

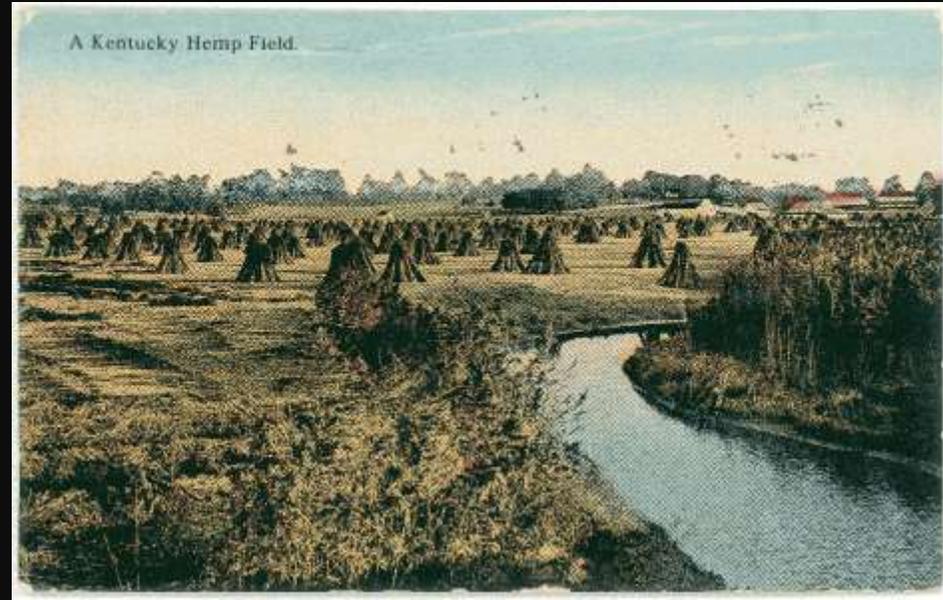
Defining the Insect Pest Management Needs of a “New” Crop: Industrial Hemp



Whitney Cranshaw
Colorado State University



What type of crop is 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.

There are 3 to 4 kinds of Hemp Crops from an Insect Management Perspective

- Hemp grown seed and/or fiber
 - Outdoor culture
- Hemp grown for CBD production
 - Outdoor culture
- Indoor culture of any Cannabis crop

Hemp Grown for Fiber and/or Seed



Produced by seeding

Plant populations are high

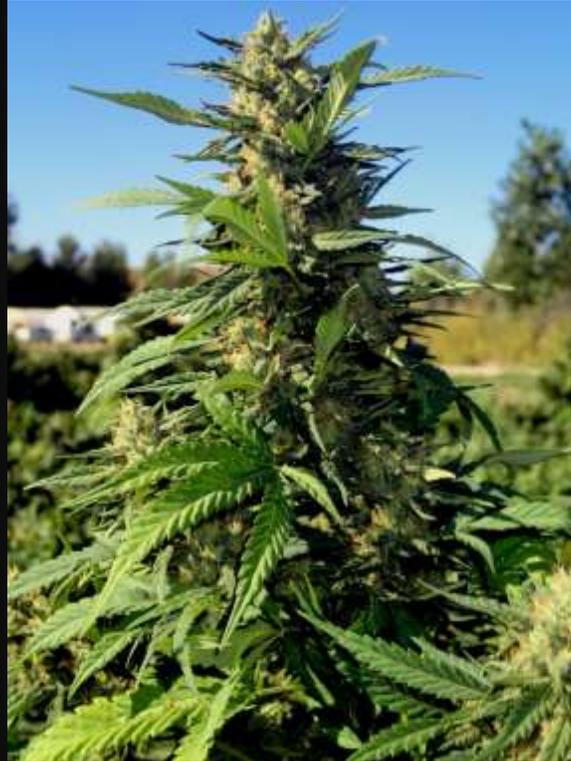
Hemp Grown for Fiber and Seed

Crop may be a mixture of separate female and male (dioecious) plants or may include monoecious plants

Pollination (wind) is needed for seed production



Hemp Grown for CBD



Most hemp being grown for CBD presently uses transplanted clones.

Parentage is often *C. indica* or *C. indica/C. sativa hybrids*



Rooted cuttings



Mother plants

This usually involves a greenhouse/indoor production phase. Some live plants (mother plants, clones) are normally present year-round.

