

Onion Thrips



Maine Hemp: Integrated Pest Management Practices

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www.maine.gov/ipm

Photos:

Whitney Cranshaw, Colorado State University, Bugwood.org

Bruce Watt, University of Maine, Bugwood.org

Important Concepts for Integrated Pest Management

Identification

- Proper identification of pest (or is it a pest??)
- Understanding the system where the pest exists

Prevention & Cultural Control

- Give the plants the best chance from the start

Monitoring & Record Keeping

- Make it useful for the future!

Set Action Thresholds

- Dynamic and flexible as methods change

Biological and Pesticide Control

- Dynamic and flexible as methods change



IPM Concepts



Identification

Prevention &
Cultural Control



Monitoring &
Record Keeping

Action
Thresholds



Biological &
Chemical Control

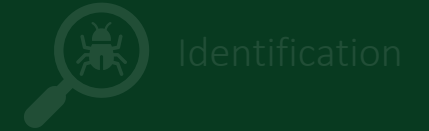
Important Concepts for Integrated Pest Management

IPM Concept Highlights

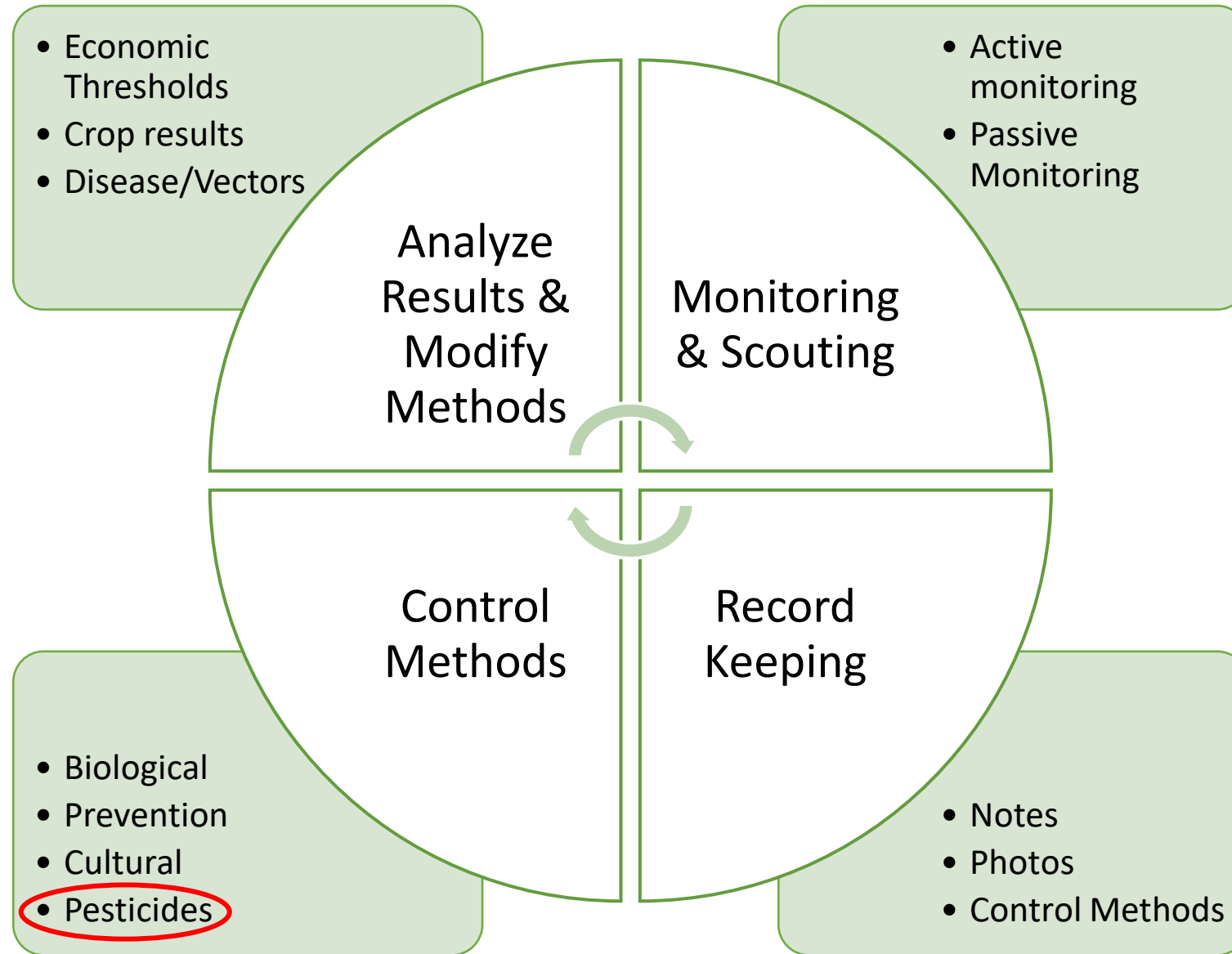
Mindset Framework!



IPM Concepts



IPM Cycle



IPM Concepts

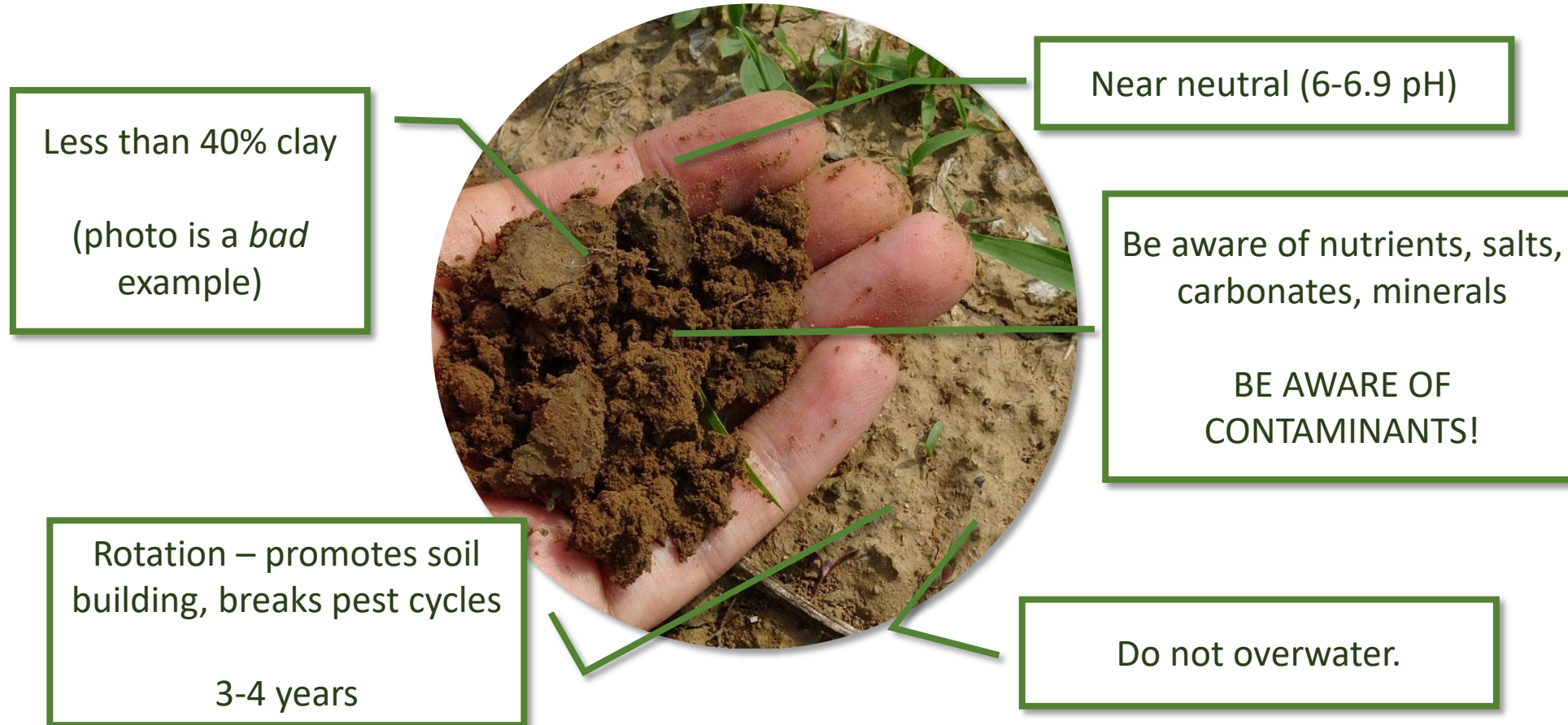
-  Identification
-  Prevention & Cultural Control
-  Monitoring & Record Keeping
-  Action Thresholds
-  Biological & Chemical Control

Should not be first or default solution!

Prevention & Cultural Control

Ensure the best growing conditions to minimize plant stress

Soil: Fertile, well-drained, and loamy.



