opinion, I think that the revised statutory definition of "marihuana" has effectively removed hemp extract from schedule I, and that reflecting such in 21 C.F.R. § 1308.11(d)(58) would be merely a conforming amendment.

[10] Hemp transportation is also addressed in annual appropriations acts, which restrict Federal appropriated funds from being used to prohibit the transportation of hemp. However, those provisions are limited in scope because they address only hemp produced under the 2014 Farm Bill authority, and they address only **Federal** government actions. That is, while the provisions prohibit Federal actors from blocking the transportation of so-called "2014 Farm Bill hemp," they do not restrict State action in that regard. *See* Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act, 2019, Pub. L. 116-6, div. B, § 728 (prohibiting funds made available by that Act or any other Act from being used in contravention of 2014 Farm Bill § 7606 or "to prohibit the transportation, processing, sale, or use of industrial hemp, or seeds of such plant, that is grown or cultivated in accordance with [2014 Farm Bill § 7606], within or outside the State in which the industrial hemp is grown or cultivated"). *See also* Commerce, Justice, Science, and Related Agencies Appropriations Act, 2019, Pub. L. 116-6, div. C, § 536 ("None of the funds made available by this Act may be used in contravention of [2014 Farm Bill § 7606] by the Department of Justice or the Drug Enforcement Administration.").

prohibits the interstate commerce of hemp. However, this provision, standing alone, does not have the effect of sanctioning the transportation of hemp in States or Tribal areas where such transportation is prohibited under State or Tribal law.

Subsection (b), however, specifically prohibits States and Indian tribes from prohibiting the transportation of hemp through that State or Tribal territory. Subsection (b) provides:

> (b) TRANSPORTATION OF HEMP AND HEMP PRODUCTS.—No State or Indian Tribe shall prohibit the transportation or shipment of hemp or hemp products produced in accordance with subtitle G of the Agricultural Marketing Act of 1946 (as added by section 10113) through the State or the territory of the Indian Tribe, as applicable.

7 U.S.C. § 1639o note. In effect, this provision preempts State law to the extent such State law prohibits the interstate transportation or shipment of hemp that has been produced in accordance with subtitle G of the AMA.

As a matter of constitutional law, "[t]he Supremacy Clause provides a clear rule that federal law 'shall be the supreme Law of the Land; and the Judges in every State shall be bound thereby, any Thing in the Constitution or Laws of any [S]tate to the Contrary notwithstanding. . . .' Under this principle, Congress has the power to preempt [S]tate law." *Arizona v. United States*, 567 U.S. 387, 398-99 (2012) (citing U.S. Const. art. VI, cl. 2). "Under the doctrine of federal preemption, a federal law supersedes or supplants an inconsistent [S]tate law or regulation." *United States v. Zadeh*, 820 F.3d 746, 751 (5th Cir. 2016).

Federal courts generally recognize three categories of preemption: (1) express preemption (where Congress "withdraw[s]" powers from the State through an "express preemption provision");[11] (2) field preemption (where States are "precluded from regulating conduct in a field that Congress, acting within its proper authority, has determined must be regulated by its exclusive governance");[12] and conflict preemption (where State laws are preempted when they conflict with Federal law, which includes situations "where 'compliance with both federal and [S]tate regulations is a physical impossibility'" or situations "where the challenged [S]tate law 'stands as an obstacle to the accomplishment and execution of the full purposes and objectives of Congress'").[13] *Arizona*, 567 U.S. at 399-400 (citations omitted); *see also Zadeh*, 820 F.3d at 751.

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[11] *See, e.g.*, 7 U.S.C. § 1639i(b) ("(b) Federal preemption.—No State or a political subdivision of a State may directly or indirectly establish under any authority or continue in effect as to any food or seed in interstate commerce any requirement relating to the labeling of whether a food (including food served in a restaurant or similar establishment) or seed is genetically engineered (which shall include such other similar terms as determined by the Secretary of Agriculture) or was developed or produced using genetic engineering, including any requirement for claims that a food or seed is or contains an ingredient that was developed or produced using genetic engineering.").