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



Hemp Grown for CBD (and other non-psychoactive cannabinoids)



**Often all-female plants
Male flowers, pollen absent**

Plants often sticky near harvest

Plant is often harvested at immature stage

Harvesting CBD hemp near Milliken, CO
October 5, 2017

Some crops are being grown from seed and some for duo-purpose (CBD/seed)



These crops have lower concentrations of cannabinoids but produce much more biomass – and seed

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Stages in Developing Insect Pest Management Systems for Industrial Hemp

- Descriptive Stage
- Development Stage
- Implementation Stages



Descriptive Phase



What kinds of arthropods will we find associated with North American hemp in this new era?



...and what is their association with the crop?

Lady beetles and other
Coleopteran predators



**Hemp may support
a diverse and robust
complement of
natural enemy
species**

Green lacewings



Syrphid flies



Spiders and other
arachnid predators



Predatory Hemiptera



Herbivores associated with Hemp

- Leaf feeding species (all crops)
- Stalk borers (all crops)
- Hemipteran seed feeders (seed crops)
- Insects that damage flower buds (CDB crops)

Defoliators



Caterpillars



Grasshoppers



Beetles

Insects/Mites that Suck Fluids of Stems/Foliage



Leafhoppers



Spider Mites



Aphids



Thrips



Russet Mites



European corn borer



**Eurasian
hemp borer**

Photograph from the website of the Canadian Hemp Trade Alliance

Stem/Stalk Boring Insects

Hemipteran seed/flower feeders



Miridae



Pentatomidae



Lygaeidae



Rhopalidae

Some of these
could be
important for
hemp crops
grown for seed

Chewing Insects that Damage Buds



A particular issue of
crops grown for
CBD production

Hemp pollen can be extremely attractive to many kinds of bees



We will hear more about this from Colton O'Brien in a short while

What is a Hemp Insect?



Zygogramma disrupta –
a leaf beetle of ragweed



What is a hemp insect?

Western corn rootworm



Argus tortoise beetles
pupating on hemp



Physiphora demandata – a
commonly seen fly that
develops on decaying OM



Diamondback moth

An Unusual Insect Event in
Hemp - 2018

A Lace Bug

Gargaphia sp.



A field of young hemp in southeastern Colorado was massively infested by a lace bug in early June. Adults of a *Gargaphia* sp. were found on essentially every plant.





Large numbers of eggs
were laid on the plants

Some plant injury was observed on the lower leaves



What happened?

Nothing. Eggs hatched but no nymphs developed.

A few adults were found on the plants for weeks.



The field as it was being readied for first harvest in September

Development Stage



What questions need to be answered to develop effective pest management of arthropod pests of hemp?



Adult



Zebra caterpillar

Often the most conspicuous caterpillar on hemp in Colorado



Mostly feeding on flowers?



Is Japanese beetle an potentially important defoliator – or is it mostly feeding on flowers?

Photograph by Hunter Konchan



Research questions: What is the relationship between leaf loss (defoliation) and yield? Do plant injuries affect production of important compounds produced by the crop (e.g. THC, CBD)?

Artificial defoliation experiments can provide answers to this question



Kadie Britt will have some information on this later this morning

Seed Feeding Bugs and Hemp

- Feeding concentrated on flowers and developing seed
- Potential damage
 - Aborted seed, damaged seed
- Significant damage?? - TBD



Insects with sucking mouthparts that feed on leaves



Leafhoppers

Damage potential of Colorado species to crop:
Negligible, at most

Could potato leafhopper be a significant pest of hemp?