IPM Concepts

- Identification
- Prevention & Cultural Control
- Monitoring & Record Keeping
- Action Thresholds
- Biological & Chemical Control

Prevention & Cultural Control

Ensure the best growing conditions to minimize plant stress

Soil:

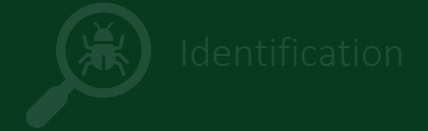
UMaine Soil Lab – Submit soil test (and conduct a lead test for safety)

[Total Sorbed Metals Test](#) is a great option.



Inspect weeds and naturally growing plants – avoid areas with wetland plants and moisture-loving weeds

IPM Concepts



Prevention & Cultural Control

Avoid Spreading Pests & Disease

Move only from the cleanest to most infested areas

Communicate which areas are problematic

Consider varieties developed in similar habitats

Empty indoor growing spaces and sanitize between crops



Quarantine purchased transplants before planting in field or introducing to the greenhouse

Prune diseased material and bury or burn

Avoid excessive damage to plants (mechanical or by pests) to reduce stress

IPM Concepts



Identification

Prevention & Cultural Control



Monitoring & Record Keeping

Action Thresholds



Biological & Chemical Control

Prevention & Cultural Control

Sanitation

Keep cultivation areas clean of plant debris



Remove any weeds growing between crops

Be aware of spreading disease through tools and growing media.

Clean propagation tools, growing media, pots and containers with a registered commercial disinfectant



IPM Concepts



Identification

Prevention & Cultural Control



Monitoring & Record Keeping

Action Thresholds



Biological & Chemical Control

Moisture, Air Flow, and Mold

Do not crowd plants

Prune foliage

Spacing of 4-6 feet between plants may be optimal – consider growth patterns of cultivar

Orient rows to encourage airflow

Avoid foliar applications of carbohydrate-based products (e.g. molasses)

Indoors:

Relative humidity below 50% for pre-flowering plants

Ventilate if possible (air moving *out*)

If plants are grown on tables or benches, it is preferable that they can drain liquid.

Plow-under fallen leaves and plow in the fall as soon after harvest as possible

IPM Concepts



Identification

Prevention & Cultural Control



Monitoring & Record Keeping



Action Thresholds



Biological & Chemical Control

Prevention & Cultural Control

Weed Prevention

Start with a weed-free field before planting or transplanting (tillage)

Planting dates should be considered (more research needed)



Early evidence for the stale seedbed approach

Plasticulture – benefits and drawbacks exist

Cover crops – research needed

Cannot go wrong with hand weeding!



Weeds can harbor insects and disease!

