Top 10 invasive insects? Insect family and life history are good predictors of invasive status.

Corn rootworms, Colorado potato beetle, asparagus beetle, Family Chrysomelidae, locally abundant, not FQ status; why?

FQ, Japanese beetles, Family Scarabaeidae

Dr. Vera Krischik, Assoc Professor/Extension Spec, Depart Entomology, UMinnesota, 612.625.7044, krisc001@umn.edu

https://ncipmhort.cfans.umn.edu/user
https://pesticidecert.cfans.umn.edu/user
Insect humor: getting your attention

“Pull out, Betty! Pull out! ... You’ve hit an artery!”

“I worry about all the saturated fats.”
Invasive, native, exotic, risk??

- Native, occurs naturally, has predators and pathogens: Elm leaf beetle, introduced, American elm, controlled by *Harmonia*, Asian lady beetle

- Invasive, high population growth, can be native or exotic; native ninebark beetle, not a lot of ninebark shrubs, locally invasive

- Exotic introduced w/o predators and pathogens, high risk, high population size, lots of viburnum shrubs
Outline: Top 10 invasive insects

• WHAT MAKES SOME SPECIES BETTER AT BEING INVASIVE?
  FAST GROWTH RATE,
  FREE FROM PREDATORS AND DISEASES,
  ABUNDANT HOST,
  GOOD DISPERSAL

• 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 manage invasive pests and the discuss similar species in the landscape that can be managed.
Invasive, Exotic, Native = risk?

beetle family Buprestidae, flatheaded bores or metallic wood boring beetles includes:

Twin lined chestnut borer, native, follows oak wilt, low risk,

Emerald ash borer, exotic, invasive, high risk

Flatheaded apple tree borer, native, follows stress, low risk

Bronze birch borer, native, European birch high risk
Invasive, Exotic, Native = risk?

beetle family Cerambycidae,
rounheaded bores or longhorned beetles includes:

Asian longhorned beetle, exotic, invasive, Maples, high risk

Dogwood twig borer, native, low risk

Elm borer, native, follows stress, high risk, DED vector

Milkweed beetle, native, low risk
Invasive, Exotic, Native = risk?

beetle family Scarabaeidae, Scarab beetles includes:

Japanese beetle, exotic, invasive, Roses. Linden, turf, high risk

Masked chafer, native, low risk

Oriental beetle, high risk,

European chafer, exotic, new MN Low risk
Outline: Top 10 invasive species in world

• Kade toad, 1935, from Central/South America, introduced into Australia for biocontrol of greyback cane beetle.

• Kudzo, vine, fast growing, from Asia in 1876, introduced to control soil erosion and increase soil fertility as it is a legume and fixes nitrogen in US
Outline: Top 10 invasive insect species

- Afrancanized “killer” bees
- Burmese Python
- Black rat
- Snakehead Fish
- Asian Carp
- Cotton whitefly
- Asian Tiger Mosquito
- Zebra mussels
Outline of talk: Top 10 insect pests

• The top 10 invasive insects in landscapes

• What is the difference between IPM and organic control

• Most insecticides kill bees, why are neonicotinoids receiving so much scrutiny?

• JB control w/o neonicotinoids
Binomial nomenclature, 1758
Carl Linnaeus, born 1707, Sweden
Systema Naturae, from 1737-1758

Order: Lepidoptera
Family: Lymantriidae, tussock moth
Genus, species
*Lymantria dispar*
Common name: gypsy moth
Top 10 landscape insect pests

1. FQ IE. emerald ash borer: ash
2. FQ IE. Gypsy moth; many plants
3. FQ IE. hemlock wooly adelgid; hemlocks in Great Smoky MT
4. FQ IE. European elm beetle, killed most American Elms
5. Native. *Erwinia amylovora* vectored by bees, killed American ash
6. IE, birch leaf miner sawfly; birch
7. FQ IE. Asian long-horned beetle; maples
8. FQ IE. Japanese beetle; lindens, roses
9. FQ IE. spotted wing drosophila; all berries
10. Q IE. spotted lanternfly; many plants
11. FQ IE. brown marmorated stink bug; fruits, veggies
12. FQ IE. Asian giant hornet; kills everything
13. FQ IE. Jumping worms; destroys soil
Do we send invasive, exotic around the world from the US? YES

2015 Japanese beetle is a serious pest in mainland Europe; at two airports in northern Italy at Piedmont and Lombardy, feeding on both wild plants and nearby crops.