[12] *See, e.g.*, *Pac. Gas & Elec. Co. v. State Energy Res. Conservation & Dev. Comm'n*, 461 U.S. 190, 212 ("[T]he federal government has occupied the entire field of nuclear safety concerns, except the limited powers expressly ceded to the [S]tates.").

[13] *See, e.g.*, 21 U.S.C. § 903 ("No provision of this subchapter shall be construed as indicating an intent on the part of Congress to occupy the field in which that provision operates, including criminal penalties, to the exclusion of any State law on the same subject matter which would otherwise be within the authority of the State, unless there is

Section 10114(b) of the 2018 Farm Bill satisfies the definition of conflict preemption because a State law prohibiting the interstate transportation or shipment of hemp or hemp products that have been produced in accordance with subtitle G of the AMA would be in direct conflict with section 10114(b), which provides that no State may prohibit such activity.[14] Therefore, any such State law has been preempted by Congress. The same result applies to Indian tribes.[15]

In sum, once the implementing regulations are published, States and Indian tribes may not prohibit the shipment of hemp lawfully produced under an approved State or Tribal plan or under a license issued under the Departmental plan.

C. States and Indian Tribes May Not Prohibit the Interstate Transportation or Shipment of Hemp Lawfully Produced Under the Agricultural Act of 2014.

Because the 2018 Farm Bill does not immediately repeal the hemp pilot authority in 2014 Farm Bill § 7606 — and because the publication of regulations implementing the hemp production provisions of the 2018 Farm Bill will likely not occur until later in 2019 — the question arises whether States and Indian tribes are prohibited from blocking the interstate transportation or shipment of hemp (including hemp products) lawfully produced under the 2014 Farm Bill. The answer depends on the meaning of the phrase "in accordance with subtitle G of the Agricultural Marketing Act of 1946" in 2018 Farm Bill § 10114(b) (7 U.S.C. § 1639o note). Only hemp produced in accordance with subtitle G is covered by the preemption provision discussed above. As explained below, it is my opinion that the answer to this question is yes, by operation of AMA § 297B(f).

AMA § 297B(f) states the legal effect of the provisions authorizing States and Indian tribes to develop plans for exercising primary regulatory authority over the production of hemp within that State or territory of the Indian tribe. Specifically, section 297B(f) provides:

> (f) EFFECT.—Nothing in this section prohibits the production of hemp in a State or the territory of an Indian tribe—
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> (1) for which a State or Tribal plan is not approved under this section, if the production of hemp is in accordance with section 297C **or other Federal laws** (including regulations); and
>
> (2) if the production of hemp is not otherwise prohibited by the State or Indian tribe.

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a positive conflict between that provision of this subchapter and that State law so that the two cannot consistently stand together.").

[14] Alternatively, section 10114(b) might be considered an express preemption provision because the statute expressly withdraws the power of a State to prohibit the transportation or shipment of hemp or hemp products through the State.

[15] AMA § 297B(a)(3) contains an anti-preemption provision stating that nothing in § 297B(a) "preempts or limits any law of a State or Indian tribe" that "regulates the production of hemp" and "is more stringent than [subtitle G]." 7 U.S.C. § 1639p(a)(3). However, that anti-preemption provision is limited to the **production** of hemp — not the **transportation** or shipment of hemp — and thus does not conflict with 2018 Farm Bill § 10114(b).

7 U.S.C. § 1639p(f) (emphasis added).

This provision addresses the production of hemp in a State or Tribal territory for which the State or tribe does not have an approved plan under AMA § 297B. This provision acknowledges that, in such a scenario, the production of hemp in that State or Tribal territory is still permissible if it is produced **either** in accordance with the Departmental plan under AMA § 297C **or** in accordance with other Federal laws, and the State or tribe does not otherwise prohibit its production.