IPM Concepts



Identification

Prevention & Cultural Control



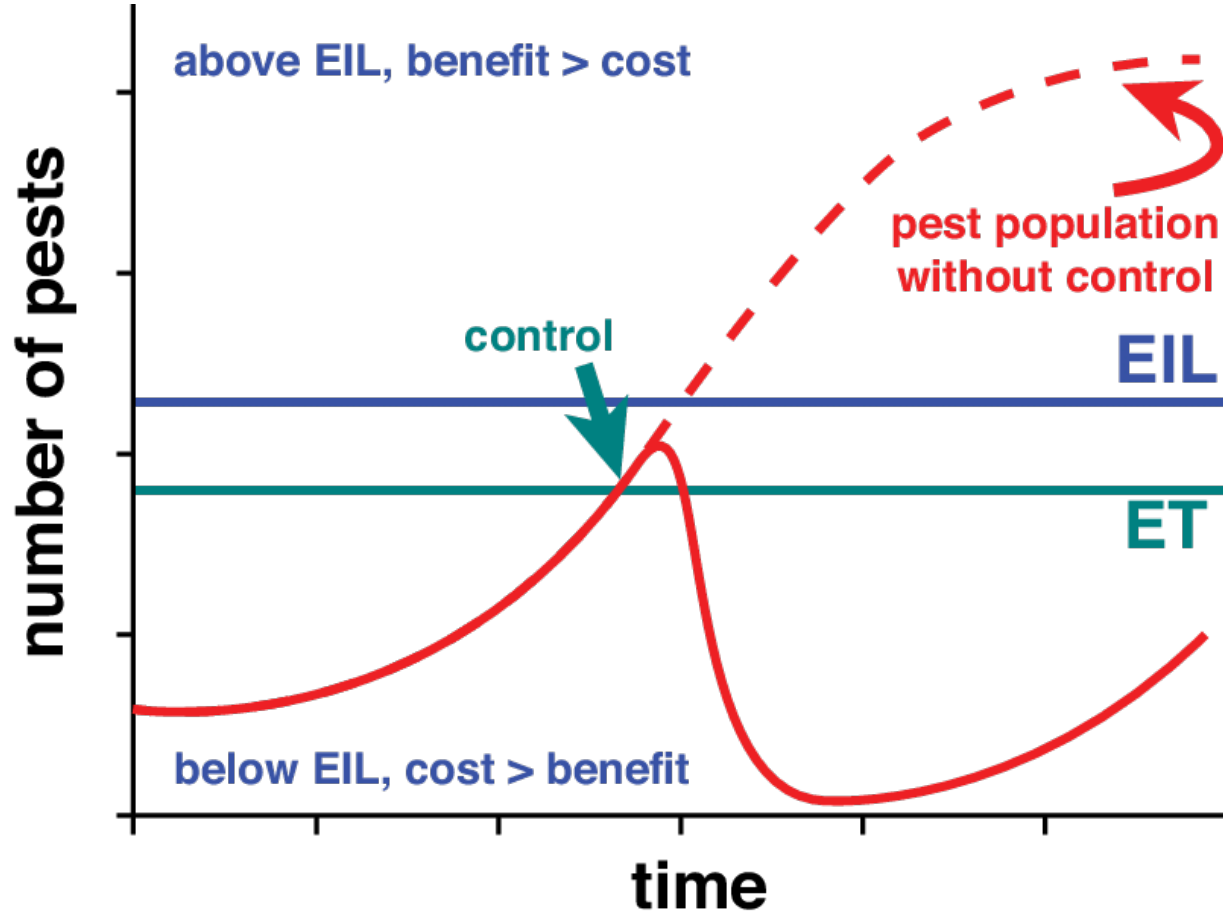
Monitoring & Record Keeping

Action Thresholds



Biological & Chemical Control

Action Thresholds



Economic Injury Level

Crop loss is more expensive than controlling the pest

Economic Threshold

Pest abundance or damage level that will exceed EIL if not treated

IPM Concepts



Identification

Prevention & Cultural Control

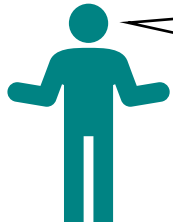


Monitoring & Record Keeping

Action Thresholds

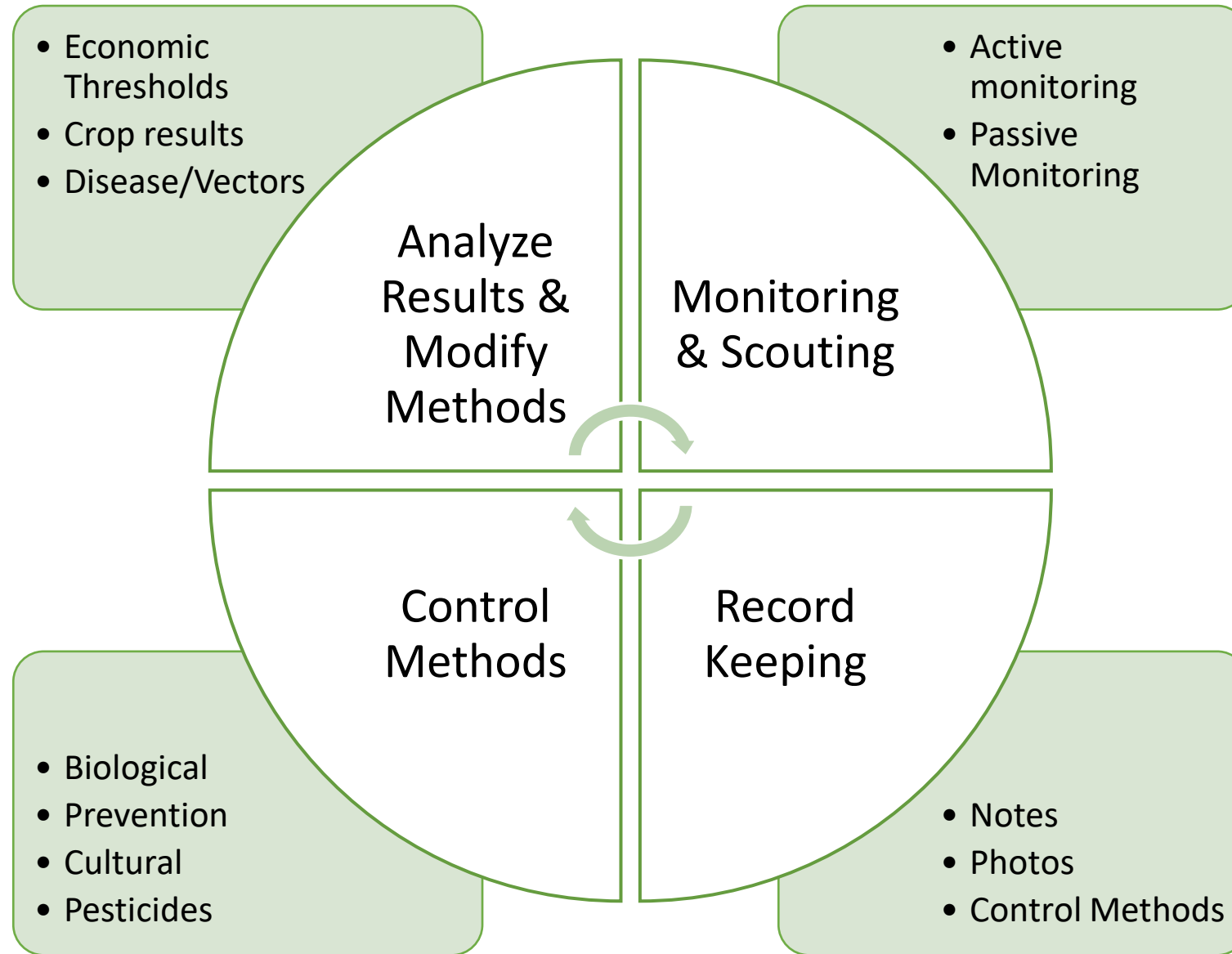


Biological & Chemical Control



How do I figure this out for my own crop and unique situation?

IPM Cycle



IPM Concepts

-  Identification
-  Prevention & Cultural Control
-  Monitoring & Record Keeping
-  Action Thresholds
-  Biological & Chemical Control

Monitoring & Record Keeping

Scouting and Monitoring Tools



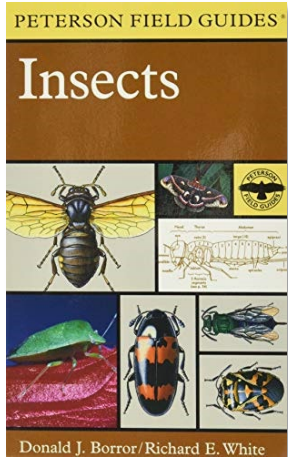
Logbook or System



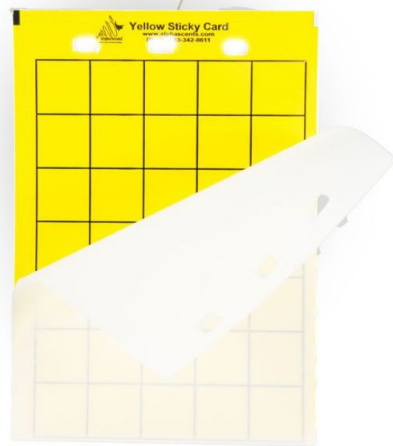
Hand Lens with LED



USB Microscope



Identification Guides



Yellow Sticky Cards



Smartphone



IPM Concepts

- Identification 
- Prevention & Cultural Control 
- Monitoring & Record Keeping 
- Action Thresholds 
- Biological & Chemical Control 

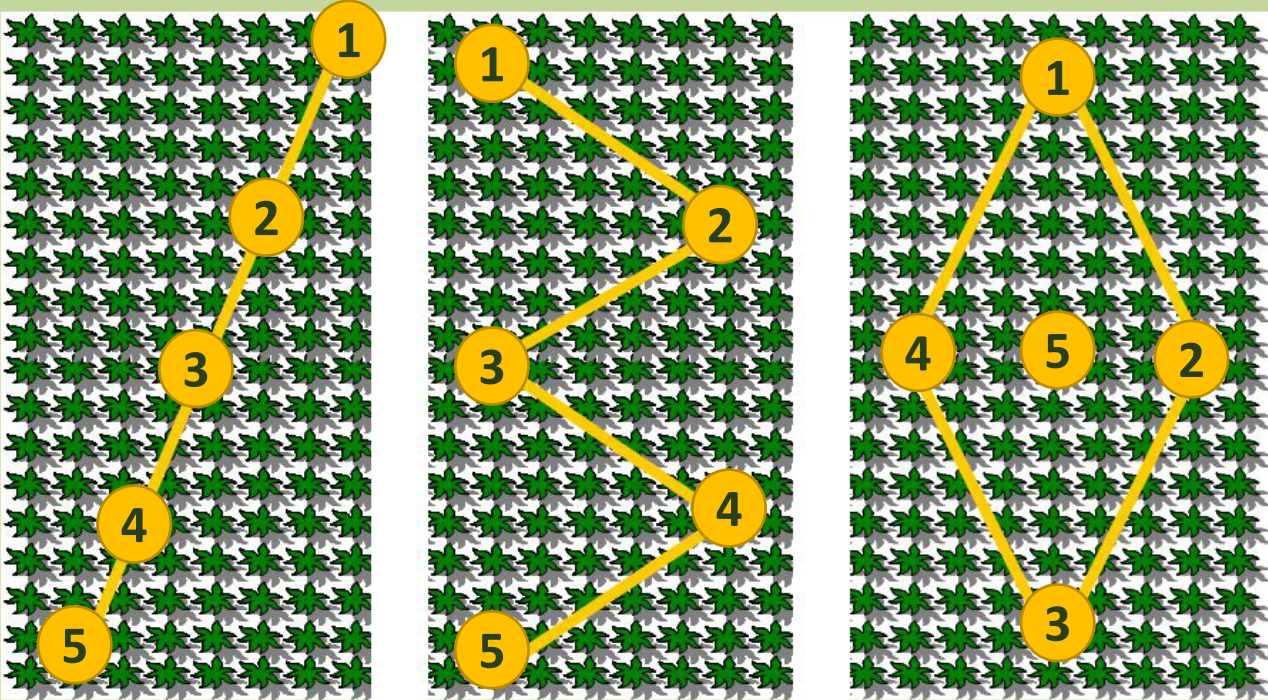
Monitoring & Record Keeping

Active/Visual/Scouting Monitoring *Systematic Sampling = Useful Results*

Examine 5-10
plants at each of
5-10 spots per
field

Look for
damage, pests,
natural enemies,
plant growth /
shape / color

Scouting patterns



Transect **Zig-zag** **Diamond**



Monitoring & Record Keeping

Passive Monitoring *Systematic Sampling = Useful Results*

- Hang cards on plants (and below plants if in pots indoors)
- Replace cards at intervals that work for you (weekly preferable)
- Inspect cards for potential pests (hobby microscope helpful)
 - Counts
 - Averages
 - Estimates (e.g., % of card) for large volume
- KEEP DATA RECORDS

Monitoring cards/devices are for monitoring – NOT for trying to capture all pests (they never will).

May be more suited for indoor use.



\$145 hobby microscope



IPM Concepts



Identification

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Monitoring &
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Thresholds



Biological &
Chemical Control

This is a method I came up with for collecting many yellow sticky cards at one time

Come up with what works for you!



Monitoring & Record Keeping

**Set up weekly and repeatable systems:
Creating your logbook is a great place to start!**

Date	Time	Initials	Crop Location	Observation Type	Description	<i>Many options...</i>

- Visual scouting – a big box to write in all pests seen *or* many columns with pest species
- Passive Monitoring – cards with unique identifiers, and columns with pest species
- Control methods – keep track of biocontrol releases, fertigation, watering, planting dates...etc!

IPM Concepts



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Biological &
Chemical Control

Monitoring & Record Keeping

The benefits of stacking data...

