Status Report: Insects Associated with Hemp

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What type of crop is hemp?
Cultivated *Cannabis* involves the use of two species (subspecies?) that freely interbreed.
Types of Cannabis Crops

- Medical/Recreational Use
  - Marijuana
- CBD (cannabidiol) production
  - Non-psychoactive extracts
- Hemp grown for seed, fiber
Colorado Amendment 64

- Passed November 2012
- Allows personal use of *Cannabis* above age 21 (regulated as alcohol)
- Establishes regulations on production and sale of *Cannabis*
  - July 1, 2013 deadline for regulations
- Sets taxes
  - Additional taxes (state, county) subsequently enacted
- Industrial hemp also included in ballot initiative
Marijuana Production

• Involves *C. sativa*, *C. indica* and hybrids
• Primary compound THC
  – Secondary cannabinoids often important
• End uses
  – Whole buds (inhaled)
  – Extracts
    • Edibles
    • Inhalation (vaping)
    • Salves, ointments

10 mg THC is standardized serving size
Primary crop outcome – Produce grossly enlarged tissues of flowering structures by preventing fertilization
Hemp and the 2013 Farm Bill*
Section 7606. Legitimacy of Industrial Hemp Research

• Allows production of industrial hemp under some conditions
  – Where state laws allow hemp production
  – Sites where hemp is grown must be under the direction and regulation of state Departments of Agriculture

• Defines hemp as:
  – “means the plant *Cannabis sativa* and any part of that plant, whether growing or not, with a *delta-9 tetrahydrocannabinol** of not more than 0.3 percent on a dry weight basis”

* Signed into law February 7, 2014

** Known as THC
Since the 2013 Farm Bill, a majority of states have passed laws that allow hemp production.
What types of Cannabis crops are hemp?
Hemp (broad sense)

Cultivars of *Cannabis* with low levels* of psychoactive compounds (THC).

* The magic number is 0.3% by dry weight. Don’t ask why.
Types of Hemp

- Hemp grown for extraction of cannabinoids ("broad sense" hemp)
- Hemp grown primarily for seed production ("narrow sense" hemp)
- Hemp grown primarily for fiber production ("narrow sense" hemp)
Most hemp being grown for CBD presently uses transplanted clones.
Hemp Grown for CBD (and other non-psychoactive cannabinoids)

Typically grown by transplants, with early season indoor production.

In-field plant populations are often low.

Male plants, and seed production is often not desirable.

Plant is often harvested at immature stage.
Some CBD crops are being grown from seed. These crops have lower concentrations of cannabinoids but produce much more biomass.
CBD (cannabidiol) Production

• Primarily involves *C. sativa*
  – *C. indica* and hybrids are sometimes grown

• Grown for production of non-psychoactive cannabinoids
  – Extracted from leaves, buds

• End uses (often mixed with oils)
  – Ingested
  – Salves, ointments
  – Inhaled (vaping)
Hemp Grown for Fiber and Seed

Produced by seeding
Plant populations are high
Hemp Grown for Fiber and Seed
Crop may be a mixture of separate female and male (dioecious) plants or may include monoecious plants

Pollination (wind) is needed for seed production
What kinds of arthropods will we find associated with hemp in this new era?
Key Arthropod Pests of Indoor Grown Cannabis

- Twospotted spider mite
- Fungus gnats
- Cannabis aphid
- Rice root aphid
- Hemp russet mite
- Onion thrips

Photograph courtesy of Karl Hillig
Twospotted spider mite

*Tetranychus urticae*
Hemp russet mite
*Aculops cannabicola*

Photograph courtesy of Karl Hillig
Rice root aphid
*Rhopalosiphum rufiabdominalis*

Colonizing roots of hydroponically cultured cannabis

Massed aphids in roots of rice

Winged forms caught on leaves

Wingless forms at base of plant
Cannabis Aphid

*Phorodon cannabis*
Onion Thrips

*Thrips tabaci*

Adult

Nymph

Extensive leaf injury by onion thrips

Leaf injury and nymphs
Darkwinged fungus gnats

*Bradysia* spp.
Pests problems associated with outdoor grown hemp will likely have little overlap with those affecting it when the plant is grown in confined conditions.