The plain language of subtitle G of the AMA, as added by the 2018 Farm Bill, thus clearly contemplates a scenario in which hemp is neither produced under an approved 297B plan nor under a license issued under the Department's 297C plan, but is still legally produced under "other Federal laws." It is my opinion that "other Federal laws" encompasses 2014 Farm Bill § 7606.[16]

To my knowledge, before enactment of 2014 Farm Bill § 7606, the CSA was the only Federal law that authorized the production of hemp. Indeed, the production of hemp — as the "manufacture" of a schedule I controlled substance — was generally prohibited under the CSA except to the extent authorized under a registration or waiver under the CSA. *See* 21 U.S.C. §§ 802(15), 802(22), 822, and 823; 21 C.F.R. part 1301. Given (1) the removal of hemp as a controlled substance under the CSA, (2) the delayed repeal of the 2014 Farm Bill § 7606 authority, and (3) the enactment of the new hemp production authorities in subtitle G of the AMA, it is my opinion that "other Federal laws" refers to the provisions of 2014 Farm Bill § 7606, which are still in effect. Such an interpretation gives immediate effect to the phrase "other Federal laws." It is a "cardinal principle of interpretation that courts must give effect, if possible, to every clause and word of a statute." *See, e.g.*, *Loughrin v. United States*, 573 U.S. 351, 358 (2014) (internal quotations and citations omitted).

Therefore, reading AMA § 297B(f) in harmony with 2018 Farm Bill § 10114(b), if the hemp is legally produced in accordance with 2014 Farm Bill § 7606 ("other Federal law"), then, by virtue of AMA § 297B(f), its production is not prohibited. Such hemp would have been produced "in accordance with subtitle G," which specifically addresses just such a scenario, as AMA § 297B(f) is part of subtitle G. Accordingly, under 2018 Farm Bill § 10114(b), a State or Indian

[16] That Congress envisioned such a scenario is apparent given the language in 2018 Farm Bill § 7605(b) delaying the repeal of 2014 Farm Bill § 7606 until 12 months **after** the Secretary establishes the 297C plan. Accordingly, this interpretation is not precluded by AMA § 297C(c)(1), which provides: "[i]n the case of a State or Indian tribe for which a State or Tribal plan is not approved under section 297B, it shall be unlawful to produce hemp in that State or the territory of that Indian tribe without a license issued by the Secretary under subsection (b)." Given the reference to "or other Federal laws" in AMA § 297B(f)(1) — and the fact that 2014 Farm Bill § 7606 is still in effect — it would be an absurd reading of AMA § 297C(c)(1) to conclude that hemp produced in accordance with Federal law (2014 Farm Bill § 7606) is, at the same time, unlawful without a separate license issued by the Secretary under the 297C plan. As courts have long recognized, statutory interpretations that "produce absurd results are to be avoided if alternative interpretations consistent with the legislative purpose are available." *Griffin v. Oceanic Contractors, Inc.*, 458 U.S. 564, 575 (1982).

tribe may not prohibit the transportation or shipment of so-called "2014 Farm Bill hemp" through that State or Tribal territory.[17]

Recent Developments

I acknowledge that this conclusion is in tension with a recent decision in a case in the District of Idaho, but it also is consistent with a recent decision in a case in the Southern District of West Virginia. Neither court addressed the "other Federal laws" language in AMA § 297B(f)(1), which I find conclusive.

In *Big Sky Scientific LLC v. Idaho State Police*, Case No. 19-CV-00040 (D. Idaho), a magistrate judge found that a shipment of Oregon hemp bound for Colorado and interdicted by Idaho State Police could not have been produced "in accordance with subtitle G" because the State of origin does not yet have an approved plan under AMA § 297B and the Secretary has not yet established a plan under AMA § 297C.[18] The magistrate acknowledged Oregon law authorizing the cultivation of hemp, noting the plaintiff's assertion that the hemp was produced by a grower licensed by the Oregon Department of Agriculture (and, thus, presumably in compliance with 2014 Farm Bill § 7606 requirements).[19] However, in denying the plaintiff's motion for a preliminary injunction, the magistrate concluded that, in enacting the 2018 Farm Bill, Congress intended to "create a regulatory framework around the production and interstate transportation of hemp for purposes of federal law, and that framework is to be contained in the federal (or compliant [S]tate or [T]ribal) plan for production of hemp found in the 2018 Farm Bill."[20] Although the 2018 Farm Bill allows hemp to be transported across State lines, the magistrate found those interstate commerce protections apply only to hemp produced under regulations promulgated under the authority of the 2018 Farm Bill.[21] Therefore, because those regulations do not yet exist, the interdicted hemp is subject to Idaho law prohibiting its transportation.