Date	Time	Initials	Crop Location	Observation Type	Description	# Thrips
8/10/2022	10:00 AM	HMP	R1	YSC		100
8/17/2022	11:00 AM	HMP	R1	YSC		50
8/24/2022	10:00 AM	HMP	R2	YSC	Card covered in dirt	0
8/31/2022	2:00 PM	DPM	R1	YSC		20
9/7/2022	6:00 PM	DPM	R1	YSC		15

IPM Concepts



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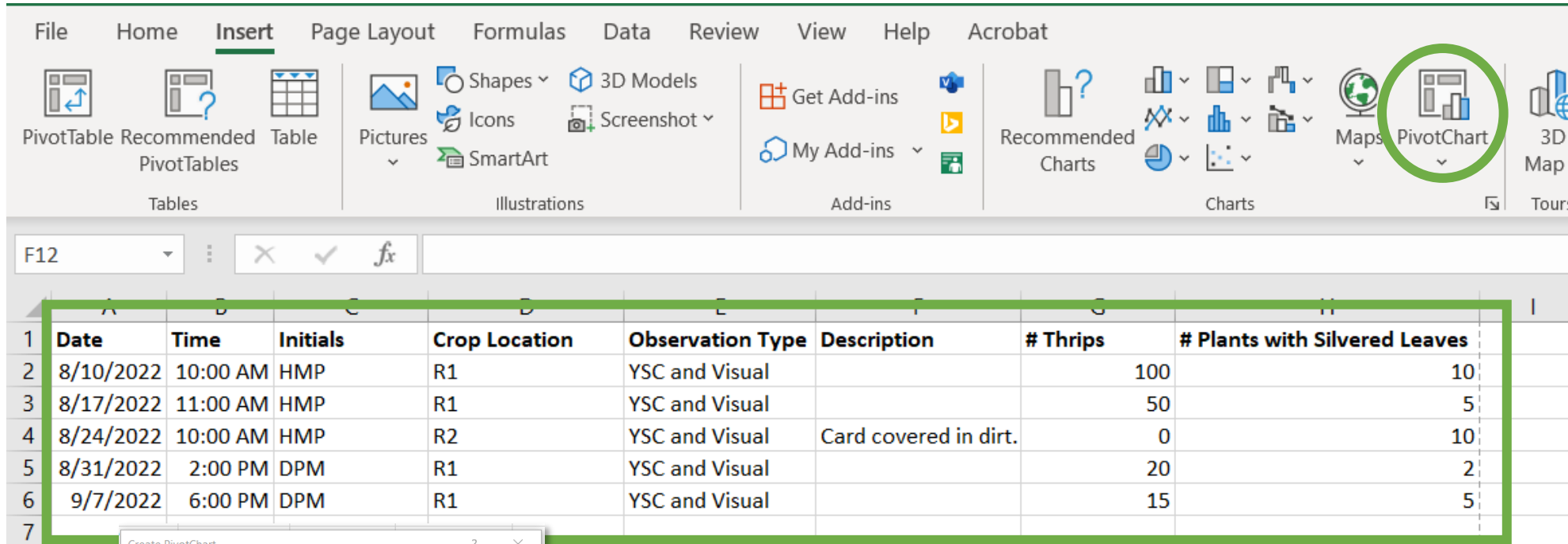


Biological &
Chemical Control

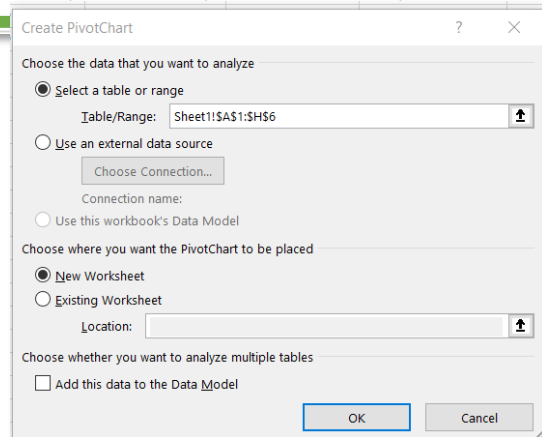
Monitoring & Record Keeping

The benefits of stacking data...

Step 2: Select PivotChart



	A	B	C	D	E	F	G	H	I
1	Date	Time	Initials	Crop Location	Observation Type	Description	# Thrips	# Plants with Silvered Leaves	
2	8/10/2022	10:00 AM	HMP	R1	YSC and Visual		100	10	
3	8/17/2022	11:00 AM	HMP	R1	YSC and Visual		50	5	
4	8/24/2022	10:00 AM	HMP	R2	YSC and Visual	Card covered in dirt.	0	10	
5	8/31/2022	2:00 PM	DPM	R1	YSC and Visual		20	2	
6	9/7/2022	6:00 PM	DPM	R1	YSC and Visual		15	5	
7									



Create PivotChart

Choose the data that you want to analyze

Select a table or range

Table/Range: Sheet1!\$A\$1:\$H\$6

Use an external data source

Choose Connection...

Connection name:

Use this workbook's Data Model

Choose where you want the PivotChart to be placed

New Worksheet

Existing Worksheet

Location:

Choose whether you want to analyze multiple tables

Add this data to the Data Model

OK Cancel

**Step 3: Just use default selections
(places in new worksheet)**

Step 1: Select Data



IPM Concepts

- Identification 
- Prevention & Cultural Control 
- Monitoring & Record Keeping 
- Action Thresholds 
- Biological & Chemical Control 

Monitoring & Record Keeping

The benefits of stacking data...

PivotChart Fields

Choose fields to add to report:

Search

- Date
- Time
- Initials
- Crop Location
- Observation Type
- Description
- # Thrips
- # Plants with Silvered Leaves
- Months

Step 4: Drag and drop!!!

Drag fields between areas below:

Filters

Legend (Series)

Axis (Categories)

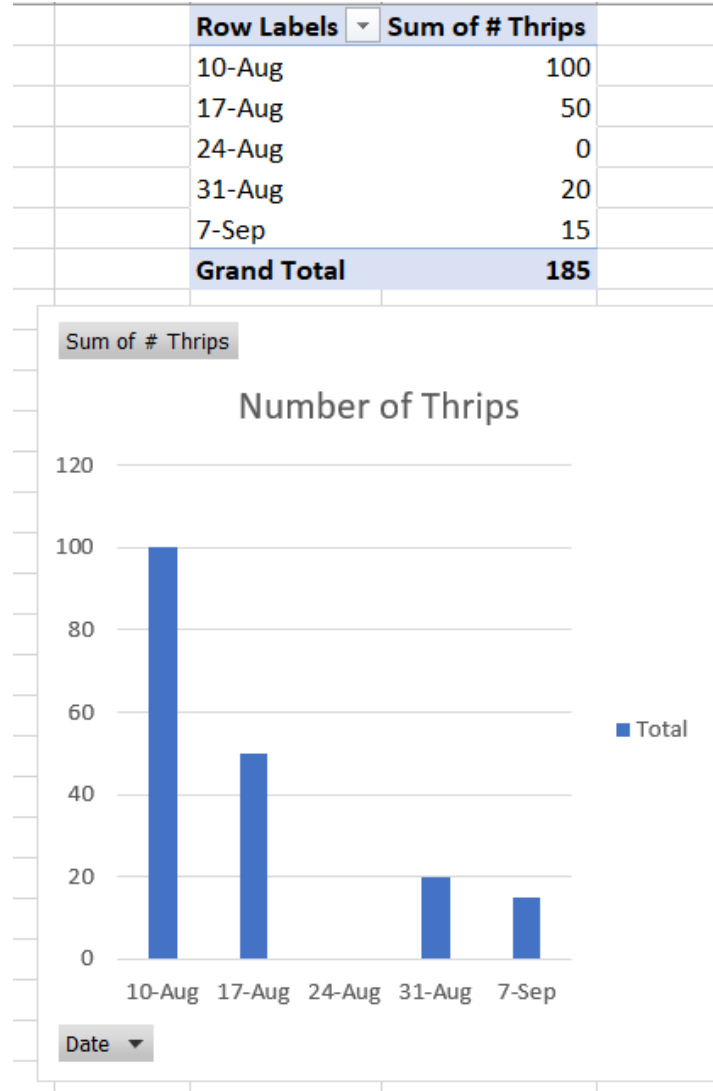
Date

Σ Values

Sum of # Thrips

Defer Layout Update

Update



IPM Concepts



Identification

Prevention &
Cultural Control



Monitoring &
Record Keeping

Action
Thresholds



Biological &
Chemical Control

Monitoring & Record Keeping

The benefits of stacking data...

Date	Time	Initials	Crop Location	Observation Type	Description	# Thrips	# Plants with Silvered Leaves
8/10/2022	10:00 AM	HMP	R1	YSC and Visual		100	25
8/10/2022	10:00 AM	HMP	R2	YSC and Visual		10	0
8/10/2022	10:00 AM	HMP	R3	YSC and Visual		1	0
8/17/2022	11:00 AM	HMP	R1	YSC and Visual		250	30
8/17/2022	11:00 AM	HMP	R2	YSC and Visual		10	0
8/17/2022	11:00 AM	HMP	R3	YSC and Visual		0	0
8/24/2022	10:00 AM	HMP	R1	YSC and Visual	Card covered in dirt	350	25
8/24/2022	10:00 AM	HMP	R2	YSC and Visual		10	0
8/24/2022	10:00 AM	HMP	R3	YSC and Visual		1	0
8/31/2022	2:00 PM	DPM	R1	YSC and Visual		425	25
8/31/2022	2:00 PM	DPM	R2	YSC and Visual		10	1
8/31/2022	2:00 PM	DPM	R3	YSC and Visual		1	1
9/7/2022	6:00 PM	DPM	R1	YSC and Visual		600	1
9/7/2022	6:00 PM	DPM	R2	YSC and Visual		0	0
9/7/2022	6:00 PM	DPM	R3	YSC and Visual		10	0

As you gather more data, you can learn more!