Michigan State University

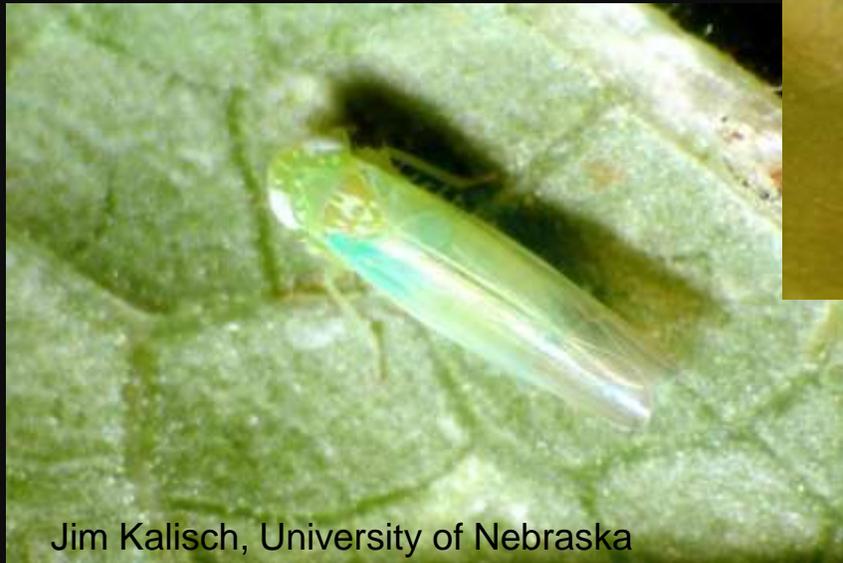


Potato leafhopper can be damaging to hops, a related species

David Shetlar, Ohio State University



Jim Kalisch, University of Nebraska



Potato leafhopper
Empoasca fabae

University of Vermont Extension



Corn earworm



Key Pests Emerging in Colorado Hemp Production

Eurasian hemp borer



Cannabis aphid



Hemp russet mite



Cannabis Aphid
Phorodon cannabis



How will cannabis aphid survive between seasons in a place with hard freezing winters?



... mostly on indoor crops?





Males and oviparous females appear in midSeptember

Eggs were laid on buds, leaves and stems



Volunteer hemp



Cannabis aphids were collected from volunteer hemp sampled in midMay

What species of parasitoids attack cannabis aphid?



Are there alternative crops for cannabis aphid? Is hops aphid a potential pest of cannabis?



A close-up photograph of a hop aphid, a small, pale green insect with a pear-shaped body and long, thin legs. It is positioned on a vibrant green leaf, with its body and legs clearly visible against the leaf's texture.

Hop aphid

Phorodon hamuli



A close-up photograph of a cannabis aphid, a small, pale green insect with a pear-shaped body and long, thin legs. It is positioned on a green stem, with its body and legs clearly visible against the stem's texture.

Cannabis aphid

Phorodon cannabis

Key Arthropod Pests of Indoor Grown Cannabis



Twospotted spider mite

A slide used in Extension presentations last Winter

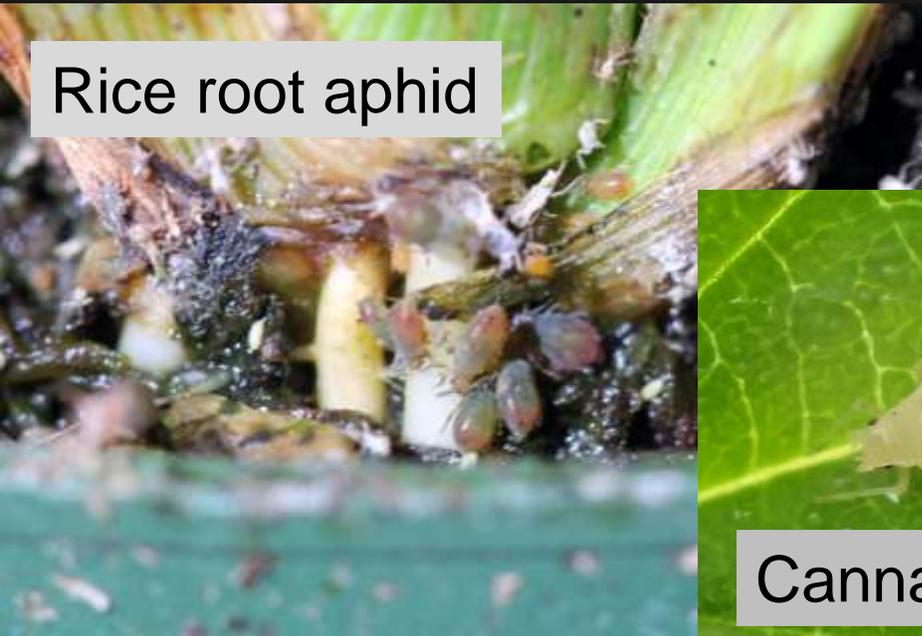


Hemp russet mite



Fungus gnats

Photograph courtesy of Karl Hillig



Rice root aphid



Cannabis aphid



Onion thrips

A slide used in Extension presentations last Winter



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.





