**Nov 20, 2020 Pesticide recertification**
**IPM, site specific IPM program development**
**UM CFANS CUES website cues.cfans.umn.edu**

**Vera Krischik, Associate Professor, Depart Entomology, Uminnesota, krisc001@umn.edu**

## Krischik lab websites

**IPM resources for greenhouses and ornamentals**
**http://cues.cfans.umn.edu/**

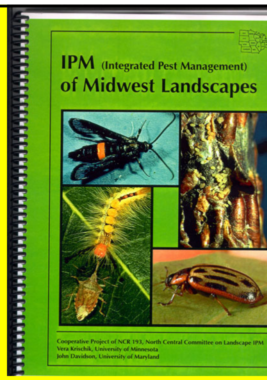
**Pollinator Conservation**
**https://ncipmhort.cfans.umn.edu/**

**MNLA online course fro certification training for MDA pesticide license**
**https://pesticidecert.cfans.umn.edu/**

**Turf Insects: white grubs and adults**

**IPM of Midwest landscapes (2004)**

**Vera Krischik, UM Entomology**

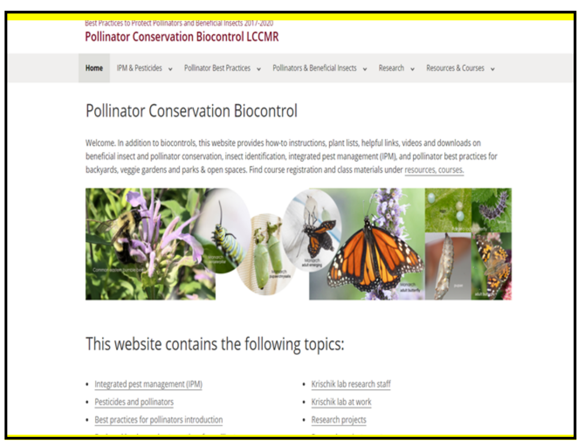



**http://cues.cfans.umn.edu/**


University of Minnesota | OneStop | Directories | Search U of M | **IPM of Midwest Landscapes**

**Pests of Trees and Shrubs**

| | | | |
|---|---|---|---|
| **Alder spittlebug** | *Clastoptera obtusa* | Lesser peachtree borer | *Synanthedon pictipes* |
| Ambrosia beetle | *Xylosandrus germanus* | Lilac/ash borer | *Podosesia syringae* |
| American hornet moth | *Sesia tibialis* | Linden borer | *Saperda vestita* |
| Aphids | Family Aphididae | Locust borer | *Megacyllene robiniae* |
| Apple bark borer | *Synanthedon pyri* | **Maple bladdergall mite** | *Vasates quadripedes* |
| Arborvitae leafminer | *Argyresthia thuiella* | Maple callus borer | *Synanthedon acerni* |
| Ash flower gall mite | *Aceria fraxiniflora* | Maple spindlegall mite | *Vasates aceriscrumena* |
| Ash plant bug | *Tropidosteptes amoenus* | Maple velvet erineum gall mite | *Aceria aceris* |
| Asian longhorned beetle | *Anoplophora glabripennis* | Mimosa webworm | *Homadaula anisocentra* |
| Azalea lace bug | *Stephanitis pyrioides* | Mountainash sawfly | *Pristiphora geniculata* |
| **Bagworm** | *Thyridopteryx ephemeraeformis* | Mourningcloak butterfly | *Nymphalis antiopa* |
| Balsam twig aphid | *Mindarus abietinus* | **Oak borer** | *Paranthrene simulans* |
| Banded ash clearwing | *Podosesia aureocincta* | Oak clearwing borer | *Paranthrene asilipennis* |
| Birch lace bug | *Corythuca pallipes* | Oak cynipid galls | Family Cynipidae |
| Birch leafminer | *Fenusa pusilla* | Obscure scale | *Melanaspis obscura* |
| Black pineleaf scale | *Nuculaspis californica* | Oriental beetle | *Exomala orientalis* |
| Black vine weevil | *Otiorhynchus sulcatus* | Oystershell scale | *Lepidosaphes ulmi* |
| Boxelder bug | *Boisea trivittatus* | **Pales weevil** | *Hylobius pales* |
| Boxwood spider mite | *Eurytetranychus buxi* | Peachtree borer | *Synanthedon exitiosa* |
| Bronze birch borer | *Agrilus anxius* | Pear sawfly | *Caliroa cerasi* |
| Brownheaded ash sawfly | *Tomostethus multicinctus* | Pin oak kermes | *Allokermes galliformus* |
| **Calico scale** | *Eulecanium cerasorum* | Pine bark adelgid | *Pineus strobi* |
| Cankerworms | *Alsophila pometaria, Paleacrita vernata* | Pine engraver | *Ips pini* |
| Clearwing borers | Family Sesiidae | Pine needle scale | *Chionaspis pinifoliae* |
| Clover mite | *Bryobia praetiosa* | Pine root collar weevil | *Hylobius radicis* |
| Cooley spruce gall adelgid | *Adelges cooleyi* | Pine shoot beetle | *Tomicus piniperda* |
| Cottonwood leaf beetle | *Chrysomela scripta* | Pine spittlebug | *Aphrophora parallela* |
| Cottony maple scale | *Pulvinaria innumerabilis* | Pine thrips | *Gnophothrips sp.* |
| Currant borer | *Synanthedon tipuliformis* | Pine tortoise scale | *Toumeyella parvicornis* |
| Cyclamen mite | *Phytonemus pallidus* | Pitch mass borer | *Synanthedon pini* |



## Integrated Pest Management

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Integrated Pest Management (IPM) is an ecosystem-based approach that employs long-term prevention of pests and pest damage through monitoring of plants, pests and weather to project ahead and plan. IPM addresses the source of the pest problems, whereas pesticides simply respond to pests. IPM minimizes the use of chemicals harmful to pollinators and beneficial insects, and toxic to the environment. The recommended best practice is to use cultural controls to reduce pest populations such as compost, bio fertilizers and aeration instead of pesticides.