2020 Pine tortoise scale invades umbrella pines in Rome

1840 Monarch butterflies in Hawaii, Australia, New Zealand, Spain, Pacific Islands, and International Space Station!!
**Agrilus planipennis**, Emerald ash borer, Asia, 1992, FQ

Arrived 1992 near Detroit, Michigan, and in 2009 in MN and spread to 30 states and 5 Canadian provinces, 100% fatal in ash, 100 million ash trees killed.
*Lymantria dispar*, gypsy moth, Asia, 1868 feds gregariously on oaks and other trees; imported to make American silkworm industry; failed
Adelges tsugae, hemlock wooly adelgid, Japan, 1920 feeds on hemlock and kills the tree.
Adelges tsugae, European elm bark beetle vectors. DED, Europe, Asia, 1930 feeds on elms.

Beetles the size of a Tic Tac can take down trees.
*Erwinia amylovora* bacteria and bees, Japan, 1920 feeds on hemlock and kills the tree
*Fenusa pusilla*, birch leaf miner sawfly, Europe, 1900 feeds on birch and kills the tree

Late birch leaf edgeminers mine (reddish hue, clean mines)

Amber-marked birch leafminer mines (yellowish-brown, mines filled with frass)
Anoplophora glabripennis, Asian longhorned beetle, China, Korea, 1996 feeds on maple and kills the tree
*Popilla japonica*, Japanese beetle, Asia, 1916, spread to 36 state, FQ
*Drosophila suzukii*, spotted wing drosophila, Asia, 2008 feeds on native and managed berries
Lyocrama delicatula, spotted lanternfly, China, India, Vietnam, 2012 feeds tree sap and kills the tree.
**Halyomorpha halys**, brown marmorated stink bug, Asia, 1990 feeds on fruits and veggies.
Vespa soror, Asian Hornet, Asia, kills Asian honeybee larvae/brood
Vespera mandarinia, Asian giant hornet, Asia, 2019 in Washington State, FQ
Amyntas agrestis, A. tokioensis and Metaphire hilgendorfi, Jumping worms, Japan, Korea, 1900s, problem since 2000 feeds on organic material and destroys seedlings
Aphids, soybean aphid, invasive, exotic

Adult aphids give birth to live young. Generally, aphids begin giving birth when they are 7 to 10 days old, depending on temperature.
Viburnum clearwing borer, invasive, native

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
• European pine sawfly
• Order Hymenoptera
• Family Diprionidae
• Sawfly larvae feed, adults do not feed
• Defoliation
• Various pines
• Rose slug sawfly
• Order Hymenoptera
• Family Tenthredinidae
• Sawfly larvae feed, adults do not feed
• Larvae skeletonize upper leaf surface
• Roses
• **Cottony maple scale**
• Order Hemiptera
• Family Coccidae
• Soft scale, sap sucking insect
• Yellowing, stunting, dieback
• Maple, elm, hawthorn, dogwood, poplar, linden
• Pine needle scale
• Order Homoptera
• Family Diaspididae
• Armored scale, sap sucking
• Stunting and dieback
• Spruce, pine
• **Kermes scale**
• Order Hemiptera
• Family Kermestidae
• Gall-like scale scale, sap sucking
• Chlorosis, foliage distortion, and tip dieback.
• Oaks
- Spruce spider mite
- Order Acari
- Family Tetranychidae
- Sucking, spider relatives
- Suck out cells
- Conifers
• Forest tent caterpillar
• Order Lepidoptera
• Family Lasiocampidae
• Moth larvae feed, adults do not feed
• Defoliation
• Fruit and shade trees
• **Whitemarked tussock moth**
• Order Lepidoptera
• Family Lymantriidae
• Moth larvae feed, adults do not feed
• Defoliation
• >60 various host plants
- **Spring cankerworm**
- Order Lepidopera
- Family Geometridae
- Moth larvae feed, adults do not feed
- Defoliation, shot hole injury
- Apple, elm, oak, hickory, linden, birch, beech, maple
• **Birch leafminer**
• Order Hymenoptera
• Family Tenthredinidae
• Sawfly larvae feed, adults do not
• Hollow out patches between leaf surfaces
• Birch trees
- **Elm leaf beetle**
- Order Coleoptera
- Family Chrysomelidae
- Beetle larvae and adults feed
- Defoliation
- Most elm species
• **Cooley spruce gall adelgid**
• Order Hemiptera
• Family Adelgidae
• Aphid like sucking insect
• Galls on tips of branches
• Spruce and Douglas-fir
• **Eriophyid mites**
• **Order Acari**
• **Family Eriophyidae**
• **Sucking arachnids causing erineum, spider relatives**
• **Erineum are gall like, foliage discoloration**
• **Various deciduous and coniferous species**
• Hackberry nipple gall maker
• Order Hemiptera
• Family Psyllidae
• Adult psyllid, aphid-like
• Plant forms gall over insect nymph
• Hackberry
• **Lace bug**
• Order Hemiptera
• Family Tingidae
• Lace bug nymphs and adults feed
• Stippled, discolored foliage, and dieback
• Various trees and shrubs
• **Honeylocust plant bug**
• Order Hemiptera
• Family Miridae
• Plant bug nymphs and adults feed
• Stippled leaf discoloration and distortion
• Honeylocust
• **Cottonwood leaf beetle**
• Order Coleoptera
• Family Chrysomelidae
• Beetle larvae and adults feed
• Defoliation
• Various willow and cottonwood
Black vine weevil
Order Coleoptera
Family Curculionidae
Weevil larvae and adults feed
Root and leaf damage
Yews, many other perennials
• **White pine weevil**
• Order Coleoptera
• Family Curculionidae
• Weevil larvae and adults feed
• Leader dieback
• Pine and spruce
Outline of talk: IPM, residues, effects on bees and beneficials of neonicotinoid insecticides