Photograph courtesy of Karl Hillig

Hemp russet mite

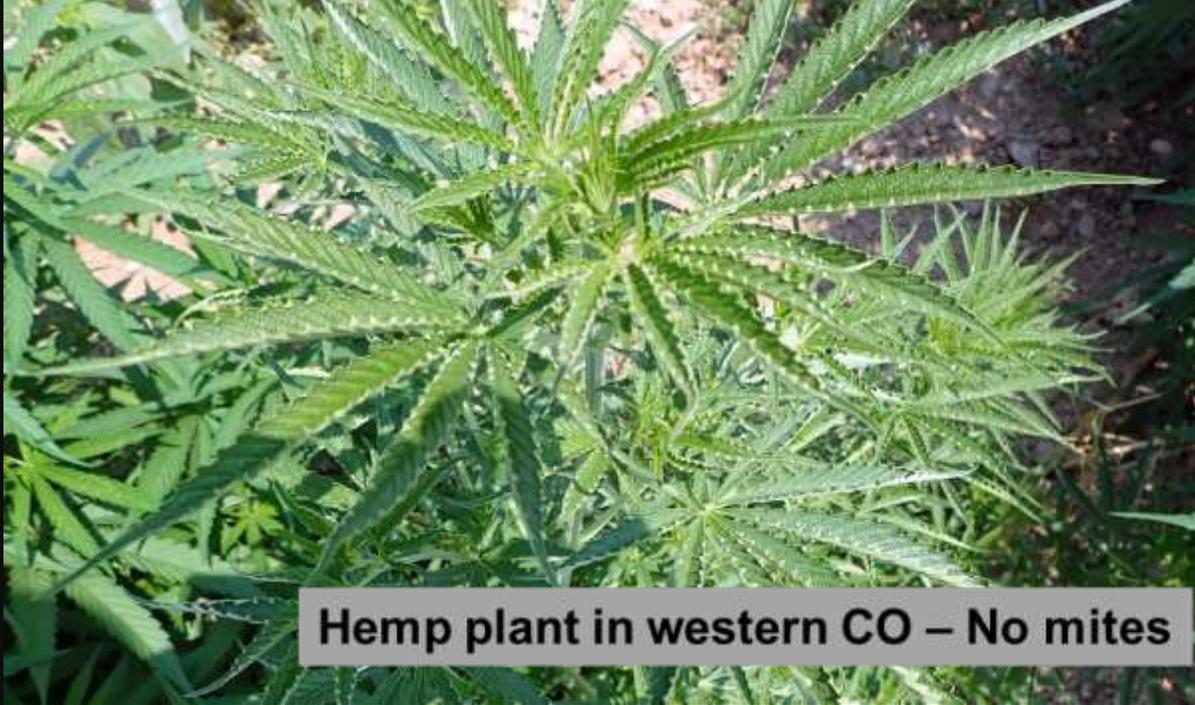
Aculops cannabicola

Photograph courtesy of Karl Hillig



Is an upward leaf curl a symptom of hemp russet mite injury?





Yes – and no. Some cultivars produce an upward leaf curl in response to hemp russet mites. Some do not.

Some genotypes normally produce upward leaf curling in the absence of mites.