**Integrated pest management practices include:**

**1. Inspection and monitoring:** Regular and close examination of plants is essential to diagnose pest problems. Monitoring includes devices such as traps, and practices such as observation and recordkeeping.

**2. Forecasting:** Weather and plant growth cycles (called plant phenology) help predict potential pest outbreaks. Properly timed pesticide applications will be more effective and reduce need for re-application.

**3. Thresholds**: Set thresholds for pest populations and plant damage. Use hardy plants that are naturally resistant to pests to avoid exceeding pest thresholds. Accept some plant damage.

**4. Education:** Regularly update the IPM plan and pesticide/treatment list so it remains effective. Stay educated and updated on IPM and best management practices.

**5. Recordkeeping**: Keep updated records to compare year to year and for decision-making. Track data including weather patterns, when pests appear, number of pests, plant damage, and practices that work and don't work.

## Minnesota Threatened and Endangered Species

Excerpt from *Environmental Quality Board, Minnesota State Agency Pollinator Report 2018.*

Federally endangered

Poweshiek skipperling

Karner blue butterfly

Rusty-patched bumble bee

Federally threatened

Dakota skipper

Under review for federal listing

Yellow-banded bumble bee

Monarch butterfly

**Endangered:** Persius duskywing, Ottoe skipper, Dakota skipper, Assiniboia skipper, Uncas skipper, Karner blue, Poweshiek skipperling, Uhler's artic.

**Threatened:** Garita skipperling.

**Special Concern:** Arogos skipper, Disa alpine, Leonard's skipper, Nabokov's blue, Grizzled skipper, Regal fritillary.

In addition to federally-listed species, Minnesota has 8 state-listed endangered pollinator species, 1 threatened, 10 species of special concern, and an additional 19 non-listed species in greatest conservation need.

## Outline: Specific IPM programs

- What is IPM
- Cultural, chemical, biorational, biological
- Develop IPM based on life history of pest
- IPM, BMP, OMRI
- What you can do.

## What is IPM?


## Changing the paradigm: reduce pesticide use


- Use contact insecticides
- Not use systemic neonicotinoid insecticides
- Reduce herbicide use
- Do not use fungicides w/o diagnosis
- Promote bee lawns

## What is PM?

- A system utilizing multiple methods
- A decision making process
- A risk reduction system
- Information intensive
- Biologically based
- Cost effective
- Site specific
- Multiple tactics: cultural, physi genetic, biological, chemical
- Least toxic pesticide first and use spot treatments
- Conserve beneficial insects

## What are best management practices (BMP) for landscapes

- Use soil test for fertilization needs.
- Avoid over-fertilization.
- Manage pests with principles of IPM, Integrated Pest Management.
- Plant flowers and shrubs for pollen and nectar for beneficial insects that kill pest insect, pollinators, and butterflies

## Understanding the partial contribution of pesticides to bee mortality and developing BMP to mitigate mortality

- Spot treatments not broad cast sprays
- Spray at less than 8 mph and when bees are not active in early morning and evening
- Spray less often, tolerate more weeds
- Use contact insecticides.
- Use the money saved on herbicide use to add nutrients back to the soil and turf to increase turf and plant health.
- Promote bee lawns + decreased herbicides

**2014 EPA: Bees and other insect pollinators can be exposed to this pesticide from:**

1. Direct contact during foliar application or contact with residues on plant surfaces after foliar application.

2. Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar application.

**When using this product take steps to:**

1. Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.

2. Minimize drift of this product onto beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives can result in bee kills.

Also, there is new language in the "Directions for use" section of the label, that states: " Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen unless one of the following conditions…."

## Insecticides: biorational, conventional, and organic

Biorational: Compatible with bees and beneficials

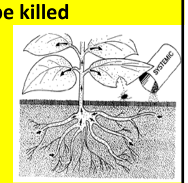
Organic: OMRI approved natural products; toxic to good bugs

Conventional: Toxic to pests, bees, beneficials

## Contact compared to systemic insecticides

**Contact insecticides:**

- Many used; sprayed on foliage
- Insect must eat leaf or walk on leaf to be killed
- Toxicity lasts 1-3 weeks
- Flowers that open after spraying do not contain insecticides.

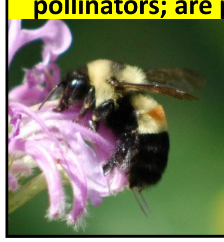


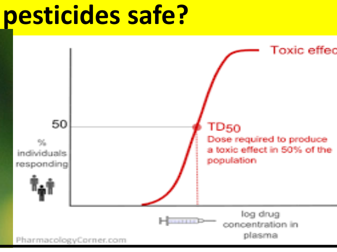

**Systemic insecticides:**

- Uncommon; treated-seed, soil drench, trunk-inject
- Insect must eat leaf, pollen, or nectar to be killed
- Toxicity can least for months to years, unknown
- Flowers that open will have the insecticide in pollen and nectar for months to years, unknown

## Issues with IPM in urban areas:

- 2018 Conserving the endangered rusty patched bumble bee; create habitat and decrease pesticide
- 2020 Updated Insecticide toxicity to pollinators; are pesticides safe?





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## 2020 Understanding Pesticide Toxicity to Pollinators

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**Pesticide Toxicity to Pollinators**

The active and inert ingredient can be found on the label on the pesticide container. The active ingredient is the chemical registered by the EPA as causing the toxicity of the product to the pest or beneficial insect. Recent papers demonstrate that inert ingredients are highly toxicity to bees as well. Inert ingredients are penetrating agents, odor maskers, stabilizers, preservatives, diluents, surfactants, emulsifiers, propellants, solvents, spreaders, stickers, antifoaming agents, dyes, and drift retardants that modify the physicochemical properties of the spray mixture. Some recent papers demonstrate that the inert ingredient called "organosilicone surfactant adjuvants" increase virus transmission in bees. Also, in recent studies fungicides demonstrated toxicity to bees. Another major issue is that the EPA registers the active ingredient and determines toxicity of the chemical based on short term, 4 day, LD 50 tests (lethal dose to 50% of the population) and not chronic, long term exposure. However, numerous papers are demonstrating that lower, sub-lethal amounts of pesticides affect behavior and alter the ability of insects to find food and survive. For these and numerous other reasons many insecticides are not safe to use around bees and other beneficial insects, such as lady beetles.

