



Growing Hemp in Controlled Environment

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Horticultural Operations

- ▶ Growing Media and Containers
- ▶ Irrigation
- ▶ Nutrient Management
- ▶ Lighting and Temperature
- ▶ Day Length Manipulation
- ▶ Propagation
- ▶ Support systems
- ▶ Integrated Pest Management
- ▶ Resources



Growing Media and Containers

Propagation

- ▶ Cuttings
 - ▶ Rockwool – 1.5 inch cubes
 - ▶ 50-cell flats in 1020 trays
 - ▶ Humidity Domes
- ▶ Seed
 - ▶ 50-cell flats in 1020 trays
 - ▶ General purpose potting mix
 - ▶ Peat
 - ▶ Perlite
 - ▶ Bark



Growing Media and Containers

Flowering and Vegetative

- ▶ Lots of options depending on:
 - ▶ Size and layout of growing space
 - ▶ Irrigation practices
 - ▶ Final goal for plant(s):
 - ▶ Seed grown to identify females for stock plants
 - ▶ Stock plants
 - ▶ Seed or flower crop
 - ▶ Fiber crop



Irrigation

- ▶ Hemp is a heavy water user
- ▶ Irrigation practices will determine the appropriate type of media :
 - ▶ Automated
 - ▶ Trickle
 - ▶ Ebb and Flow benches or floors
 - ▶ Coarse, free-draining media
 - ▶ Hand watering
 - ▶ Time-based
 - ▶ coarse, free draining media
 - ▶ Skill-based
 - ▶ Finer, more water-retentive media
- ▶ Irrigation practices are important for root disease management



Nutrient Management

Irrigation Source

- ▶ Municipal
- ▶ Well

Water tests

- ▶ Professional water testing services
- ▶ Hand held meters
 - ▶ Injector calibration
 - ▶ pH
 - ▶ Water
 - ▶ Media



Nitrogen Deficiency



Nutrient Management

Sample Foundation Nutrient Program

Cuttings

- Once roots have started to form
- 20-10-20 @ 50-100 ppm N Constant Liquid Feed (CLF)
- Clear water once a week to flush excess salts

Seedlings

- Once 1st set of true leaves is fully expanded
- 20-10-20 @100 ppm N CLF
- Clear water once a week to flush excess salts

Vegetative – Potting up

- Osmocote® Plus 15-9-12, 3-4 or 5-6 month at medium rate by pot size

Vegetative – Growing on

- Rotate 20-10-20 and 13-2-13 @ 100 ppm N CLF
- Clear water once a week to flush excess salts
- Stock Plants – clear water only 1-2 weeks before taking cuttings

Flowering

- 15-30-15 @ 100 ppm N CLF
- Clear water once a week to flush excess salts
- Clear water only 2-3 weeks before harvest



Lighting, Temperature, and Humidity

Lighting

- ▶ High-pressure Sodium
 - ▶ Double-ended
 - ▶ 1000W adjustable
- ▶ Other options
 - ▶ Ceramic Metal Halide
 - ▶ LED
 - ▶ Fixed spectrum
 - ▶ Programmable spectrum

Temperature

- ▶ Heating Setpoint
 - ▶ 60-65°F (~15-18°C)
- ▶ Cooling Setpoint
 - ▶ 70-78°F (~20-25°C)

Humidity

- ▶ Important for disease management
- ▶ Summer vs. Winter



Day length Manipulation

- ▶ Hemp is a short day (long night) plant
 - ▶ Auto-flowering varieties are the exception
- ▶ To maintain vegetative plants
 - ▶ 18 hours light – 6 hours dark
- ▶ To Induce and maintain flowering
 - ▶ 12 hours light – 12 hours dark

Options to create short day/long night

- ▶ Programmable black-out cloth
- ▶ Manual black-out cloth
- ▶ Closet

Programmable Black-out Cloth



Manual Black-out Cloth





Propagation



Seed

- ▶ Very easy
- ▶ Sow 0.5 inch deep
- ▶ Germination time = 5-7 days
- ▶ Begin supplemental lighting as soon as cotyledons emerge at 18 hours per day
- ▶ Male to female ratio usually 1:1
 - ▶ Feminized seed is the exception
- ▶ Ready for transplant in 3-4 weeks

Vegetative

- ▶ A.k.a. Cloning
- ▶ Requires female stock plants
- ▶ Tip cuttings preferred for flowering plants
- ▶ 4-5 inch cuttings
- ▶ Rooting hormone
- ▶ Supplemental lighting from time cuttings are stuck at 18 hours per day
- ▶ Ready for transplant in 2-3 weeks

Propagation

Female



Male



Propagation





Propagation

Stock Plants for vegetative cuttings

- ▶ Sow 10 seeds – 4-6 of 10 will be female
 - ▶ Assign each of the individual plants an ID#
- ▶ Grow plants vegetatively until 10 cuttings can be taken from each plant
 - ▶ Label each cutting with the ID# from the original 10 plants
 - ▶ Root cuttings and maintain under long days (18 Hours)
- ▶ Induce the original 10 plants to flower (12 hours)
 - ▶ Identify females and males
- ▶ Discard males and the cuttings taken from them
- ▶ The cuttings taken from female plants should be grown on as stock plants under long day conditions

Support Systems

- ▶ Dependent on:
 - ▶ Cultivar
 - ▶ Final plan for plant(s)
 - ▶ May not need much for fiber crops
 - ▶ Will definitely need for any crop with mature flowers and/or seeds



Support Systems



Integrated Pest Management

Pest Insects and Mites

- ▶ Spider Mite
- ▶ Aphids
- ▶ Thrips
- ▶ Fungus gnats
- ▶ Whitefly

Pathogens

- ▶ Pythium spp.
- ▶ Fusarium spp.
- ▶ Botrytis spp.