This will happen from increased activities of natural controls combined with dispersal of pest species.
A robust complex of natural enemies can be expected to be found in hemp.
Some generalist insect predators (piercing-sucking mouthparts)

- Damsel bugs
- Spined soldier bugs
- Minute pirate bugs
Some generalist insect predators (chewing mouthparts)

- Convergent lady beetle
- Green lacewings
- Collops beetles
- Spider mite destroyer lady beetles
Several species of lady beetles are common in hemp fields.
Lady beetles laying a mass of eggs
Lady beetles lay masses of eggs near sources of food for their young.
Lady beetle larvae at egg hatch
Lady beetle larvae

Predators of small soft-bodied arthropods (aphids etc...)

Convergent lady beetle

Multicolored Asian lady beetle
Lady beetle pupae
Convergent lady beetles

Pre-pupae and pupae of lady beetles in hemp

Multicolored Asian lady beetle
Adult lady beetles emerging from the pupa
Twospotted Collops beetle
Green Lacewings
Green lacewing eggs are uniquely stalked
Left: Green lacewing larva eating aphid

Right: Green lacewing larva eating leaf beetle larva
Green lacewing preying on cabbage looper
Some generalist insect predators (piercing-sucking mouthparts)

- Damsel bugs
- Spined soldier bugs
- Minute pirate bugs
A very common insect in hemp fields and a generalist predator of many insects, including caterpillars.
Spiders likely will be very important natural enemies of insects associated with hemp.
Common spiders in hemp

Crab spiders
Jumping spiders
Long-jawed spiders
What kinds of arthropods will we find feeding on hemp plants in this new era?
There are some fluid feeding insects that occur on the leaves

Aphids

Leafhoppers
Most surprising insect associated with the crop?

Cannabis Aphid

*Phorodon cannabis*
Hop aphid
*Phorodon hamuli*

Cannabis aphid
*Phorodon cannabis*
Aphids normally reproduce asexually (without males) and give live birth
Aphid populations can increase rapidly.

Only a single female can establish an infestation on a plant.
A robust complex of natural enemies can be expected to be found in hemp.
Cannabis Aphid

- *Cannabis* spp. are the only plants on which cannabis aphid can feed and develop
Cannabis Aphid

- Winged and wingless forms are produced

Winged forms allow aphids to disperse to new plants, fields
Cannabis Aphid

• In autumn, with shortening day length, darker forms are produced that lay eggs

Eggs are the stage that can survive outdoors between seasons
Diagnostic: “Cast skins” discarded after molting
Diagnostic: Honeydew
Uptake of phloem fluids here
Emergence of “honeydew” here
Leaf with sparkles of honeydew – *and* cast skins
How will cannabis aphid survive between seasons in Colorado?

... mostly on indoor crops?
Leafhoppers

Insects with sucking mouthparts that feed on leaves

Damage potential to crop: Negligible, at most
More obvious will likely be the insects that chew leaves of the plant (defoliators)
Various caterpillars chew leaves of the plant (defoliators)

Yellowstriped caterpillar

Yellow woollybear

Thistle caterpillar

Beet armyworm

Beet webworm

Zebra caterpillar
Two late season “woollybear” caterpillars

Saltmarsh caterpillar

Yellow woollybear
Zebra caterpillar

Adult
Leaf beetles

Palestriped flea beetle

Western black flea beetle

Southern corn rootworm adult and damage
Grasshoppers (at least three species)
Stem feeding seems to cause the most injury by grasshoppers.
Hemp response to hail injury can give some insight on how the crop may respond to grasshopper injuries.
Research question: What is the relationship between leaf loss (defoliation) and yield?
Artificial defoliation experiments can provide answers to this question.
There are some stem boring species that will be important *in some areas*

**European corn borer**

*Ostrinia nubilalis*

Photographs courtesy of Frank Peairs

Photograph from the website of the Canadian Hemp Trade Alliance
An insect that surprised me when found in Colorado

Eurasian hemp borer
*Grapholita dilineana*
Eurasian Hemp Borer

- Caterpillars develop in small stems
- Caterpillars develop within seed head
- Host range includes hops
- Presently only known from east of the Rockies
Several hemipterans may primarily feed on developing seeds

Stink bugs (4 species)

Lygus bugs (2-3 species)
Hemipteran seed feeders

False chinch bugs

Hyaline grass bug
Seed Feeding Bugs and Hemp

- Feeding concentrated on flowers and developing seed
- Potential damage
  - Aborted seed, damaged seed
- Real damage??
Most significant potential pest of the crop in Colorado?