• The top landscape pests

• What is the difference between IPM and organic control

• Most insecticides kill bees, why are neonicotinoids receiving so much scrutiny?

• JB control w/o neonicotinoids
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, physical, genetic, biological, chemical
- Least toxic pesticide first and use spot treatments
- Conserve beneficial insects
What are best management practices (BMP) for landscapes

• Use woody ornamentals and herbaceous perennials
• Prepare the planting bed tilling to a depth of 8 - 12 in.
• Add appropriate amendments.
• Avoid general-purpose fertilizers in the planting hole.
• Apply 3 to 5 inches of mulch on the soil surface.
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.
How to control overwintering insects?

• Tillage exposing insects in the soil
• Horticultural oils in the fall to killing overwintering stages on woody plants
• Removal of weeds to remove overwintering sites.
• Removal of all debris that may harbor pests.
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
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.
What is organic pest control?

- Organic means a practice that is governed by certification 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 organic pesticides

- OMRI listed
- Are natural plant products or microbial organisms
- Degrade due to light, water, microbes.
- Work on smaller insects and immatures
- Low mammalian toxicity.
Microbial insecticides OMRI approved

- BT
- *Beauveria bassiana*, Mycotrol-O, many
- *Chromobacterium subtsugae*, Grandevo, many
- *Cydia pomonella granulosis*, CYD-X, codling moth
- Spinosad, Entrust, soil bacteria toxin, caterpillars
- Nematodes, Steinernema and Heterorhabditis, Biosafe, Bio Vector, Nemasys, soil inhabiting insects
Organic OMRI=natural sources pesticide?

- OMRI approved
- *Bacillus thuringiensis*, *Beauveria bassiana*, Boric acid, *Cydia pomonella granulosis*, diatomaceous earth (HT), garlic, Koalin clay, limonene, neem oil, azadiractin, horticultural oil, pyrethrins (HT), spinosad (HT), pheromone, boric acid
When should biological control be used?

Biological control is most effective when enemies are release during low pest densities.

When using biological control agents in the greenhouse, it is important to avoid broad-spectrum pesticides; these may be detrimental to biological control agents. Carefully choose biorational insecticides to conserve biological control agents in the greenhouse.
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 last for months to years, unknown
- Flowers that open will have the insecticide in pollen and nectar for months to years, unknown
Use insecticides compatible with biocontrol.

Acelepryn, chlorantraniliprole for grubs in soil and on landscape plants.