USDA is not a party in the *Big Sky* case, and this office does not concur with the reasoning of the magistrate regarding the shipment of hemp lawfully produced under the 2014 Farm Bill. In

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[17] This conclusion seems to be supported in the legislative history as well. In explaining the effect of the preemption provision, the Conference Report states: "While [S]tates and Indian tribes may limit the production and sale of hemp and hemp products within their borders, the Managers, in Sec. 10112 [sic], agreed to not allow [S]tates and Indian tribes to limit the transportation or shipment of hemp or hemp products through the [S]tate or Indian territory." H.R. REP. NO. 115-1072, at 738 (2018). Notably, the Managers referred to hemp generally, not merely hemp produced under a plan developed under subtitle G of the AMA.

[18] *See Big Sky*, ECF Doc. #32, Memorandum Decision and Order Re: Plaintiff's Motion for Preliminary Injunction; *see also* ECF Doc. #6, Memorandum Decision and Order Re: Plaintiff's Emergency Motion for Temporary Restraining Order and Preliminary Injunction and Plaintiff's Motion to File Overlength Brief (*available at* 2019 WL 438336 (Feb. 2, 2019)).

[19] *Big Sky*, ECF Doc. #32, at 5, 7-8.

[20] *Id.* at 3.

[21] *Id.* at 19-26.

interpreting the statutory language, the magistrate correctly noted the well-recognized principle of statutory construction that statutes should not be interpreted "in a manner that renders other provisions of the same statute inconsistent, meaningless, or superfluous."[22] However, seemingly ignoring that guiding principle of interpretation, the magistrate did not address the effect of the "other Federal laws" language in AMA § 297B(f) or attempt to give that language any meaning. The Idaho court failed to read the statute as a whole and did not consider the "other Federal laws" clause that I find conclusive. Given the preliminary nature of the magistrate's ruling, I find his opinion denying a preliminary injunction unpersuasive.[23]

Conversely, the interpretation of 2018 Farm Bill § 10114 advanced by this legal opinion is consistent with a decision issued in the Southern District of West Virginia. In *United States v. Mallory*, Case No. 18-CV-1289 (S.D. W. Va.), the Department of Justice filed a civil action to seize hemp allegedly grown in violation of the CSA and also outside the scope of the 2014 Farm Bill. At issue in that case was hemp purportedly grown by a producer licensed by the State of West Virginia under a 2014 Farm Bill § 7606 pilot program, where the hemp seeds were shipped from a Kentucky supplier licensed by the Commonwealth of Kentucky under a 2014 Farm Bill § 7606 pilot program. The court relied on a combination of laws — the 2014 Farm Bill, the appropriations acts provisions,[24] and the 2018 Farm Bill — to dissolve a preliminary injunction against the defendant[25] and to dismiss entirely the government's case.[26] In dissolving the preliminary injunction, the court permitted the defendants to transport the hemp product across State lines to Pennsylvania for processing and sale.[27]

Although the *Mallory* court did not have occasion to address any State attempts to block the transportation of hemp, the court did reference 2018 Farm Bill § 10114, noting that it "expressly allows hemp, its seeds, and hemp-derived products to be transported across State lines."[28] The district judge's opinion addressed hemp produced under 2014 Farm Bill § 7606 and not hemp produced under State, Tribal, or Departmental plans. The conclusion reached by the *Mallory* court is consistent with my interpretation that States cannot block the shipment of hemp, whether

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[22] *Id.* at 21-22 (citing *Padash v. I.N.S.*, 258 F.3d 1161, 1170-71 (9th Cir. 2004)). The magistrate continued:

> It is a cardinal principle of statutory construction that a statute ought, upon the whole, to be so construed that, if it can be prevented, no clause, sentence, or word shall be superfluous, void, or insignificant. . . . It is our duty to give effect, if possible, to every clause and word of a statute.