**IPM: Systemic Compared to Contact Insecticides**

The conservation of beneficial insects, that includes bees, insect predators, parasitic wasps, and butterflies, is an essential part of Integrated Pest Management (IPM) programs. IPM promotes multiple tactics to manage pests and to suppress the population size below levels that will damage the plant. Beneficial insects can only manage small, pest populations, when populations of pests are high, conventional insecticides must be used. For most pests that eat leaves, use contact insecticides that sit on the leaf surface and do not move into the plant and the toxicity to pests last for a few days on the foliage. Flowers that open after being sprayed with contact insecticides do not contain insecticide residue. Systemic insecticides move from the leaves or soil into OTHER plant parts as nectar and pollen. Flowers that open after systemic insecticides are sprayed can absorb the insecticide and the residue in leaves and flowers can last for many months.

Systemic, neonicotinoid insecticides are widely used, due to their low mammalian toxicity and the ability of the insecticide to move systemically from soil into the entire plant. However, they often move into pollen and nectar and when fed on by bees alter bee behavior or increase bee mortality. Application methods include seed treatments, foliar sprays, soil and trunk drenches, and trunk-injections. There are six systemic neonicotinoid active ingredients, imidacloprid, dinotefuran, thiamethoxam, clothianidin, acetamiprid and thiacloprid. You will find these active ingredients listed on the insecticide label in small print. Neonicotinoid insecticides are very toxic to bees and beneficial insects, especially as residue in pollen and nectar.

**Manage with IPM** by using cultural control, sanitation, biological control, using insecticides friendly to beneficial insects (low toxicity in the table). Remember "organic MRI approved insecticides" can be very toxic.
1. Scout for populations of both pest and beneficial insects, such as lady beetles and bees.
Determine if the good bugs are suppressing the pest bugs and no loss to flowering or food production can be found.
2. If beneficial insects are present and the pest population is increasing, then spray CONTACT insecticides on the foliage. Contact insecticides are degraded in a few days by light, water, and microbes.
3. Do not apply insecticides to flowers.
4. Spray contact insecticides on leaves in the evening when bees and lady beetles are not foraging.
5. Use insecticides that are less toxic to bees, such as oils, soaps, neem oil, Acelepryn (chlorantraniliprole), miticides, and insect growth regulators

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**Toxicity to pollinators of insecticides used in greenhouse, nursery, landscape.**
Highlighted in gray are less toxic AI.

| | | | Toxicity to honeybees** | | | |
|---|---|---|---|---|---|---|
| **Chemical class/MOA** | **Common name/MOA** | **Trade name** | **LD50* ug/bee** | **Non** | **Moderate** | **Highly** |
| Carbamates/1A | carbaryl | Sevin | 0.014 | | | x |
| | methomyl | Lannate | 0.816 | | | x |
| Neonicotinoids/4 | imidacloprid | Merit, Marathon | 0.004 | | | x |
| | thiamethoxam | Flagship, Meridian | 0.004 | | | x |
| | clothianidin | Arena, Aloft | 0.005 | | | x |
| | dinotefuran | Safari, Venom | 0.023 | | | x |
| | imid+bifenthrin | Allectus | 0.004 | | | x |
| | imid+cyfluthrin | Discus | 0.004 | | | x |
| | flypyradifurone | Altus | 1.2 | | | x |
| | sulfoxaflor+spinetoram | XXpire cancelled | 0.02+0.1 | | | x |
| | acetamiprid | Tristar, Assail Calypso | 14.5 | | x | |
| | thiacloprid | | 27.8 | x | | |
| Organophosphates/1B | acephate | Orthene | 0.1082 | | | x |
| | chlorpyrifos | Dursban/Lorsban | 0.06 | | | x |
| | dimethoate | Dimethoate | 0.038 | | | x |
| | malathion | Malathion | 0.16 | | | x |
| | phosmet | Imidan | 0.1 | | | x |
| Pyrethroids/3A | bifenthrin | Attain/Talstar | 0.1 | | | x |
| | cyfluthrin | Tempo, Decathalon | 0.001 | | | x |
| | fenpropathrin | Tame | 0.05 | | | x |
| | lambda-cyhalothrin | Scimitar | 0.038 | | | x |
| | permethrin | Astro, Pounce | 0.029 | | | x |
| | resmethrin | foggers | 0.065 | | | x |
| Botanical/3 | pyrethrin | Pyganic | 0.15 | | | x |
| Insect growth regulators | diflubenzuron/15 | Adept, Dimilin | 25 | x | | |
| | tebufenozide/18 | Confirm | 234 | x | | |
| | azadirachtin/UN | Aza-Direct, Azatin | 2.5 | | x | |
| | Neem oil | | 163 | x | | |
| | buprofezin/16 | Talus | 100 | x | | |
| | pyriproxyfen/7C | Distance, Fulcrom | 100 | x | | |
| | novaluron/15 | Pedestal | 150 | x | | |
| | cyromazine/17 | Citation | 25 | x | | |
| Juvenile hormone /7A | s-kinoprene | Enstar II | 35 | x | | |
| Anthranilic Diamides/28 | chlorantraniliprole | Acelepryn | >104 | x | | |
| | cyantraniliprole | Mainspring | 0.116 | | | x |
| Macrocyclic lactones/6 | abamectin | Avid, Sirocco | 0.009 | | | x |
| | emamectin-benzoate | Tree-age, Enfold | 0.41 | | | x |
| Miticides | acequinocyl/20B | Shuttle | >100 | x | | |
| | etoxazole/10B | TetraSan, Beethoven | 200 | x | | |
| | fenpyroximate/21A | Akari, Vendex | 162 | x | | |

## Outline: Specific IPM programs

- What is IPM

**Cultural, chemical, biorational, biological**

- Develop IPM based on life history of pest
- IPM, BMP, OMRI
- What you can do.