Corn earworm

*Helicoverpa zea*
Corn earworm is known by several common names
The caterpillars are quite variable in coloration.
One night’s light trap capture, September 8, 2016

Adults of the corn earworm
Corn earworm moths lay eggs at night

Photographs of eggs courtesy of Kansas State University
Corn Earworm

The insect that has shown the most potential to damage hemp in Colorado is the corn earworm (Helicoverpa zea). This is one of the most widespread and commonly damaging insects in much of the United States, affecting both field crops and vegetable crops. Evidence of its importance is indicated by it having three accepted common names: corn earworm (when in corn), tomato fruitworm (when feeding on fruits of peppers, tomatoes, etc.), and bollworm (when feeding on cotton bolls).

In hemp the primary damage occurs when they tunnel into buds and developing seeds. Damage to hemp by corn earworm has potential to cause significant damage, particularly to crops grown for production of large buds to extract CBD or other pharmaceutical compounds.
Present proposed IPM program for corn earworm in hemp

Proposed Management Plan for Corn Earworm in Hemp

Background. Corn earworm (*Helicoverpa* zea) is a key pest of hemp grown in Colorado. Damage is caused by the larva (caterpillar) that tunnels through and destroys maturing buds. This insect is present every growing season in Colorado, where it may be found on a wide variety of crops and weed hosts. However, population size, and associated damage, can vary greatly from season to season and by location.

Traps (light, pheromone) can be used to capture the adult stage of this insect, a night flying moth. When used over a period of time these traps can provide information on in changes in abundance of the insect, with high trap captures being associated periods of peak egg laying on plants.

The insecticides that have the most potential to control corn earworm - and are allowable by the Colorado Department of Agriculture for use on cannabis crops – are certain strains of the microbial insecticide *Bacillus thuringiensis* (Bt). These are best applied at times coinciding with periods of peak egg laying by the adult moths and subsequent egg hatch, which occurs a couple of days after eggs are laid.

**Use of Traps for Monitoring Corn Earworm**

Two types of traps can be used to capture the night flying moths of the corn earworm, light traps or pheromone traps.

Basic design of a light trap uses a light, preferably UV, to attract insects that fly at night. The insects then hit a vane and are funneled into a collecting container below. Usually a killing agent (often a dichlorvos Pest-Strip) is placed in the collecting container to minimize damage to the collected insects, particularly damage to the delicate wings of moths, which may be torn by “June bugs” and other other active insects that come to these traps.

Light traps will capture a wide variety of insects, mostly various kinds of moths and beetles. Traps should be set in light, where they are not expected to catch the number of insects that are of interest in this monitoring method.
Outline of Corn Earworm Management Program in Hemp

- Establish a program to monitor flights of adult corn earworms using pheromone traps
  - This should begin by midsummer to establish baseline of adult captures
  - Traps should be checked twice a week and the number of new moths recorded
Outline of Corn Earworm Management Program in Hemp

• If very high numbers of moths are discovered during flowering, treatment should be considered
  – *Bacillus thuringiensis* var. *aizawi*
    • Agree WG
    • XenTari Biological Insecticide
Risk factor of corn earworm damage to hemp?

Maturing corn next to flowering hemp
What is the potential value of hemp as a pollen resource in agricultural regions?
Hemp may be a very heavily used by many kinds of bees as a pollen source late in the season.

Many species of native solitary bees.
Hemp grown for seed production with pollen producing male plants/flowers – potentially excellent resource for many pollinators.

Hemp grown for extractable compounds (e.g. CBD) without male plants – not a potential pollen source.
Pollen traps can be used to track the relative use of hemp pollen in production areas – or to collect hemp pollen.
Honey from hemp??

No. Hemp *does not provide nectar*, which is used to produce honey.

Hemp does provide pollen, used by the developing bee larvae.
Pollinator use may complicate controls if there are insects that are pests of the crop during flowering.