IPM Concepts



Identification

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Biological &
Chemical Control

Monitoring & Record Keeping

The benefits of stacking data...

PivotChart Fields

Choose fields to add to report: 

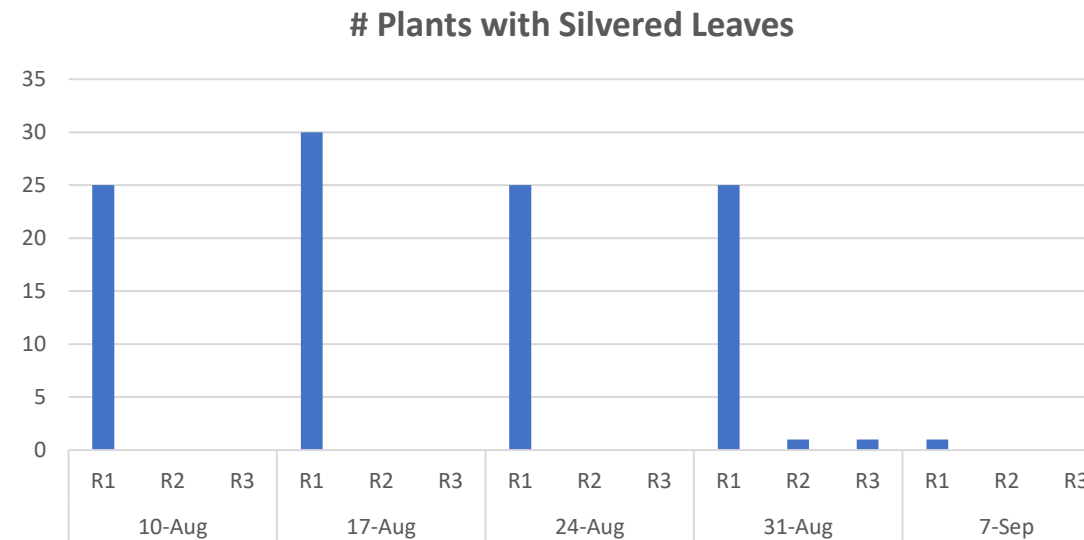
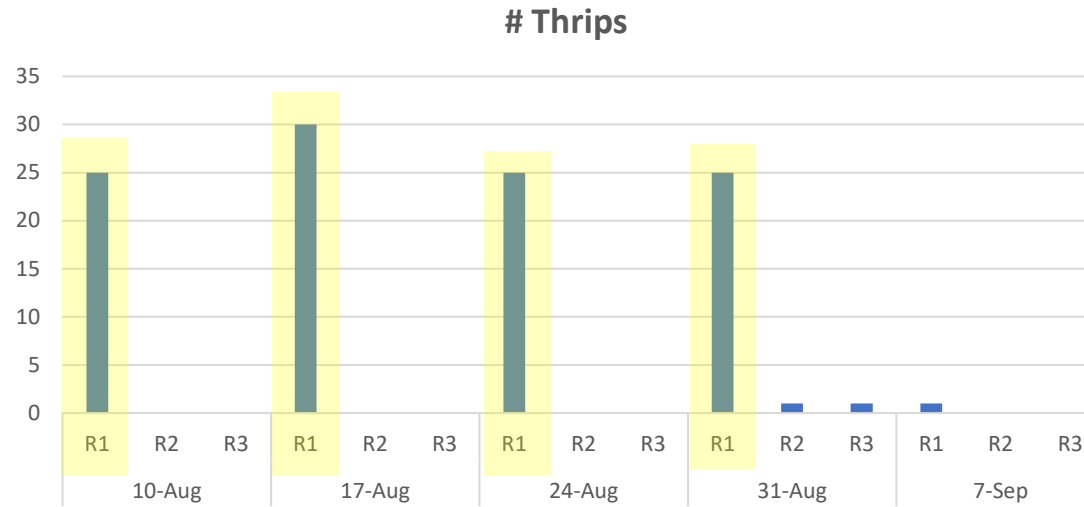
Search 

- Date
- Time
- Initials
- Crop Location
- Observation Type
- Description
- # Thrips
- # Plants with Silvered Leaves
- Months

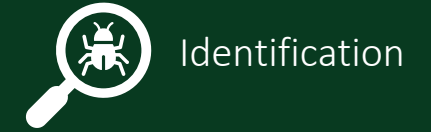
Drag fields between areas below:

Filters	Legend (Series)
Axis (Categories)	Σ Values
Date	Sum of # Thrips
Crop Location	

Defer Layout Update **Update**



IPM Concepts



Monitoring & Record Keeping

Another option for record keeping: Pre-made programs and tools.

- [Google Forms \(free\)](#) – create your own custom forms for filling out data in the field (Google sheets output -> excel)
- [Crop-Scanner](#) – tool by BioBest
- [Koppert iPM](#) – tool by Koppert Biological Systems
- [Greenhouse Management Software](#) – tool by Redbud
- [Pocket IPM Greenhouse Scout Mobile App](#) – tool by Cornell



These are just a few examples of the types of programs that exist on the market.

Inclusion is not an endorsement of these pieces of software.

IPM Concepts



Identification

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Monitoring &
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Thresholds



Biological &
Chemical Control

Biological Control

Considerations for Biological Controls

Indoors, Purchase, and Release

- *KNOW* your pest species first – great guidelines by the [Association of Natural Biocontrol Producers](#)
- Determine if biocontrols to be released are compatible with other control measures
- Purchase from trustworthy sources – many guides are available online through the [Association of Natural Biocontrol Producers](#)
- Keep records of release information – date, amount, control achieved



Greenhouses and Interiorscapes		predatory mites	14
		predatory insects	31
	leafminers	parasitic wasps	52, 55
		predatory insects	25, 41, 42
	mealybugs	parasitic wasps	54
		predatory mites	19-24
	mites	predatory insects	28, 33
		predatory insects	30
	scales	parasitic wasps	46
		predatory mites	14, 18, 20
	thrips	predatory insects	31
		predatory insects	26, 35, 41, 42
parasitic wasps		46-48	



Predatory mite
Phytoseiulus persimilis

Any organisms to be released in Maine must be on the IF&W unrestricted list.

Outdoors

- Preserve natural enemies outdoors by following IPM guidelines before resorting to pesticide treatments

IPM Concepts



Identification

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Monitoring & Record Keeping

Action Thresholds



Biological & Chemical Control

Biological Control

Considerations for Biological Controls



“Alligator shaped” biocontrol insects (rove beetles, lacewing larva, ladybug larva) have the potential to get stuck in trichomes.

Oh mama mia, mama mia, mama mia, let me go!

IPM Concepts



Identification

Prevention & Cultural Control



Monitoring & Record Keeping

Action Thresholds



Biological & Chemical Control

General Guidelines & Resources

- Home-made pest control substances (including food-based solutions) are not permitted
- The label is the law
- Must be registered with BPC
- Do NOT apply on flowering plants
- Guidelines available on the [maine.gov hemp website](https://www.maine.gov/hemp)

▾ Pest Management Resources for Hemp Crops

- [Best Management Practices for Plant Health, Pest Prevention and Pest Management in Maine Hemp Cultivation \(PDF\)](#)
- [Maine Registered Pesticide Products Labeled for Use on Hemp \(XLSX\)](#)
- [Hemp Insect Factsheets](#), Colorado State University
- [2020 On-Farm New England Hemp Pest & Disease Scouting Report \(PDF\)](#)
- **Presentations from Maine Board of Pesticides Control 2019 Hemp Meeting:**
 - [Maine's Hemp Program \(PDF\)](#), Gary Fish, State Horticulturist
 - [Pesticides Risk and Hemp \(PDF\)](#), Pam Bryer, Maine BPC Toxicologist
 - [Agronomics of CBD Hemp Production \(PDF\)](#), John Jemison, Extension Professor, Soil and Water Ecology
 - [Hemp and Maine Registered Pesticides \(PDF\)](#), Mary Tomlinson, Maine BPC
 - [Pesticide Rules & Regulations, Record Keeping and BMPs \(PDF\)](#), John Pietroski, Maine BPC
 - [Hemp Insects and What to Do About Them \(PDF\)](#), Kathy Murray, Entomologist

IPM Concepts



Identification

Prevention &
Cultural Control



Monitoring &
Record Keeping

Action
Thresholds



Biological &
Chemical Control

Identification: Pests, Pathogens, and Friends, oh my!