## Top 10 landscape pests

worst

- 1. Japanese beetle; lindens, roses
- 2. emerald ash borer: ash
- 3. aphids
- 4. trunk borers, clearwing, Zimmerman pine moth;
  root feeders: leather jackets, black vine weevil, bluegrass billbug, Japanese beetles
- 5. scales
- 6. mites
- 7. sawflies
- 8. plant bugs, leaf hoopers**
- 9. leaf-feeding caterpillars beetles and leps: white marked tussock moth, forest tent caterpillar
- 10. galls

## Top insect pests

- Insect pests can be grouped according to the way they damage the plant.
- Insects that vector diseases are the most damaging and insects that remove leaf tissue are the least.
- Insect evolution is conservative so if you know the family of the insect, then most insects in that family will perform similar damage.
- We will discuss how to develop IPM programs fro 10 major landscape pests, and proper insecticide choice and timing.

## Bluegrass Billbug

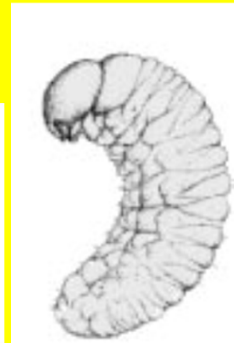
- Bluegrass Billbug
- Order Coleoptera
- Family Curculionidae
- Weevil larvae in grass sheath and adults feed on foliage
- Root and leaf damage

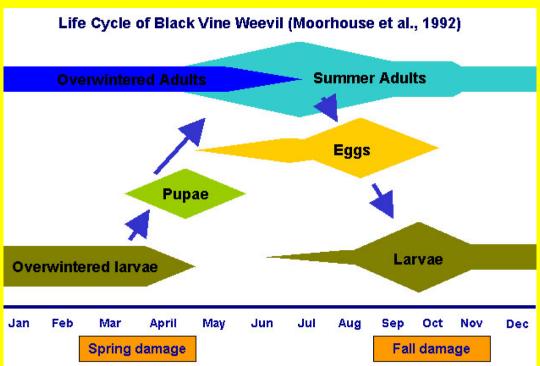

- Black vine weevil
- Order Coleoptera
- Family Curculionidae
- Weevil larvae and adults feed
- Root and leaf damage
- Yews, many other perennials

## Larvae

Weevil larva

Scarab beetle grub

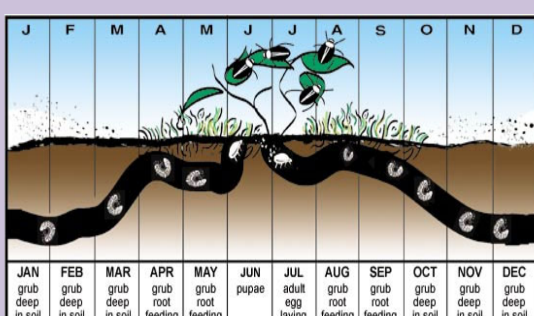




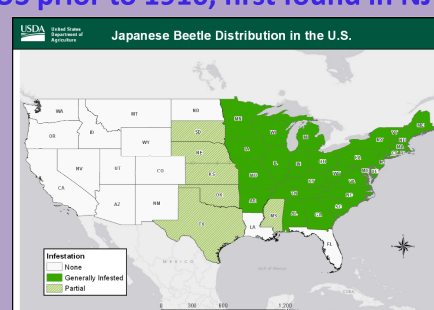


- Japanese beetle
- Order Coleoptera
- Family Scarabeidae
- Beetle larvae on roots and adults on foliage
- Grass

## One year life cycle of Japanese beetle

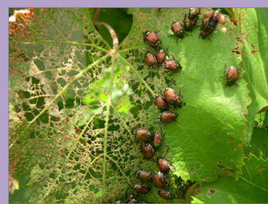



## Japanese beetle was accidently brought to the US prior to 1916, first found in NJ




Currently established in over 25 states

## Adult Japanese Beetle: About ½ in. long, emerald green with copper elytra



**Main symptom is skeletonized leaves from feeding between veins**

## Adults are active from mid-June to mid-August and are polyphagous

They feed on **>300 plants in about 80 families**

## Japanese Beetle Damage to Linden Tree


## JB grub control

**Neonicotinoids**

**Anthranilic Diamides, bee friendly**

imidacloprid clothianidin

Acelepryn®

MERIT®

Arena®


thiamethoxam dinotefuran

Zylam® Liquid Systemic Insecticide

Meridian Insecticide

## JB grub control

**Grub gone, Phyllom Bio Products**

***Bacillus thuringiensis galleriae*** **(Btg)**

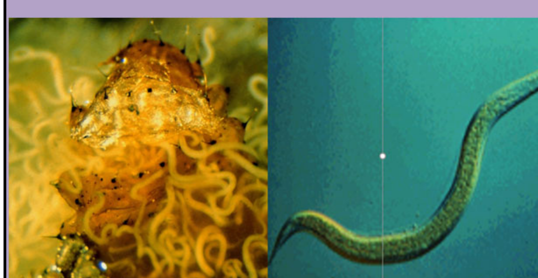
**Japanese, Asiatic, June and Oriental Beetles, and European, Cupreous, Southern and Northern Masked Chafers. is an effective control of the larger, beetles**

grubGONE!® G BIOLOGICAL INSECT CONTROL

## Parasitic nematodes

***Steinernema carpocapsae***

***Heterorhabditis bacteriophora***



## JB grub damage is the worst in late summer and fall


Symptoms: Turf turns brown and easily rolls back, like a rug

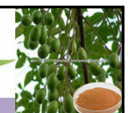
## JB grub control in August

- Expect no more than 75% control once grubs are large
- 2 main products used: Dylox or a neonicotinoid
- Acelepryn is NOT a curative product, slow acting

## JB adult control: insecticides

Acelepryn (4 weeks residual)
Pyganic OMRI approved, pyrethrins
Pyrethroids
Onyx, bifenthrin (4 weeks)
Talstar, bifenthrin (2-3 wks)
Tempo, cyfluthrin
Sevin, carbaryl, harmful to bees
(1-2 weeks residual)

## JB adult control: Azadirachtin,anti-feeding



- From Indian neem tree, *Azadirachta indica*
- *Active* against thrips.
- Caterpillars and aphides
- Biodegerades in sun.
- More effective on young larvae.
- Works best at temperatures, greater/equally to 70
- Azera combination product with azadirachtin