Symptoms of hemp russet mite infestation on developing buds of hemp



Dispersal



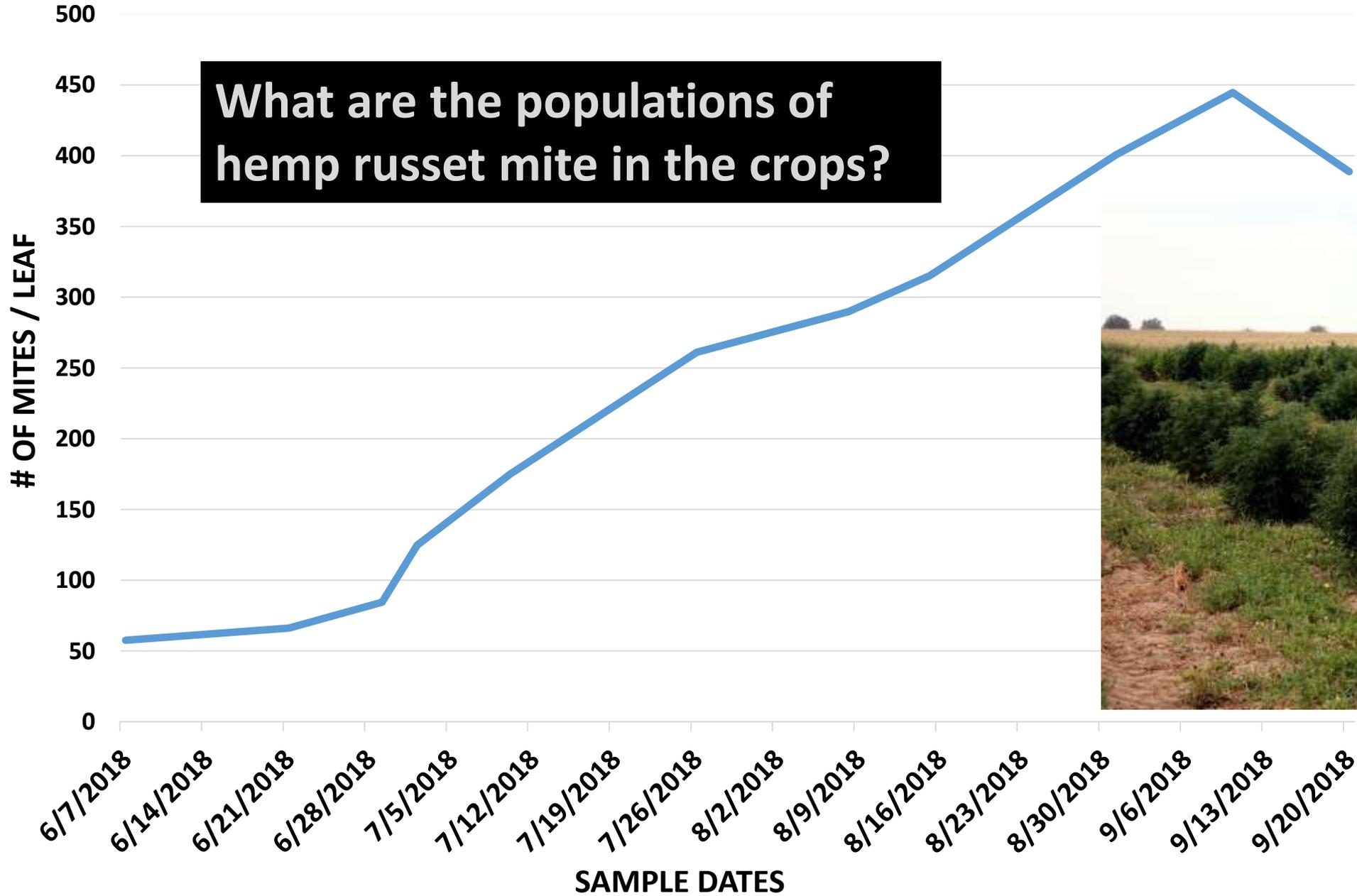
Hemp russet mites could be collected from glass slides placed above the crop canopy

Wind-blown dispersal occurs, as with other eriophyid mites



HEMP RUSSET MITES # / LEAF

What are the populations of hemp russet mite in the crops?



What is eating hemp russet mites in the field?



Minute pirate bugs were the only species regularly observed that could credibly be considered a hemp russet mite predator

Predatory Mites?



University of California IPM Program

Extremely low populations were present in fields

Attempts to augment populations with release of *Amblyseius andersoni* were not promising



Direct release on plants



Release with hanging sachet



How does hemp russet mite survive outdoors through winter?

Mites were observed on a volunteer plant on June 18. The plant was next to the building used to dry the plants of the 2017 crop.

Is there some non-Cannabis living bridge host that allows survival between growing seasons????



The current trend is to develop cultivars that can be grown from true seed. Some growers are already at that point.



This will have a huge impact on hemp russet mite problems on the crop.