Overview of pest & problem types:

Fungal Pathogens



Viral Pathogens



Abiotic Diseases & Problems



Invertebrate Pests



Vertebrate Pests



Weeds



IPM Concepts



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Identification: Pests, Pathogens, and Friends, oh my!

Overview of pest & problem types:

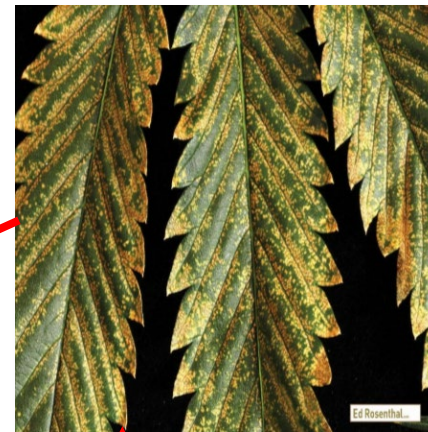
Fungal Pathogens



Viral Pathogens



Abiotic Diseases & Problems



Invertebrate Pests



Vertebrate Pests



Weeds



IPM Concepts



Identification

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Monitoring &
Record Keeping

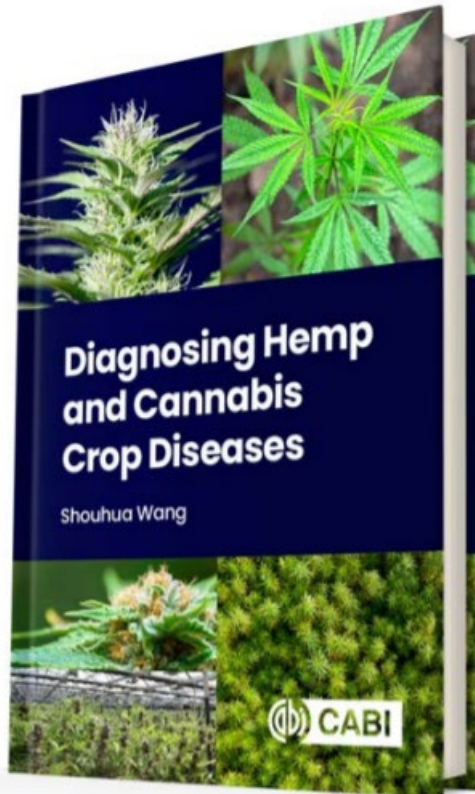
Action
Thresholds



Biological &
Chemical Control

Identification: Pests, Pathogens, and Friends, oh my!

New Resource: Diagnosis Hemp and Cannabis Crop Diseases



<https://www.cabi.org/bookshop/book/9781789246070/>

Published September 2021

IPM Concepts



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Identification: Pests, Pathogens, and Friends, oh my!

Other Broad Identification Resources: (Google search or use hyperlinks posted online)

- [Colorado State University Hemp Resource Center](#)
- [University of Tennessee Hemp Disease and Pest Management Guidelines](#)
- [University of Wisconsin-Madison: Insect and Mite Pests of Field Grown Hemp in Wisconsin](#)
- [Michigan State University: Insects in Industrial Hemp Production in Michigan](#)
- [Developing Insect Pest Management Systems for Hemp in the United States: A Work in Progress](#) (Open Access Research Paper with a lot of pest information)
- [Insects found on yellow sticky traps in the greenhouse](#) (NC State Extension)

Use good resources (university, government, etc.) –
be wary of company websites looking to sell a
product!

IPM Concepts



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Tips for finding good resources



Google

Septoria cannabis

Use the Latin name!

Stick with websites
ending in .edu and .gov

Commodity magazine
sites and product sites
may be trying to sell you
products.

<https://plantpathology.ca.uky.edu/ppfs-ag-h-01> PDF

Septoria Leaf Spot of Field Hemp - Plant Pathology

Septoria cannabis is known to cause disease only in hemp. Septoria leaf spot spreads by spores called conidia. Infective conidia develop within capsule-like ...

2 pages

You visited this page on 1/6/22.

<https://pubmed.ncbi.nlm.nih.gov>

Reemergence of Septoria Leaf Spot Caused by ... - PubMed

by M Rahnema · Cited by 1 — Reemergence of Septoria Leaf Spot Caused by **Septoria cannabis** on Hemp in Kentucky. Plant Dis. 2021 Sep;105(9):2286-2289. doi: 10.1094/PDIS-12-...

You visited this page on 1/6/22.

IPM Concepts



Identification

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Biological &
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Identification: Pests, Pathogens, and Friends, oh my!

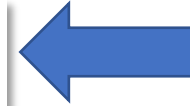
Tips for finding good resources



Septoria cannabis



Articles Case law



Google scholar is a great place to find peer-reviewed research

Google Scholar

My profile

My library

Metrics

Alerts

Settings



You can even set up “alerts” – a term you enter will be searched daily (or weekly) and new results will be emailed to you.

Try “Hemp Integrated Pest Management”

IPM Concepts



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Monitoring &
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Biological &
Chemical Control

Identification: Pests, Pathogens, and Friends, oh my!



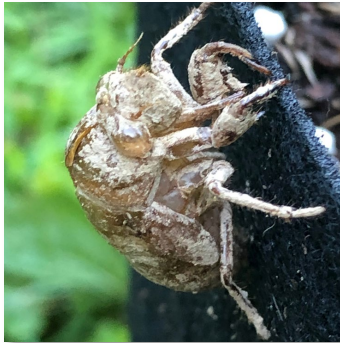
Beneficial

Neutral

Incidental Pests

Low Damage

High Damage



Factors:

Context, Perception, Personal Allowance, Understanding, Population Size, Health of Plants, Indoor vs. Outdoor etc.

IPM Concepts



Identification

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Biological &
Chemical Control

Beneficial Organisms



IPM Concepts



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Biological &
Chemical Control

Beneficial Organisms

Predatory stink bug
egg mass

In Maine on hemp!



IPM Concepts



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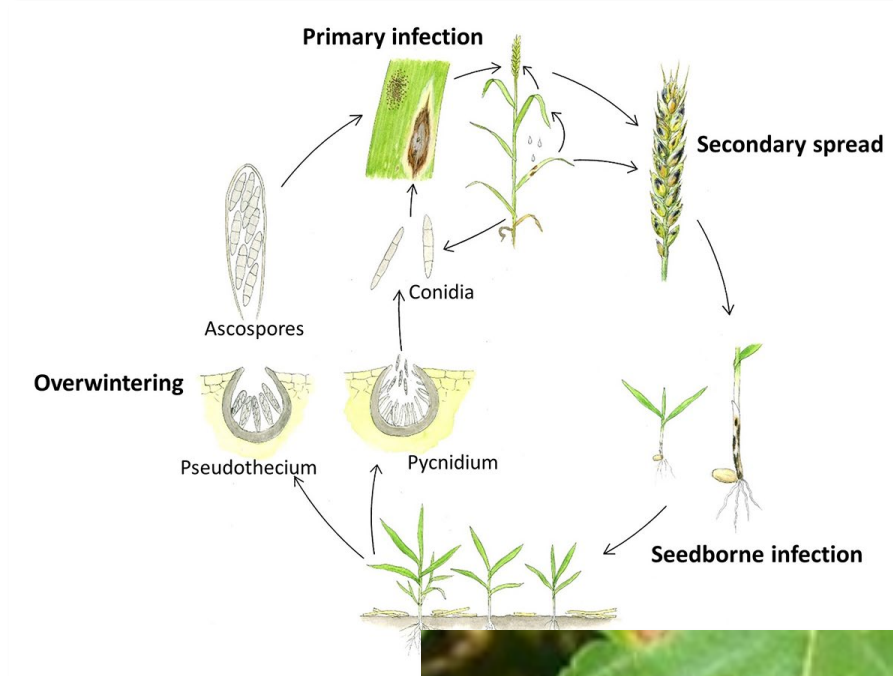
Pathogen: Septoria Leaf Spot (*Septoria cannabis*)

IPM Strategies

- Scout lower leaves and inner canopy for small irregular spots with bright yellow margins
- Weather – be aware that rainy summers bring rapid spread of disease
- Destroy debris – can survive for 9 months
- Increase plant spacing
- Thin plants
- Apply mulch
- Deep till at the end of the season

Resources for Identification & Information

- [University of Kentucky Factsheet](#)
- [University of California Factsheet](#)