## JB adult control: Neem oil, anti-feeding

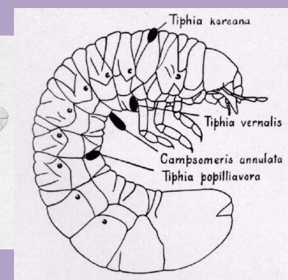

- From Indian neem tree, *Azarchta indica*
- Clarified hydrophobic extract of neem, very little azadirachtin in neem oil
- MOA suffocates by blocking breathing pores.
- Good for soft bodied, aphids, spider mites, scales, whiteflies, mealybugs
- Can kill beneficials
- Low mammalian toxicity

## JB traps: Do not use unless you empty daily before 6pm

## Biological control of JB

- Japanese beetle parasites *Tiphia vernalis (*Hymenoptera) and *Istocheta* sp. (Diptera) known to be active in MA and CT
- MDA is released both in MN, but are not affective at control.

## Biological control of JB: *Tiphia vernalis*




Females of different species lay eggs on distinct parts of grub.

## Biological control of JB: *Tiphia vernalis*

- In the northeastern U.S., adult spring *Tiphia* wasps feed primarily on the honeydew exuded from aphids, scale insects, and leafhoppers.
- The wasp will also feed on the nectar of blossoms, such as forsythia, and on the extra-floral nectaries of peonies.
- In China the knowledge of food plants to increase the rates of *Tiphia* parasitization of white grubs to an average of 85%.

## Biological control of JB: *Isotecha aldrichi,* tachnid fly

- This solitary fly is an internal parasite of adult Japanese beetle.
- The female flies deposit 100 eggs during a period of about 2 weeks.
- The eggs are usually laid on the thorax of the female beetles and the maggot bores directly into the body cavity.
- Food sources: aphid nectar and Japanese knotweed (*Polygonum cuspidatum*), a persistent perennial weed native to Japan.

## Biological control of JB: : Fungal pathogen

- Fungal microsporidian pathogen, *Ovavesicula popilliae,* infects JB Malpighian tubules and spreads systemically. JB has been long established in CT and NY and it suppresses JB population growth. It infected approximately 25% of all JB grubs in CT.
- After introduction in MI it reduced winter survival by 25 to 50 %. Female JB emerging from infected grubs lay about 50 percent fewer eggs. Results indicate *O. popilliae* caused a 75 percent decline in JB populations during the 15-year study period. It takes the pathogen about six years to have a noticeable effect.
- Kentucky, Colorado, and Arkansas have introduced *Ovavesicula.*
- *Ovavesicula* needs to be introduced in Minnesota

## Specific IPM program for bluegrass billbug, black vine weevil, JB

**Billbug**
**Adults:** after May contact insecticides
Biorationals: chlorantraniliprole, spinosad
**Larvae:** After Jul 15 IGR, *Steinernema glaseri* and JB nematodes, chlorantraniliprole
Conventional: imidacloprid, clothianidin

**Black vine weevil**
**Adults:** at night and all summer contact insecticides
Biorational: chlorantraniliprole, spinosad
**Larvae:** IGR, *Steinernema glaseri* and *Heterorhabditis bacteriophora* nematodes, chlorantraniliprole
Conventional: imidacloprid, clothianidin

**JB**
**Adults:** contact insecticides July-Sept
Biorational: chlorantraniliprole, spinosad
**Larvae:** After July 15
Biorationals: IGR, *Steinernema glaseri* nematodes, *JB* nematodes, Grub b gone BTg bacteria, chlorantraniliprole
Conventional: imidacloprid, clothianidin

- **Clearwing borer**
- **Order Lepidoptera**
- **Family Sesiidae**
- **Moth borer larvae feed under bark; adults do not feed**
- **Chlorosis, wilting, and dieback**
- **Many deciduous trees and shrubs**

## Clearwing Borers


Cottonwood Borer

**Several species**
**Family Sesiidae**
**Native pests**

**Hosts:** **Alder, ash, birch, dogwood, fir, lilac, hawthorn, mountain-ash, maple, oak, pine, poplar, sycamore, viburnum, willow, and fruit trees such as apricot, cherry, peach, and plum.**

## Clearwing Borers

**Life History:** **Most adults emerge in May and June (banded ash borer emerges in August). Larvae mine sapwood during the summer and pupate in the following spring. One generation a year.**

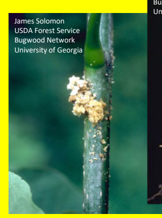


Dogwood Borer

## Clearwing Borers

**Overwintering:** **Mature larvae in tunnels under bark.**

**Damage:** **Gnarled or rough bark, weakened branches.**






## Clearwing Borers

**Monitoring:** **Look for frass, tunnels, and pupal skins around tree wounds, loose bark, and cracks. Use pheromone traps.**

**Cultural Control:** **Avoid damage to trees and minimize tree stress. Do not band trees.**

**Chemical Control:** **Chlorpyrifos or permethrin on bark in spring.**

**Biological Control:** **Several parasitic wasps, nematodes.**


Larva killed by nematodes

## Zimmerman Pine Moth

***Dioryctria zimmermani***
**Family Pyralidae**
**Native pest**


**Hosts:** **All pines except white pines.**

**Life History:** **Larvae feed until late July, when the adults fly. Eggs hatch in August; larvae hibernate and continue feeding the following spring. One generation a year.**

**Overwintering:** **Larvae under bark.**

## Zimmerman Pine Moth

Damage: Feeding under bark leads to brown terminal growth with a “shepherd’s crook” or fish-hook appearance, frass and pitch masses.

Monitoring: Look for damage, pitch masses, and dead branches.


## Zimmerman Pine Moth


Physical Control: Prune out damaged shoots in June before adults emerge, remove pitch masses in August.

Chemical Control: Insecticides in May and August.