No. Russet Mites/Terminal following 3 applications at one week intervals

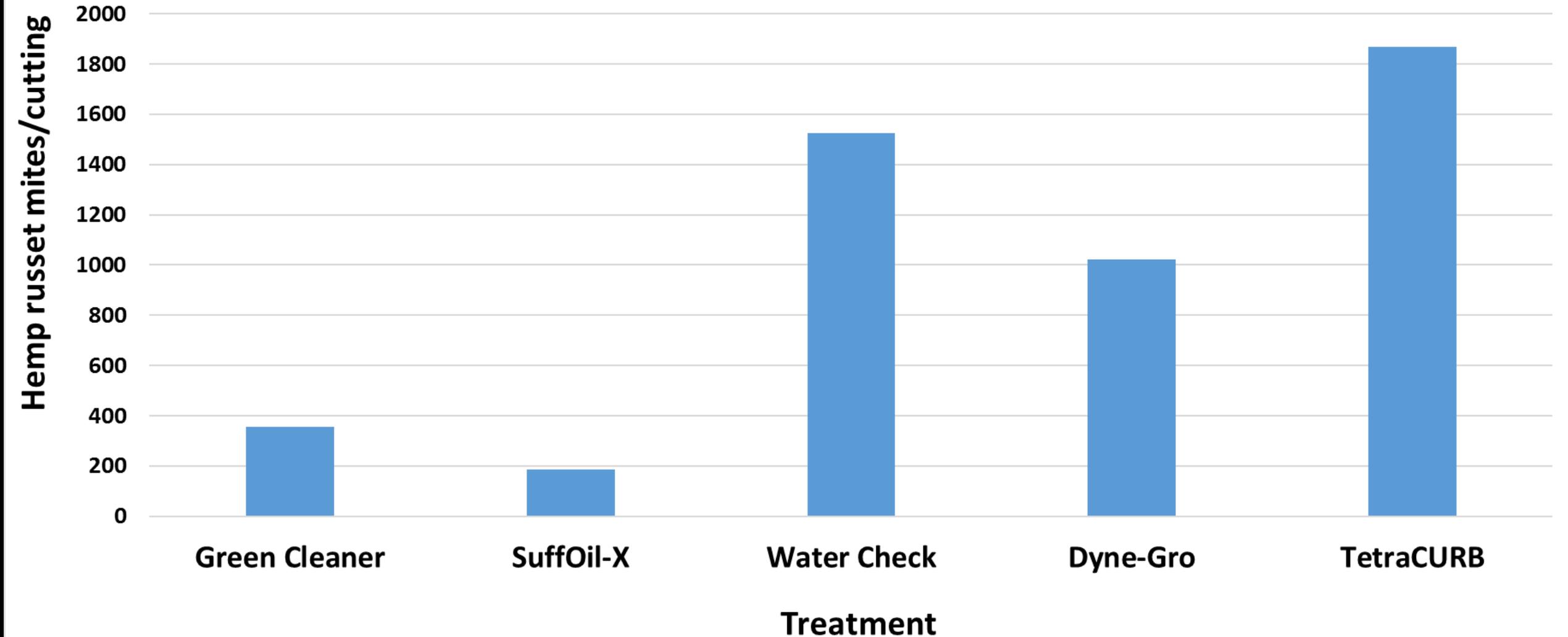
• Dyne-Gro*	11.3
• SuffOil-X	12.8
• TetraCURB	61.4
• Green Cleaner	67.7
• Untreated Check	239.4

* Rate of 1 ½ tsp/qt + 1/3 tsp/qt Dawn Dishwashing Liquid



A few preliminary control trials were attempted

Hemp Cutting Disinfestation Trial



Key Questions in Managing Hemp Russet Mite

- How does hemp russet mite survive outdoors between growing seasons?
- What natural controls help regulate populations of hemp russet mite in fields?
- How damaging is hemp russet mite to hemp (economic injury levels studies)?
- What products can be used to help manage hemp russet mite as economic thresholds are approached?

Eurasian Hemp Borer

Grapholita delineana





**Adults were found in fields from
5 of the 6 eastern Colorado
counties visited in 2018**

Volunteer hemp examined June 18 were infested with larvae in late stages of development





The last stage larva changes from cream colored to pinkish, as do some other *Grapholita* species



Exterior symptom of stalk tunneling – leaf flagging





Serious damage to buds
was observed in one field
located in northeastern
Colorado





Pheromone lure to monitor Eurasian hemp borer?

Traps containing available lures used to monitor three other *Grapholita* species (oriental fruitworm, cherry fruitworm, lesser appleworm) failed to capture Eurasian hemp moth



Adults were found everywhere – in areas with no previous history of hemp....

There *must be* significant non-*Cannabis* host plants that can sustain this insect



Some knotweed (*Polygonum*)?
Hops?

What natural enemies can help control Eurasian hemp borer in hemp fields?



Predatory Hemiptera



Green lacewings



Spiders



Pathogens? Parasitoids?

Proposed project for 2019 – Attempt suppression of Eurasian hemp borer with releases of *Macocentrus ancilyvorus* (“Mac”)

[Conservation](#) > [Biocontrol](#) > [Oriental Fruit Moth Biocontrol](#)

Oriental Fruit Moth Biocontrol

What is the Oriental Fruit Moth?