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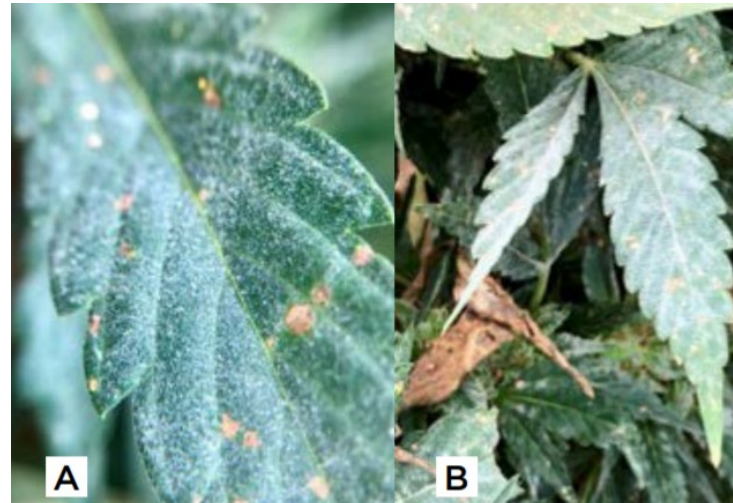
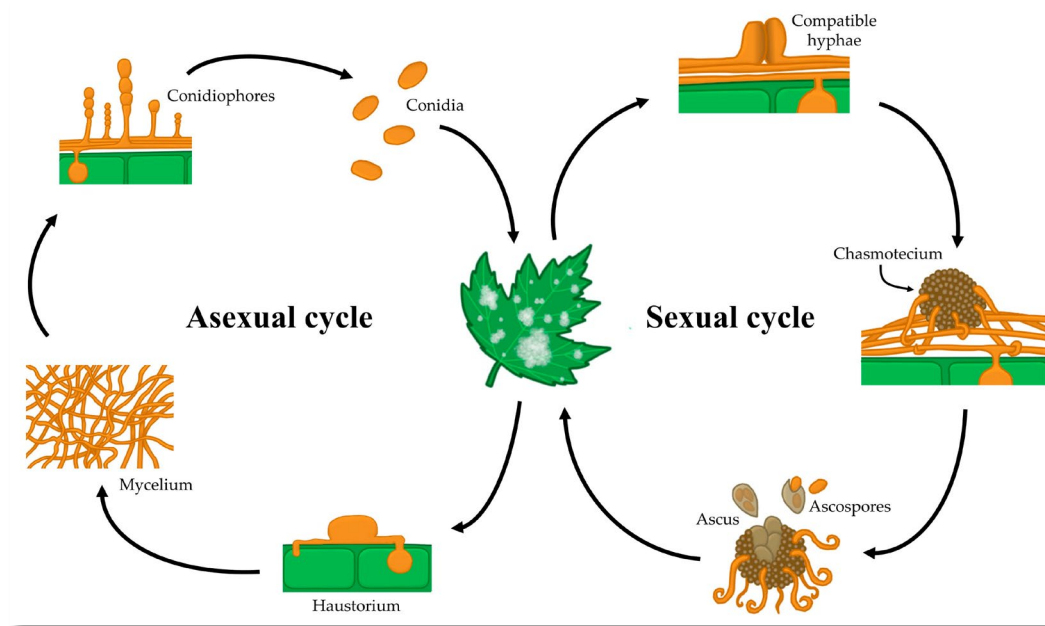
Pathogen: Powdery Mildew

IPM Strategies

- Avoid humid conditions
- Avoid planting near cucurbit fields
- Take care to disinfect tools and equipment
- Prune lower leaves and small interior branches

Resources for Identification & Information

- [University of Tennessee Factsheet](#)
- [University of Massachusetts Factsheet](#)



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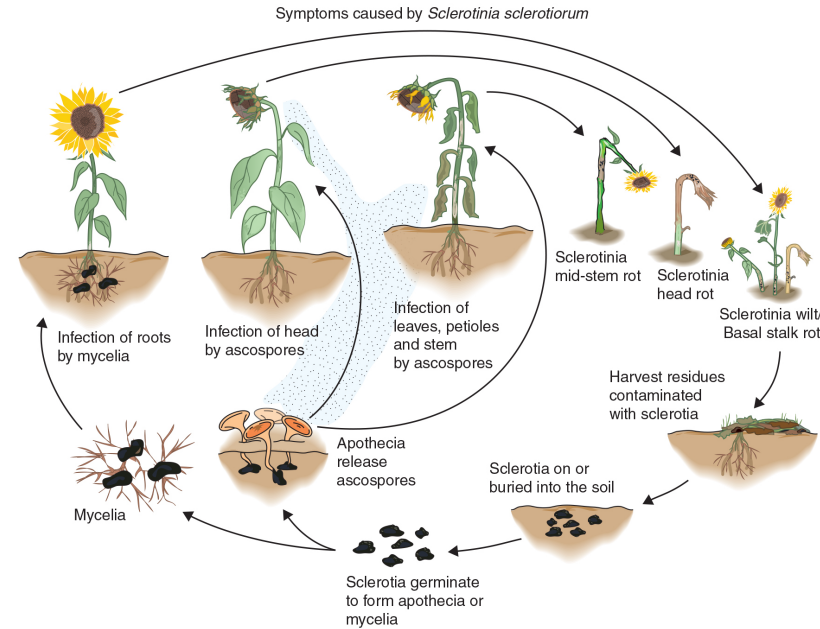
Pathogen: White Mold (*Sclerotinia sclerotiorum*)

IPM Strategies

- Keep equipment clean
- Remove dead/infected plants
- Do not remove during wet conditions
- Keep humidity below 50% RH

Resources for Identification & Information

- [NC State Extension](#)
- [Diseases Affecting Hemp in New York](#)



Photos: American Phytopathological Society; Brian Whipker

IPM Concepts



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Action
Thresholds

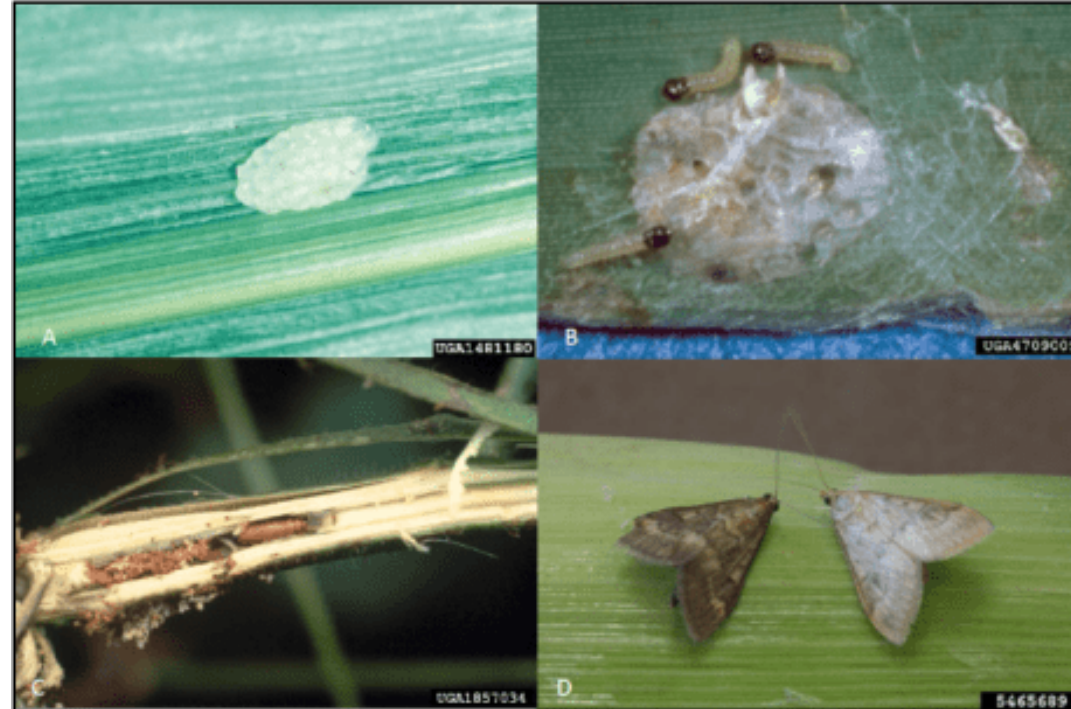


Biological &
Chemical Control

Insect Pest: European Corn Borer (*Ostrinia nubilalis*)

IPM Strategies

- Be aware of increased risk if planted close to corn
- Scout for:
 - Eggs on top/bottom of leaves
 - Bulging in the stem
- Monitor for adults with [baited traps](#)
- Weed management of off-target hosts
- Do not hold over stalks or stems from previous crops



Resources for Identification & Information

- [Colorado State University Factsheet](#)
- [University of Vermont Blog Post](#)
- [Identification Guide \(University of Missouri\)](#)
- [How to tell apart stem borers \(Purdue\)](#)
- [UMaine Extension sweet corn weekly reports](#)



IPM Concepts



Identification

Prevention &
Cultural Control



Monitoring &
Record Keeping

Action
Thresholds



Biological &
Chemical Control

Insect Pest: Corn Earworm (*Helicoverpa zea*)