### Specific IPM program for clearwing borers, Zimmerman pine moth

Clearwing borers
Adults: after May contact insecticides
Biorationals: chlorantraniliprole, spinosad
Larvae: May IGR, *Steinernema glaseri* and JB nematodes, imidacloprid, chlorantraniliprole
Conventional: pyrethroid, imidacloprid, clothianidin

Zimmerman pine moth
Adults: put sticky traps on tree to time adult sprays, contact insecticides, permethrin
Larvae: IGR, *Steinernema glaseri* nematodes, *Heterorhabditis bacteriophora* nematodes, chlorantraniliprole
Conventional: imidacloprid, clothianidin, permethrin

- **Forest tent caterpillar**
- **Order Lepidoptera**
- **Family Lasiocampidae**
- **Moth larvae feed, adults do not feed**
- **Defoliation**
- **Fruit and shade trees**

## Forest Tent Caterpillar

***Malacosoma disstria***
**Family Lasiocampidae**
**Native pest**


**Hosts: Alder, aspen, ash, basswood, birch, cherry, elm, hawthorn, maple, oak, peach, poplar, willow and flowering fruit trees.**

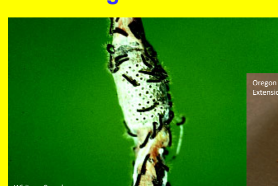
**Life History: Larvae appear in May and feed gregariously. Pupae and adults occur in summer, and eggs are laid on twigs in late summer. One generation a year.**

## Forest Tent Caterpillar

**Overwintering: Black egg masses on twigs.**

**Damage: Shot holes, defoliation.**

**Monitoring: Look for shot holes in May.**




Left: Young larvae and hatched eggs
Below: Adult male

## Forest Tent Caterpillar

**Physical Control:** Physically remove egg masses and groups of larvae.

**Chemical Control:** Residual insecticides or ***Bacillus thuringiensis*** **var.** ***kurstaki*****.**

**Biological Control:** Nuclear polyhedrosis virus, several hymenopteran and dipteran parasitoids (such as the fly *Sarcophaga aldrichi*).

Cocoon


- **Whitemarked tussock moth**
- **Order Lepidoptera**
- **Family Lymantriidae**
- **Moth larvae feed, adults do not feed**
- **Defoliation**
- **>60 various host plants**

## Whitemarked Tussock Moth

**Damage:** Skeletonization, consumption of all but mid vein.

**Monitoring:** Look for shot holes in April.

**Chemical Control:** Residual insecticides or ***Bacillus thuringiensis*** **var.** ***kurstaki*****.**

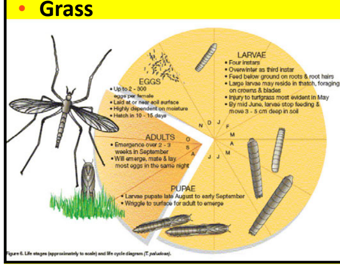
**Biological Control:** Parasites such as *Hyposoter* spp. (Ichneumonidae), predators, microbial diseases.


Specific IPM program for leaf feeding lepidoptera

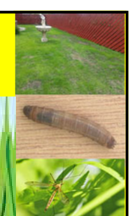
White marked tussock moth
Adults: never
Larvae: chlorantraniliprole, spinosad
Conventional: pyrethroid, imidacloprid, clothianidin

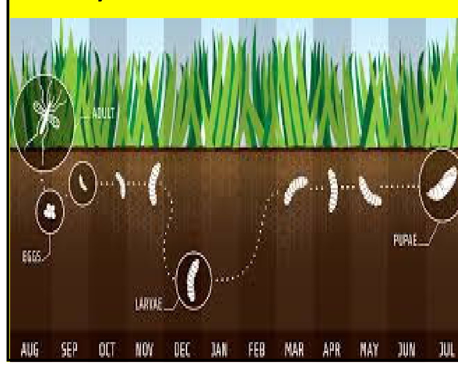
Forest tent caterpillar
White marked tussock moth
Adults: never
Larvae: chlorantraniliprole, spinosad
Conventional: pyrethroid, imidacloprid, clothianidin

- **Leather jackets**
- **Order Diptera**
- **European crane fly, *Tipula paludo*** **marsh crane fly, *T. oleracea***
- **Family Tipulididae, crane fly**
- **Adults do not feed**
- **Defoliation**
- **Grass**




- **Leather jackets**
- **Life cycle**





### Leather jackets

**Damage:** Chews on grass blades

**Monitoring:** Brown turf like JB damage; 40 larvae/sgft; stressed 15 larva/sgft

**Chemical Control:** Acelepyrn, chlorantraniliprole, imidacloprid, clothianidin

**Biological Control:** nematodes, *Steinernema feltiae*

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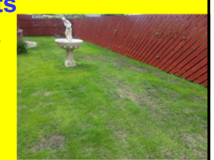
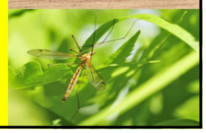




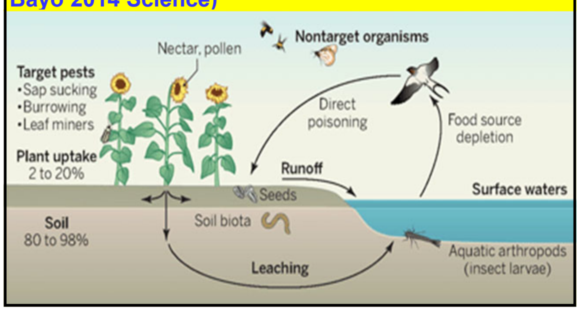
### Outline: Specific IPM programs

- What is IPM

Cultural, chemical, biorational, biological

- Develop IPM based on life history of pest
- IPM, BMP, OMRI
- What you can do.