The Oriental Fruit Moth (OFM), *Grapholita molesta*, (Lepidoptera: Tortricidae) is an introduced pest of orchards native to China. It was accidentally introduced in Washington, D.C. from Japan on nursery stock in 1913. By 1945 the OFM had spread nationwide on infested fruit and nursery stock. It is now found on all continents where stone-fruit is grown.

How do I recognize Oriental Fruit Moth?

OFM is a small (7-10 mm) moth, dull grayish brown in color with a row of black dots near the end of the forewing. Larvae are thin, 10-13 mm in length, appear pinkish to creamy-white, and have a reddish brown, apparently bisected head capsule.



**Most significant pest of
the crop in Colorado?**



**Corn
Earworm**
Helicoverpa zea



Corn earworm tunnels into and can extensively damage developing buds of hemp



At what plant growth stage is hemp attractive (and not attractive) to corn earworm?





In 2016 and 2018 corn earworm caused serious losses to CBD hemp in southeastern Colorado

One night's light trap capture, September 8, 2016

Adults of the corn earworm



Present fact sheet on Corn Earworm at the **Hemp Insect Website**

Insects that Feed on Hemp – Seed/Bud Feeders

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. Potential damage to fiber or seed producing cultivars is likely to be minimal. Populations of this insect vary greatly from season to season in Colorado and will usually peak in hemp during late August and/or September.



Corn earworm caterpillars in hemp. The bottom photo is by Janna Beckerman, purduehemp.org

Parts of Colorado include areas of the northern range of where corn earworm has historically been able to survive through winter (as a pupa in the soil). However, mild winters will allow this



An updated version is in the works



Melissa Schreiner

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

Present
proposed IPM
program for
corn earworm in
hemp

An IPM
Implementation
Phase effort

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

Pheromone trap used to monitor corn earworm



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
 - ***Helicoverpa NPV***
 - ***HelicoVex***

Agree[®] WG

BIOLOGICAL INSECTICIDE

For control of lepidopterous insect pests of certain terrestrial fruits, vegetables, ornamentals and flowers, tobacco, corn, cotton, soybeans, and citrus.

FOR ORGANIC PRODUCTION



Active Ingredient: *Bacillus thuringiensis* subspecies *aizawai* strain GC-91
Solids, spores and Lepidopteran active toxins* 50.0%
Other Ingredients: 50.0%
Total: 100.0%

*The percent active ingredient does not indicate product performance and potency measurements are not federally standardized.

KEEP OUT OF REACH OF CHILDREN
CAUTION

Net Contents: 5 or 20 Pounds
EPA Reg. No. 70051-47
EPA Est. No. 67545-AZ-1[†]
(Lot Number with "G")
EPA Est. No. 70051-CA-001
Lot No.:

Manufactured by
Certa USA, L.L.C.
9145 Guilford Road
Suite 175
Columbia, MO 65205

See ad

Bacillus thuringiensis
(*aizawai* strain)



Colorado allowed insecticides that can be used to control corn earworm in hemp

Andermatt USA where Nature leads Innovation www.andermattusa.com

HELICOVEX[®]

Insecticidal Virus for Use in Greenhouses and Open Fields for the Control of the Corn earworm, the Tobacco budworm and the African cotton bollworm

FOR ORGANIC PRODUCTION

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Active Ingredient:
Helicoverpa armigera nucleopolyhedrovirus strain 8V-0003 0.60%
Other Ingredients: 99.40%
Total: 100.00%

*Contains a minimum of 7.5 x 10¹² viral occlusion bodies per liter.

SEE SIDE/INSIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS AND FIRST AID

Net Contents:
Lot No.:
EPA Reg. No.: 69553-2
EPA Est. No.:

Manufactured by: Andermatt Biocontrol AG
Stahlermatten 6
6146 Grossdietwil
Switzerland

KEEP OUT OF REACH OF CHILDREN
CAUTION

Helicoverpa Nuclear Polyhedrosis Virus

2018 Corn Earworm Monitoring Program

- Traps were provided to 7 growers (8 counties)
- In two sites (SE Colorado) high trap captures were noted in September
- At least 3 growers treated for corn earworm in 2018



Connecting Hemp and Insects: Where No Entomologist Has Gone Before!