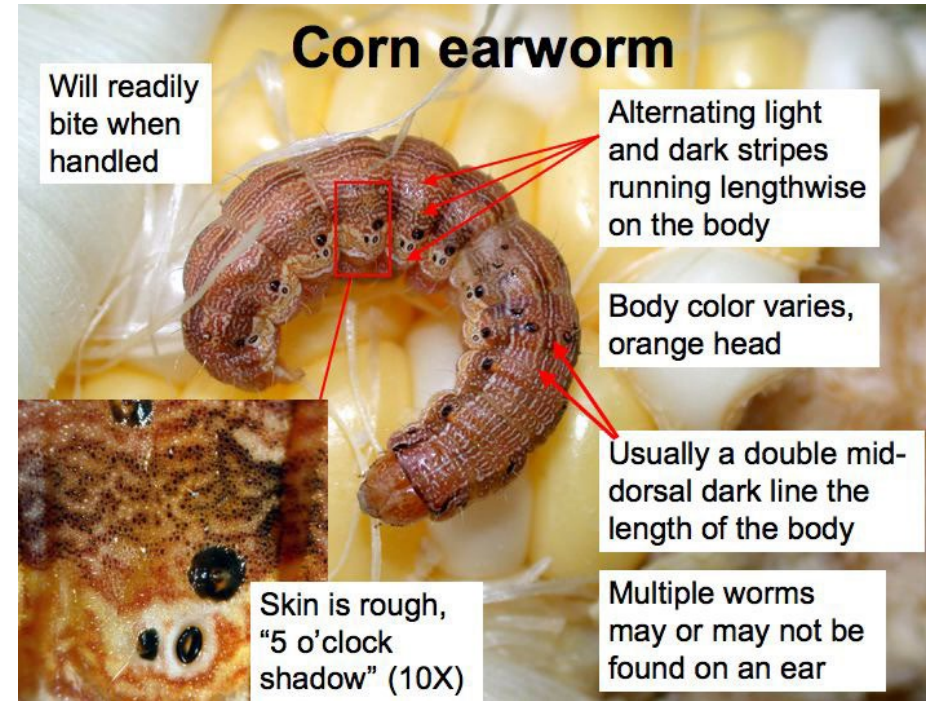
IPM Strategies

- Scout for damage – larval frass (poop), tunneling on the bugs, wilting of leaves
- Destruction of weeds before planting kills pupae
- Monitor for adults using [pheromone traps](#)
 - An increase in moth capture indicates eggs may be laid in crop
 - *If buds need protection* – Helicoverpa may be considered for treatment ([read more](#))

This does not constitute an endorsement or a recommendation by the State of Maine or the Board of Pesticides Control to use this product in the production of hemp. Any products without an EPA registration number have not been reviewed or registered by the EPA. The label must be strictly followed.

Resources for Identification & Information

- [How to tell apart stem borers \(Purdue\)](#)
- [Colorado State University Factsheet](#)
- [Colorado State Proposed Management Plan](#)
- [NC State Extension Factsheet](#)



IPM Concepts

- Identification
- Prevention & Cultural Control
- Monitoring & Record Keeping
- Action Thresholds
- Biological & Chemical Control

Insect Pest: Aphids (multiple species)

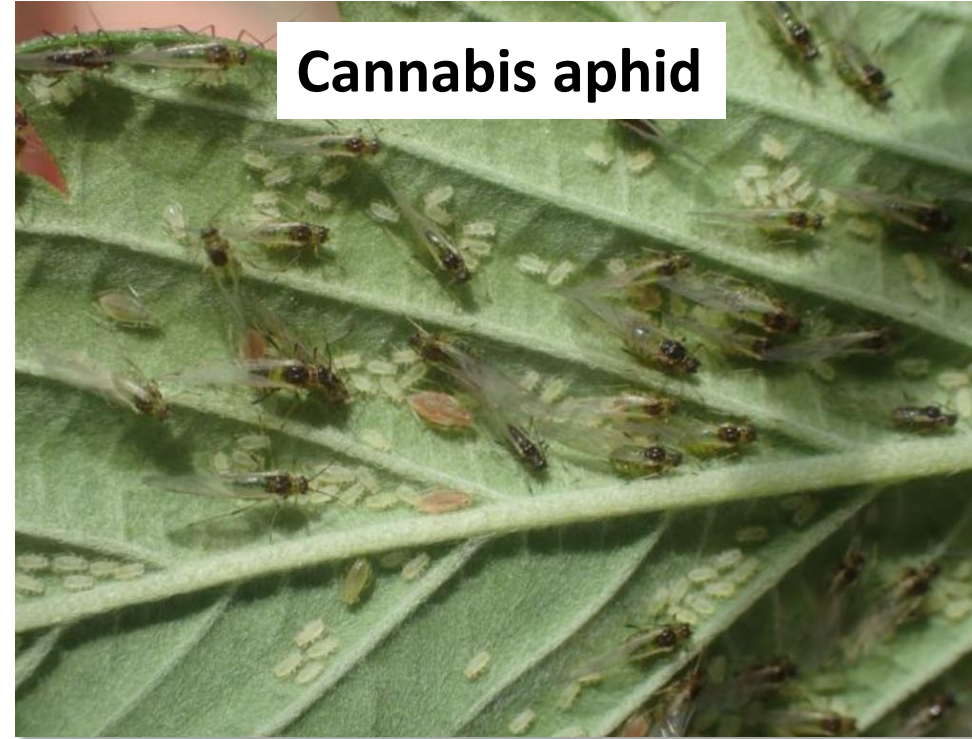
IPM Strategies

- Be aware of slowed growth, wilting, and leaf yellowing
- Scout for:
 - honeydew spots (small, shiny)
 - cast skins (exoskeletons)
- Remove any volunteer seedlings outdoors
- Be aware – more likely for indoor populations to survive the winter
- **Biocontrol option** – *Aphidius colemani*



Resources for Identification & Information

- [Cannabis aphid \(*Phorodon cannabis*\) Factsheet](#) (Colorado State)
- [Rice root aphid \(*Rhopalosiphum rufiabdominalis*\) Factsheet](#) (Colorado State)



IPM Concepts

- Identification
- Prevention & Cultural Control
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Insect Pest: Thrips (multiple species)

IPM Strategies

- Scout for flecking wounds
- Monitor with yellow sticky cards
 - Within leaves and below plant
- Be aware – more problematic for indoor growing operations

Resources for Identification & Information

- [Thrips factsheet \(Colorado State University\)](#)



Western flower thrips caught on a blue sticky card.
Photo by J. R. Baker, NC State University



IPM Concepts

- Identification 
- Prevention & Cultural Control 
- Monitoring & Record Keeping 
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- Biological & Chemical Control 

Insect Pest: Leafhoppers (many species)

IPM Strategies

- Scout for hopperburn symptoms
 - Yellowing at tips of leaves
 - Leaf curling
 - Areas of leaf death

Resources for Identification & Information

- [General hemp leafhopper factsheet \(Colorado State\)](#)
- [Potato leafhopper factsheet \(Colorado State\)](#)
- [Potato leafhopper factsheet \(Michigan State\)](#)



IPM Concepts



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Biological &
Chemical Control

Non-Insect Arthropod Pest: Twospotted Spider Mites

IPM Strategies

- Be aware that this species has a larger potential to be a problem in indoor hemp or hoop houses
- Remove weeds & grass adjacent to fields
- Restrict movement of employees
- *Indoors* – Biocontrol – predatory mites



Resources for Identification & Information

- [Factsheet \(Colorado State University\)](#)
- [Factsheet \(NC State Extension\)](#)



IPM Concepts

- Identification
- Prevention & Cultural Control
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- Biological & Chemical Control

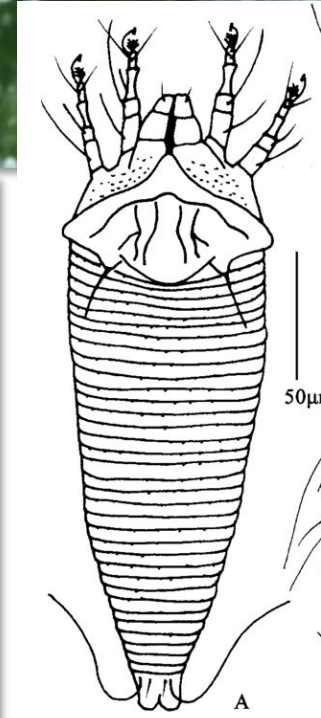
Non-Insect Arthropod Pest: Hemp Russet Mites

IPM Strategies

- Ensure quarantined and clean cuttings
- Scout for dull leaves (grayish/bronze)
- Incredibly small
- Biocontrol – predatory mites

Resources for Identification & Information

- [Recent study comparing miticides](#)
- [Factsheet \(Colorado State University\)](#)
- [Factsheet \(NC State Extension\)](#)



IPM Concepts



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Chemical Control

Questions?

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