### Neonicotinoid birds + bees: Fate of neonicotinoids + pathways of environmental contamination (Sanchez-Bayo 2014 Science)




### Understanding pesticide toxicity pollinators:

- LD50 based on 72, 96 hr exposure by oral, dermal, and inhalation routes.
- LD50 is lethal death to 50% of the test animals.
- Sublethal rates alter behavior and foraging and impact colonies.
- Herbicide active ingredients, AI, considered nontoxic to bees, but inert ingredients, adjuvants make them toxic.
- Fungicides toxic to bees

### Systemic insecticides

**Organophosphates**
aldicarb (Temik), oxamyl (Vydate), dimethoate (Cygon)

**Neonicotinyl**
imidacloprid (Marathon, Merit), clothianidin, thiamethoxam, dinotefuran, spirotetramat (Movento/Kontos, class tectronic acid, lipd synthesis), sulfloxaflor (Transform/Closer)

**Novel mode of action**
pymetrozine (Endeavor)

**Translaminar, or local, systemic activity**
Botanical- azadirachtin, neem
Microbial- abamectin (Avid)
IGR- pyriproxyfen (Distance)
PR- chlorfenapyr (Pylon)
SP-spinosad (Conserve)
OP- acephate (Orthene)
C-carbofuran (Furadan)

### Neonicotinoids are 5,000-10,000X more toxic than DDT to bees

LD50 DDT … 27,0000ng/bee
LD50 neonicotinoid insecticides
Imidacloprid ……..4 ng/bee….40 ppb
Clothianidin ……..4 ng/bee….40 ppb
Dinotefuran ………4 ng/bee….40 ppb
Thiamethoxam …..5 ng/bee….50 ppb

aspirin 80mg=80,000microg=80,000,000ng

## Imidacloprid rates vary among sites

### Agricultural field

0.1 mg imid/canola seed (Gaucho)
1.2 mg imid/corn seed (Gaucho)
4 mg imid/sg ft ag field (soil, Admire Pro)
2.5 mg imid/sg ft ag field (foliar, Admire Pro)

### Nursery/greenhouse

300 mg /3 gallon pot (~1 sg ft surface) (Marathon1%G)

### Landscape

3.7 mg/sg ft turf (Bayer Adv Season Long Grub)
122 mg rose @ 4 times/yr (Bayer Adv Rose Fl)
10.2mg/sg ft beds @ 4 times/yr (Bayer Adv Rose Fl)

## Insecticides: biorational, conventional, and organic

**Biorational: Compatible with bees and beneficials**

**Organic: OMRI approved natural products; toxic to good bugs**

**Conventional: Toxic to pests, bees, beneficials**

## What is organic pest control?

- Organic means a practice that is governed by certifi... in each state to grow food without the use of synthetic pesticides in soils that are considered living and maintained by adding organic materials and not synthetic fertilizers.
- The National Organic Standards Board (NOSB)advises the National Organic Program (NOP).
- An organic certification is obtained from a USDA certified organic agency.
- The OMRI Organic Materials Research Institute has a list of organically approved products. Excluded are nitrogen(N), phosphate (P), or potash/potassium (K), and ammonia and nitrate fertilizers.

## Characteristics of biorational insecticides

- Short residual
- Degrade due to light, water, microbes.
- Work on smaller insects and immatures
- Less harmful to beneficial insects, predators, parasitoids, bees.
- Low mammalian toxicity.
- May take longer to kill a pest.

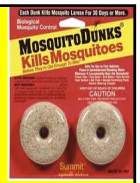
## Use biorational insecticides for bees

Acelepryn, chlorantraniliprole for grubs in soil and on landscape plants
Spinosad for caterpillars and sawflies
Neem oil, soaps, and oils for aphids
Need imidacloprid or dinotefuran for borers

## Use biorational insecticides for bees

## Parasitic nematodes: *Steinernema carpocapsae, Heterorhabditis bacteriophora*

## Use biorational insecticides for bees: BT, *Bacillus thuringiensis*




- BT is a protein crystal that puts an hole in the insect's gut wall after ingestion.
- BT kurstaki, moth larvae, Dipel, Javelin
- BT aizawai, moth larvae and suckers, Xentari
- BT tenebrionis, beetle larvae, Trident
- BT galleria, grubs, Grubgone
- BT israelensis, fly larvae, Aquabac
- Burkholderia, caterpillars, Venerate

## Organic OMRI=natural insecticides?


- OMRI approved
- *Bacillus thuringiensis*, *Beauveria bassiana*, Boric acid, *Cydia pomonella granulosis*, diatomacous earth (HT), garlic, Koalin clay, limonene, neem oil, azadiractin, horticultural oil, pyrethrins (HT), spinosad (HT), pheromone, boric acid

## OMRI Botanical insecticides are toxic to bees, beneficial, and mammals

- Pyrethrins, Pyganic
- Linalool (citrus peel oil derivatives) consumer
- Limonene (citrus peel oil derivatives)
- Avenger, OrangGuard
- Neem oil, clarified hydrophobic extract of neem,
- Dyna-Gro, Triact70
- Azadirachtin (*Azadiractin indica* tree fruits),
- Azatin, AzaGuard
- Garlic oils? Consumer, aphids, beetles, caterpillars,
- Garlic barrier
- Hot peeper extract, Capasaicin, ? Consumer, Nemitol
- Rosemary oil, with peppermint oil, Ecotrol, Ecotec
- New in progress, Citronella, Pennyroyal

## Azadirachtin OMRI

- From Indian neem tree, *Azadirachta indica*
- *Active* against thrips, caterpillars, and aphids.
- Biodegerades in sun.
- More effective on young larvae.
- Works best at temperatures, greater/equally to 70.

## Neem Oil OMRI


- From Indian neem tree, *Azarchta indica*
- Clarified hydrophobic extract of neem, very little azadirachtin in neem oil
- MOA suffocates by blocking breathing pores.
- Good for soft bodied, aphids, spider mites, scales, whiteflies, mealybugs
- Can kill beneficials
- Low mammalian toxicity

## Pyrethrins/Pyrethrum OMRI

- South African daisy, *Tanacetum cinerariafolia*
- *Requires PBO, piperonyl butoxide synergist, PyGanic*

## Outline: Specific IPM programs

- What is IPM

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- Develop IPM based on life history of pest
- IPM, BMP, OMRI
- What you can do.