Id. at 23 (internal quotations and citations omitted).

[23] Indeed, the magistrate's ruling is under appeal. *See Big Sky Sci. LLC v. Bennetts*, Case No. 19-35138 (9th Cir.).

[24] *See supra* footnote 10.

[25] *Mallory*, ECF Doc. #60, Memorandum Opinion and Order, 2019 WL 252530 (S.D. W. Va. Jan. 17, 2019).

[26] *Mallory*, ECF Doc. #72, Memorandum Opinion and Order, 2019 WL 1061677 (S.D. W. Va. Mar. 6, 2019).

[27] *Mallory*, ECF Doc. #60, 2019 WL 252530, at *3.

[28] *Mallory*, ECF Doc. #72, 2019 WL 1061677, at *6.

that hemp is produced under the 2014 Farm Bill or under a State, Tribal, or Departmental plan under the 2018 Farm Bill. It is also a final judgment of the Southern District of West Virginia court, and not a preliminary ruling as with the District of Idaho magistrate's opinion.[29]

In matters of statutory interpretation, the text of the statute governs. One must read that text in its entirety and give every word meaning. The reference to "other Federal laws" must be given meaning, and that language clearly refers to the Federal law that currently authorizes the production of hemp — 2014 Farm Bill § 7606. Therefore, hemp produced under that pilot authority is hemp produced in accordance with subtitle G of the AMA. States and Indian tribes may not prohibit the transportation or shipment of such hemp through that State or Tribal territory.

D. The 2018 Farm Bill Places Restrictions on the Production of Hemp by Certain Felons.

The 2018 Farm Bill added a new provision addressing the ability of convicted felons to produce hemp. The 2014 Farm Bill is silent on the issue. AMA § 297B(e)(3)(B) (hereafter, "Felony provision"), as added by the 2018 Farm Bill, provides:

> (B) FELONY.—
>
> (i) IN GENERAL.—Except as provided in clause (ii), any person convicted of a felony relating to a controlled substance under State or Federal law before, on, or after the date of enactment of this subtitle shall be ineligible, during the 10-year period following the date of the conviction—
>
> (I) to participate in the program established under this section or section 297C; and
>
> (II) to produce hemp under any regulations or guidelines issued under section 297D(a).
>
> (ii) EXCEPTION.—Clause (i) shall not apply to any person growing hemp lawfully with a license, registration, or authorization under a pilot program authorized by section 7606 of the Agricultural Act of 2014 (7 U.S.C. 5940) before the date of enactment of this subtitle.

7 U.S.C. § 1639p(e)(3)(B) (emphasis added). The references to "the date of enactment of this subtitle" are to subtitle G of the AMA, as added by section 10113 of 2018 Farm Bill. Therefore, the "date of enactment of this subtitle" is the date of enactment of the 2018 Farm Bill — December 20, 2018.

In explaining the Felony provision, the Conference Report notes:

> Any person convicted of a felony relating to a controlled substance shall be ineligible to participate under the [S]tate or [T]ribal plan for a 10-year period following the date of the conviction. However, this prohibition shall not apply to producers who have been lawfully participating in a [S]tate hemp pilot program as authorized by the Agricultural Act of 2014, prior to enactment of this subtitle. Subsequent felony convictions after the date of enactment of this subtitle will trigger a 10-year

[29] *Mallory*, ECF Doc. #72, 2019 WL 1061677, at *9 (denying the United States' motion to amend and granting the defendants' motion to dismiss). *Big Sky*, ECF Doc. #32, at 28 (denying the plaintiff's motion for preliminary injunction and noting that the court will separately issue an order setting a scheduling conference to govern the case going forward).