Spinosad for caterpillars and sawflies

Neem oil, soaps, and oils for aphids

Need imidaclorpid or dinotefuran for borers.
Use biorational insecticides for bees: Soaps and oils

• Triact 70, clarified extract of Neem oil
• Mantis EC insecticide/miticide formulated with the natural insecticidal activity of rosemary, peppermint, and NON-GMO soybean botanical oils. Oils, mites
Types of BT

- BT is a protein crystal that puts a hole in the insect’s gut wall after ingestion.
- Kurstaki, moth larvae, Dipel, Javelin
- Aizawai, moth larvae and suckers, Xentari
- tenebrionis, beetle larvae, Trident
- galleria, grubs, Grubgone
- bifenthrin, NOT organic, grubs, Grub B Gone Ortho
- chlorantraniliprole, NOT organic but conserves beneficials, grubs, Grub Ex Scotts
- israelensis, fly larvae, Aquabac
- Burkholderia, caterpillars, Venerate
Beauveria bassiana is a fungus

- *Beauveria bassiana* is a fungus which causes a disease. When spores of this fungus come in contact with the cuticle (skin) of susceptible insects, they germinate and grow directly through the cuticle to the inner body of their host. Here the fungus proliferates throughout the insect's body, producing toxins and draining the insect of nutrients, eventually killing it.
- Unlike bacterial and viral pathogens of insects, *Beauveria* and other fungal pathogens infect the insect with contact and do not need to be consumed by their host to cause infection.
Use biorational insecticides for bees:

*Beauveria bassiana* is a fungus

- Fungal spores contact and germinate and grow directly through the cuticle to the inner body. The fungus proliferates throughout the insect's body, producing toxins and KILLING IT.
Use biorational insecticides for bees
Parasitic nematodes: *Steinernema carpocapsae*, *Heterorhabditis bacteriophora*
OMRI Botanical insecticides are toxic to bees, beneficial, and mammals

- Nicotine (leaves tobacco), rotenone (roots of Derris sp., other legumes) Ryania (Ryania shrub), Sabadilla (tropical lily), no longer approved
- Pyrethrins, Pyganic
- Linalool (citrus peel oil derivatives) consumer
- Limonene (citrus peel oil derivatives) Avenger, OrangGuard
- Neem oil, clarified hydrophobic extract of neem, DynaGro, 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

- 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
Neem Oil

- 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
Dusts

- Kaolin clay, **Surround**, can kill stink bugs
Pyrethrins/Pyrethrum

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

• Oils, mites, scales, aphids
• Triact 70, clarified hydrophobic extract of Neem oil
• Mantis EC is an agriculture grade organic insecticide/miticide formulated with the natural insecticidal activity of rosemary, peppermint, and NON-GMO soybean botanical oils.
Botanical Oils (Insecticidal Oils)

Mantis EC is an agriculture grade organic insecticide/miticide formulated with the natural insecticidal activity of rosemary, peppermint, and NON-GMO soybean botanical oils.
Outline of talk: IPM, residues, effects on bees and beneficials of neonicotinoid insecticides

• The top landscape pests

• What is the difference between IPM and organic control

• Most insecticides kill bees, why are neonicotinoids receiving so much scrutiny?

• JB control w/o neonicotinoids
Understanding the partial contribution of pesticides to bee mortality and developing BMP to mitigate mortality, IPM is part of BMP.
Neonicotinoid birds + bees: Fate of neonicotinoids + pathways of environmental contamination (Sanchez-Bayo 2014 Science)
Contact insecticides:
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Systemic insecticides:
- Uncommon; treated-seed, soil drench, trunk-inject
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- Toxicity can last for months to years, unknown
- Flowers that open will have the insecticide in pollen and nectar for months to years, unknown
A really big issue understanding systemic compared to contact insecticides.
Why are neonicotinoids so much more toxic to bees compared to other insecticides?