Reduce pesticide use:
Understanding the partial contribution of pesticides to bee mortality and developing BMP to mitigate mortality


- Use contact insecticides
- Not use systemic neonicotinoid insecticides
- Reduce herbicide use
- Do not use fungicides w/o diagnosis
- Promote bee lawns

## Krischik lab websites

IPM resources for greenhouses and ornamentals
http://cues.cfans.umn.edu/

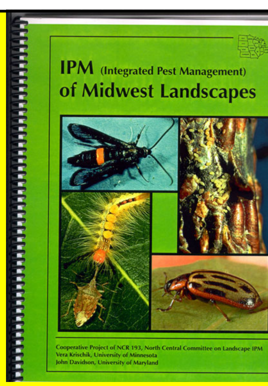
Pollinator Conservation
https://ncipmhort.cfans.umn.edu/

MNLA online course fro certification training for MDA pesticide license
https://pesticidecert.cfans.umn.edu/

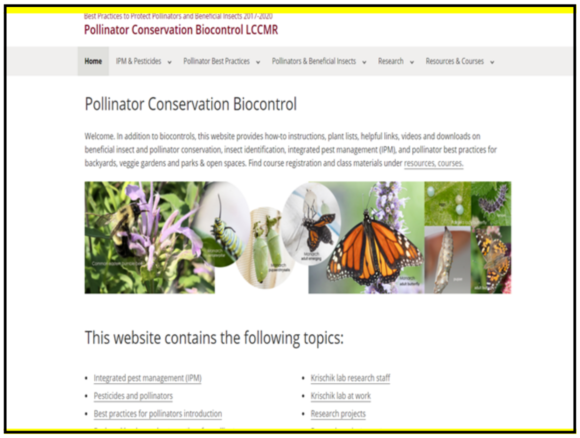

Turf Insects: white grubs and adults

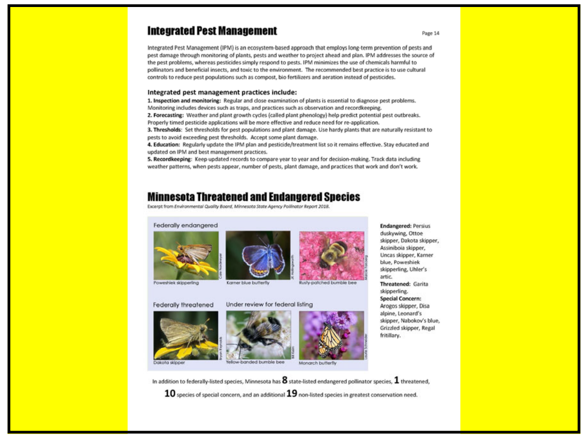
IPM of Midwest landscapes (2004)

Vera Krischik,
UM Entomology

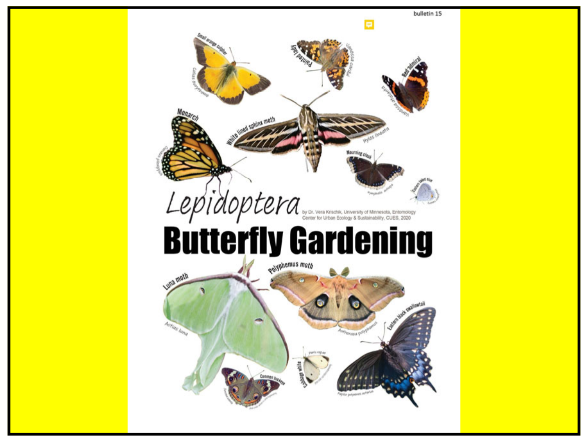


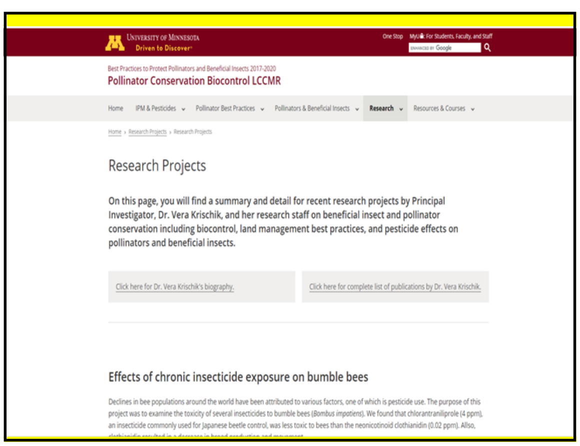

http://cues.cfans.umn.edu/


Best Practices to Protect Pollinators and Beneficial Insects 2017-2020
Pollinator Conservation Biocontrol LCCMR
Home
IPM & Pesticides
Pollinator Best Practices
Pollinators & Beneficial Insects
Research
Resources & Courses
Pollinator Conservation Biocontrol
Welcome. In addition to biocontrols, this website provides how-to instructions, plant lists, helpful links, videos and downloads on beneficial insect and pollinator conservation, insect identification, integrated pest management (IPM), and pollinator best practices for backyards, veggie gardens and parks & open spaces. Find course registration and class materials under resources, courses.
This website contains the following topics:
Integrated pest management (IPM)
Pesticides and pollinators
Best practices for pollinators introduction
Krischik lab research staff
Krischik lab at work
Research projects


Integrated Pest Management
Integrated pest management practices include:
Minnesota Threatened and Endangered Species
Federally endangered
Federally threatened
Under review for federal listing


Think IPM
for pollinator conservation
Integrated Pest Management
BIOLOGICAL CONTROL
PLANT NATIVE & HEIRLOOM
INTEGRATED PEST MANAGEMENT
LAWN CARE
MONITORING
CHEMICAL CONTROLS
CONSERVE POLLINATORS
ncipmhort.dl.umn.edu


bulletin 15
Lepidoptera
Butterfly Gardening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Resources & Courses
Research Projects
On this page, you will find a summary and detail for recent research projects by Principal Investigator, Dr. Vera Krischik, and her research staff on beneficial insect and pollinator conservation including biocontrol, land management best practices, and pesticide effects on pollinators and beneficial insects.
Click here for Dr. Vera Krischik's biography.
Click here for complete list of publications by Dr. Vera Krischik.
Effects of chronic insecticide exposure on bumble bees


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Vera Krischik, Department of Entomology, krisc001@umn.edu
LCCMR, August 2017 - June 2020 Conservation Biocontrol