Stippling damage from two-spotted spider mite

Integrated Pest Management

PESTICIDE USE



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- Connecticut General Statutes 21a-92 “Pesticide Chemical” is defined as any substance that, alone, in chemical combination or in formulation with one or more other substances is an “economic poison” within the meaning of the federal Insecticide, Fungicide and Rodenticide Act, 7 USC 135-135k, and that is used in the production, storage or transportation of raw agricultural commodities

Currently, there are no pesticides that are specifically labeled for use on hemp by the EPA. Hemp and hemp products may be subject to testing for the use of non-approved pesticides if they are grown for human or animal consumption.

https://www.ct.gov/doag/lib/doag/inspection_regulation/Hemp_Outreach_6.2.19.pdf

June 2, 2019 – Connecticut Department of Agriculture, Hemp Research Pilot Program: Information for Growers and Processor

Integrated Pest Management

Insect, Mite and Other Pests

- Cultural Controls
 - **Sanitation**
 - **Exclusion**
 - Monitoring
 - Cultivar Selection (to some extent)
- Beneficial Insects, Mites and nematodes
 - Predators
 - Specialists
 - Generalists
 - Parasites



Mouse damage on Predatory Mite Sachets

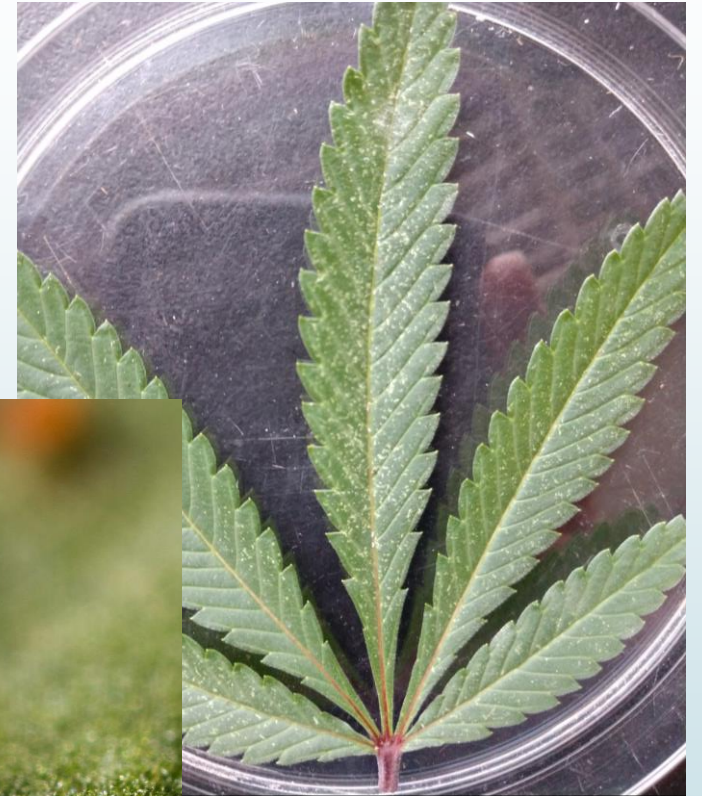
Integrated Pest Management



Extensive Western Flower Thrips damage

Phytoseiulus persimilis

Predator of Two-spot spider mite



<https://www.koppertus.com/spidex/>

Integrated Pest Management

Pathogen Management

- ▶ Cultural Controls
 - ▶ **Sanitation**
 - ▶ **Exclusion**
 - ▶ **Pest Management**
 - ▶ Monitoring
 - ▶ Water Management
 - ▶ Humidity Control
 - ▶ Air Movement
 - ▶ Cultivar Selection

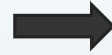


Powdery Mildew

Integrated Pest Management



Pythium spp.





Resources

- ▶ Meetings and Conferences
- ▶ Extension Websites, Educators, Specialists, and Services
- ▶ University Resources
 - ▶ University of Connecticut
 - ▶ <http://www.ipm.uconn.edu/root/>
 - ▶ Colorado State University Hemp Insects Website
 - ▶ <https://hempinsects.agsci.colostate.edu/>
- ▶ Northeastern IPM Center
 - ▶ Webinar (recorded 5/16/19) - IPM for Industrial Hemp, Whitney Cranshaw, Professor and Extension Specialist, Colorado State University
 - ▶ <https://www.northeastipm.org/ipm-in-action/the-ipm-toolbox/industrial-hemp-ipm/>
- ▶ IPM Consultants
- ▶ Biological Control Suppliers

Thank you!