- Receptors in bees not in mammals
- Adjuvants increase toxicity
- Alters behavior + foraging at sublethal doses
- Water soluble
- Binds with soil
## Pesticides: toxicity / bees (LD₅₀ ng/bee)

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>®</th>
<th>Use</th>
<th>Dose g/ha</th>
<th>LD₅₀ ng/ab</th>
<th>Tox/DDT</th>
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<tr>
<td>DDT</td>
<td>Dinocide</td>
<td>insecticide</td>
<td>200-600</td>
<td>27 000.0</td>
<td>1</td>
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<tr>
<td>thiaclopride</td>
<td>Proteus</td>
<td>insecticide</td>
<td>62.5</td>
<td>12 600.0</td>
<td>2.1</td>
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<tr>
<td>amitrazé</td>
<td>Apivar</td>
<td>acaricide</td>
<td>-</td>
<td>12 000.0</td>
<td>2.3</td>
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<tr>
<td>acetamiprid</td>
<td>Supreme</td>
<td>insecticide</td>
<td>30-150</td>
<td>7 100.0</td>
<td>3.8</td>
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<tr>
<td>coumaphos</td>
<td>Perizin</td>
<td>acaricide</td>
<td>-</td>
<td>3 000.0</td>
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<tr>
<td>methiocarb</td>
<td>Mesurol</td>
<td>insecticide</td>
<td>150-2200</td>
<td>230.0</td>
<td>117</td>
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<tr>
<td>tau-fluvalinate</td>
<td>Apistan</td>
<td>acaricide</td>
<td>-</td>
<td>200.0</td>
<td>135</td>
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<tr>
<td>carbofuran</td>
<td>Curater</td>
<td>insecticide</td>
<td>600</td>
<td>160.0</td>
<td>169</td>
</tr>
<tr>
<td>λ-cyhalothrin</td>
<td>Karate</td>
<td>insecticide</td>
<td>150</td>
<td>38.0</td>
<td>711</td>
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<tr>
<td>thiaméthoxam</td>
<td>Cruiser</td>
<td>insecticide</td>
<td>69</td>
<td>5.0</td>
<td>5 400</td>
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<tr>
<td>fipronil</td>
<td>Regent</td>
<td>insecticide</td>
<td>50</td>
<td>4.2</td>
<td>6 475</td>
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<tr>
<td>imidaclopride</td>
<td>Gaucho</td>
<td>insecticide</td>
<td>75</td>
<td>3.7</td>
<td>7 297</td>
</tr>
<tr>
<td>clothianidine</td>
<td>Poncho</td>
<td>insecticide</td>
<td>50</td>
<td>2.5</td>
<td>10 800</td>
</tr>
<tr>
<td>deltamethrine</td>
<td>Décis</td>
<td>insecticide</td>
<td>7.5</td>
<td>2.5</td>
<td>10 800</td>
</tr>
</tbody>
</table>
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)
Why are bumblebee more susceptible to neonicotinoids?

- Honeybee queens never forage. Bumble bee queens forage in fall + spring.
- Honeybee colonies have 50,000 workers Bumble bee colonies have 30 workers.
- Honeybee forager is the last stage in lifecycle. Bumble bee workers forage at any age.
- Honeybee bread = pollen + nectar + saliva + hypo pharyngeal secretion, detoxifies
- Bumble bees do not make bee bread.
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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

July 8

July 18
ID white grubs to species by rastral pattern, Why? Damage potential
<table>
<thead>
<tr>
<th>species</th>
<th>species</th>
<th>years</th>
<th>larval food</th>
<th>adult food</th>
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<tbody>
<tr>
<td>JB</td>
<td>one year</td>
<td>turf</td>
<td>adults feed on grape, linden, rose</td>
<td></td>
</tr>
<tr>
<td>false JB</td>
<td>one year</td>
<td>unknown</td>
<td>adults feed on grape, linden, rose</td>
<td></td>
</tr>
<tr>
<td>rose chafer</td>
<td>one year</td>
<td>unknown</td>
<td>adults feed on grape, linden, rose</td>
<td></td>
</tr>
<tr>
<td>masked chafer</td>
<td>one year</td>
<td>turf</td>
<td>adults do not feed; do not leave turf</td>
<td></td>
</tr>
<tr>
<td><em>Ataenius</em></td>
<td>3 gen. year</td>
<td>turf, manure</td>
<td>adults feed on turf; adults overwinter in woodlots</td>
<td></td>
</tr>
<tr>
<td><em>Aphodius</em></td>
<td>June, July, Sept</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large June beetle</td>
<td>three years</td>
<td>turf</td>
<td>adults feed on grape, linden, rose</td>
<td></td>
</tr>
</tbody>
</table>
One year life cycle of Japanese beetle