Fortunately, the *Bacillus thuringiensis* (Bt) products used for corn earworm are compatible with pollinators.
Criteria for Pesticides Allowed to be Used on Cannabis in Colorado

• Pesticides that require federal registration under Section 3 of FIFRA
  – Active ingredient is exempt from the requirements of food crop tolerance, \textit{and}
  – Label has directions for use on unspecified food crops, including unspecified food crops grown as bedding plants
  – EPA and CDA registration is required
  – Pesticide is registered on tobacco

• Section 25b minimum risk pesticides (exempt from most federal registration)
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• Section 25b minimum risk pesticides (exempt from most federal registration)
  – Must be registered in Colorado!
In Colorado, the Colorado Department of Agriculture maintains a website of pesticides that may be applied to hemp grown within the state.
Web site page to access what Colorado Department of Agriculture considers to be *not not allowable* (= allowable) for use on Cannabis in Colorado.

Pesticides Allowed for Use on Cannabis

Each time we update the Cannabis pesticides list or have industry news we will send out an email blast and you can sign up here to be included. As of March 30, 2016 all past lists will be removed from the CDA website and updates will be made only to the list of approved pesticides that may be used in accordance with Pesticide Applicators’ Act Rule - Part 17.

The list developed by CDA is intended to assist Colorado Cannabis growers in identifying which pesticides can be used legally in accordance with the Pesticide Applicators’ Act and its Rules in the production of Cannabis (marijuana and industrial hemp). It is not an endorsement or recommendation to use these products in the production of Cannabis in Colorado. These products have not been tested to determine their health effects if used on Cannabis that will be consumed and thus the health risks to consumers is unknown. By including products on this list, therefore, CDA make no assurances of their safety or effectiveness when used on Cannabis and is not responsible or liable for any such use.

To view or download the current list, click the link below:

- Pesticides allowed for use in Cannabis production in accordance with the PAA Rule: Effective June 29th, 2016
  - PDF
  - Excel
- This link provides a list of products that have been removed from the list of pesticides that may be used on Cannabis. These products were either removed from the list prior to the effective date of the rule or were removed as a result of them not meeting the rule criteria as of March 30th, 2016.
  - Excel
- Selected Examples of pesticides that cannot be used in marijuana production January 13 2016
  - PDF

Products added since the last update are now highlighted in red on the PDF version of the file. The Excel version has the date that each product was added and can be sorted or filtered by name, date, active ingredient, etc.
A page listing the current products that are allowed for use on all Cannabis (including hemp) grown in Colorado.
When hemp “grows up” as a crop, addressed by federal laws and regulations as are all other crops - *how will the pesticides issues work out?*

*It will very likely vary by the type of hemp crop, and end use*
For seeds, perhaps this would be considered under Crop Group 20 (Oilseeds, such as sunflower, cotton seed and canola/rape seed)

For a strictly fiber grown crop?
Hemp Grown for CBD

This poses some more serious registration problems.
This poses some obvious registration problems.

This produces an extracted product that is consumed by humans, and in different manners (e.g., ingested, inhaled)
Hemp Grown for CBD

This poses some obvious registration problems.

This produces a product that is applied to humans, and in different manners.

Extraction methods used will affect potential for residues, and these must be studied.
Insect Management Considerations in Hemp Production

The Hemp Insect Website is designed to provide hemp producers a way to recognize and to better understand the insects, mites, and other “bugs” that are present when this crop is grown in North America.

The goals of the Hemp Insect Website are to: (1) Provide description of all insects and mites observed in production of hemp; (2) Provide information on the habits of all insects that are associated with hemp production.

In this start-up form (2017), the Hemp Insect Website is giving particular attention to insects and mites that are
Please submit photos, identification questions to the Hemp Insect Website!

Got Bugs?

Send in your photos!

Hemp producers are encouraged to send in photos of insects they observe associated with the crop. We will then try to give you an identification of the insect in question. Photos submitted are highly valued to help improve this website by identifying additional insects that are associated with the crop.

To send in images to Whitney.Cranshaw@ColoState.EDU

Please do include the header “Hemp Insect Photo” to make sure that your message will be recognized in the email queue so that it can get most prompt attention.

With a response you may be asked if we may post the picture, with the description of the insect, on this website, so that it can be shared with other producers. This would only be done with the photographer’s permission. No other identifying information (e.g., location, time, date) will be included in the posting.