> nonparticipation period regardless of whether the producer participated in the pilot program authorized in 2014.

H.R. REP. NO. 115-1072, at 737 (2018).

In sum, a person convicted of a State or Federal felony relating to a controlled substance — regardless of when that conviction occurred — is ineligible to produce hemp under subtitle G of the AMA for a period of 10 years following the date of the conviction. An exception exists in clause (ii) of the Felony provision that applies to a person who was lawfully producing hemp under the 2014 Farm Bill **before December 20, 2018**, and who had been convicted of a felony relating to a controlled substance before that date. States and Indian tribes now have a responsibility to determine whether a person wishing to produce hemp in that State or Tribal territory has any Federal or State felony convictions relating to controlled substances that would make that person ineligible to produce hemp.

III. OTHER ISSUES

There are two additional important aspects of this issue that should be emphasized.

First, the 2018 Farm Bill preserves the authority of States and Indian tribes to enact and enforce laws regulating the production of hemp that are more stringent than Federal law. *See* AMA § 297B(a)(3) (7 U.S.C. § 1639p(a)(3)) ("Nothing in this subsection preempts or limits any law of a State or Indian tribe that . . . (i) regulates the production of hemp; and (ii) is more stringent than this subtitle."). For example, a State may continue to prohibit the growth or cultivation of hemp in that State.[30] As discussed above, however, while a State or Indian tribe may prohibit the production of hemp, it may not prohibit the interstate shipment of hemp that has been produced in accordance with Federal law.

Second, the 2018 Farm Bill does not affect or modify the authority of the Secretary of Health and Human Services ("HHS Secretary") or Commissioner of Food and Drugs ("FDA Commissioner") under the Federal Food, Drug, and Cosmetic Act (21 U.S.C. § 301 et seq.) and section 351 of the Public Health Service Act (42 U.S.C. § 262). *See* AMA § 297D(c) (7 U.S.C. § 1639r(c)). While AMA § 297D(b) provides that the Secretary of Agriculture shall have "sole authority" to issue Federal regulations and guidelines that relate to the production of hemp, this authority is subject to the authority of the HHS Secretary and FDA Commissioner to promulgate Federal regulations and guidelines under those FDA laws. 7 U.S.C. § 1639r(b).

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[30] Certain states continue to prohibit the cultivation of hemp. *See* National Conference of State Legislatures, "State Industrial Hemp Statutes," *available at* http://www.ncsl.org/research/agriculture-and-rural-development/state-industrial-hemp-statutes.aspx#state (updated Feb. 1, 2019).

IV. CONCLUSION

I have analyzed the hemp provisions enacted as part of the 2018 Farm Bill and reach the following conclusions:

1. As of the enactment of the 2018 Farm Bill on December 20, 2018, hemp has been removed from schedule I of the CSA and is no longer a controlled substance.

2. After USDA publishes regulations implementing the hemp production provisions of the 2018 Farm Bill contained in subtitle G of the AMA, States and Indian tribes may not prohibit the interstate transportation or shipment of hemp lawfully produced under a State or Tribal plan or under a license issued under the Departmental plan.

3. States and Indian tribes may not prohibit the interstate transportation or shipment of hemp lawfully produced under the 2014 Farm Bill.

4. A person with a State or Federal felony conviction relating to a controlled substance is subject to a 10-year ineligibility restriction on producing hemp under subtitle G of the AMA. An exception applies to a person who was lawfully growing hemp under the 2014 Farm Bill before December 20, 2018, and whose conviction also occurred before that date.

The 2018 Farm Bill preserves the authority of States and Indian tribes to enact and enforce laws regulating the production of hemp that are more stringent than Federal law. Additionally, the 2018 Farm Bill does not affect or modify the authority of the HHS Secretary or FDA Commissioner to regulate hemp under applicable FDA laws.