- **January (JAN)**: Grub deep in soil
- **February (FEB)**: Grub deep in soil
- **March (MAR)**: Grub deep in soil
- **April (APR)**: Grub root feeding
- **May (MAY)**: Grub root feeding
- **June (JUN)**: Pupae
- **July (JUL)**: Adult egg laying
- **August (AUG)**: Grub root feeding
- **September (SEP)**: Grub root feeding
- **October (OCT)**: Grub deep in soil
- **November (NOV)**: Grub deep in soil
- **December (DEC)**: Grub deep in soil
Use different insecticides for JB adults or grubs

Japanese beetle is the worst white grub.
# Neonicotinyl insecticides are safer for people but NOT for bees…

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Clas</th>
<th>Application method</th>
<th>Toxicity bees</th>
<th>LD50 (µg/bee)</th>
<th>LD 50 (mg/kg rats)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imidacloprid</td>
<td>Neo</td>
<td>Oral acute (24–48h)</td>
<td>Highly</td>
<td>0.004 - .04</td>
<td>450</td>
</tr>
<tr>
<td>Clothianidin</td>
<td>Neo</td>
<td>Oral acute</td>
<td>Highly</td>
<td>0.004</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contact acute</td>
<td>Highly</td>
<td>0.044</td>
<td>4000</td>
</tr>
<tr>
<td>Thiamethoxam</td>
<td>Neo</td>
<td>Oral acute</td>
<td>Highly</td>
<td>0.005</td>
<td>1563</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contact acute</td>
<td>Highly</td>
<td>0.024</td>
<td>2000</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>OP</td>
<td>Acute oral</td>
<td>Highly</td>
<td>0.36</td>
<td>155</td>
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<tr>
<td></td>
<td></td>
<td>Acute contact</td>
<td>Highly</td>
<td>0.070</td>
<td>202</td>
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<tr>
<td>Coumaphos</td>
<td>OP</td>
<td>Acute oral</td>
<td>Moderately</td>
<td>2.030</td>
<td>13 - 41</td>
</tr>
<tr>
<td>Esfenvalerate</td>
<td>PYR</td>
<td>Acute contact</td>
<td>Highly</td>
<td>0.21</td>
<td>88.5</td>
</tr>
<tr>
<td>Fluvalinate</td>
<td>PYR</td>
<td>Acute contact</td>
<td>Highly</td>
<td>0.2</td>
<td>2000</td>
</tr>
</tbody>
</table>

highly toxic (< 2µg/bee)  
moderately toxic (2 - 10.9 µg/bee)  
slightly toxic (11 - 100µg/bee)  
non-toxic (>100µg/bee)
JB grub control

Neonicotinoids

- imidaclorpid
- clothianidin

Anthranilic Diamides, bee friendly

- dinotefuran

Zylam® Liquid Systemic 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
Parasitic nematodes

*Steinernema carpocapsae*

*Heterorhabditis bacteriophora*

Elm Leaf Beetle Pupa Infected With Nematodes
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
- Biodegrades 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

- Trap
- Lure in trap
- Stand or rebar
- Complete trap
- Double lure: pheromone and rose scent
Ecosystem management

susceptible

- Most lindens
- Purple leaf plum
- Purple sandcherry
- Norway maple
- Roses
- Certain crabapples
- Birch

resistant

- Red maples
- Dogwoods
- Redbud
- Beech
- Tuliptree
- Sweet gum
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% fewer eggs. Results indicate *O. popilliae* caused a 75% 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
• 2018 Conserving the endangered rusty patched bumble bee; create habitat and decrease pesticide
• 2018 Updated Insecticide toxicity to pollinators on website with pdf of this ppt
What is IPM?

I am letting my lawn grow so the flowers in it help the bees

Bees Friendly Lawn

Bees unfriendly lawns

Flowers that are in the lawn provide vital food for bees and long grass is important for Bumble Bee nests and is crucial for butterflies.

We have lost half our bees in the last 20 years due to loss of habitat and pesticides.

We have lost 80% of our flowery meadows since 1970, so giving the bees the flowers in my lawn really helps.

Bumble bees and solitary bees are more important for pollination than honey bees, especially for tomatoes, strawberries and apples.

Last year British farmers had to import 50,000 pollinators (that's 6 million bees) in order to pollinate soft fruits and tomatoes.

For more info: http://www.bumblebeeconservation.org.uk
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