

IPM and Organic Management, May 7, Hennepin County Master Gardeners



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USDA e-extension [://campus.extension.org/enrol/index.php?id=1245](http://campus.extension.org/enrol/index.php?id=1245)

NCIPM webinars pollinator+plant videos <http://ncipmhort.cfans.umn.edu/>

UM CFANS CUES website cues.cfans.umn.edu/

UM AFNR extension greenhouse, nursery, and landscape website
www.extension.umn.edu/garden/plant-nursery-health/



Introduction to talk: emerging issues

- **200 million lbs herbicides used annually**
- **Use has increased in farmland.**
- **1993-1996 to 2014-2016 levels of glyphosate also spiked by 1208% during that time.**
- **In July 2017, in accordance with the Safe Drinking Water and Toxic Enforcement Act of 1986, the state of California listed glyphosate as a probable carcinogen.**

GMO sprayed with glyphosate are tolerant so residue accumulates in the plant,

JAMA, Oct 24, 318 (16):1610-1613 2017

- **Animals fed an ultra-low dosage of 50-ng/L glyphosate concentration showed non alcoholic fatty liver disease and its progression to hepatosis.**
- **In July 2017, in accordance with the Safe Drinking Water and Toxic Enforcement Act of 1986, the state of California listed glyphosate as a probable Carcinogen.**
- **Mean glyphosate and AMPA levels and the proportion of samples with detectable levels increased over time.**
- **A 2015 review of nonfarmer US and European adults reported mean urinary glyphosate levels of 1.35 µg/L (US) and 0.215 µg/L (EU).**

GMO sprayed with glyphosate are tolerant so residue accumulates in the plant,

<https://www.euractiv.com/section/agriculture-food/news/overwhelming-majority-of-germans-contaminated-by-glyphosate/> ,Heinrich Böll Foundation

- **Glyphosate residue was recorded in 99.6% of the 2,009 people monitored by the study. The most significant values were found in children aged from zero to nine and 10 to 19.**
- **Glyphosate residue in urine and it concluded that 75% of the target group displayed levels that were five times higher than the legal limit of drinking water. 1/3 population showed levels that were between 10 and 42 times higher than standard. Urban and rural people showed similar amounts.**

Outline of talk: IPM, residues, effects on bees and beneficials of neonicotinoid insecticides

- **Most insecticides kill bees, why are neonicotinoids receiving so much scrutiny?**
- **What is the difference between IPM and organic control?**
- **JB control w/o neonicotinoids**

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 FI)

10.2mg/sg ft beds @ 4 times/yr (Bayer Adv Rose FI)

Rising Toxicity of pesticides 1945-2003

Pesticide	Brand Name	Use	LD50 (ng / bee)	Toxicity DDT = 1
DDT	Dinocide	Insecticide	27,000.0	1
Amitraz	Apivar	Acaricide	12,000	2
Coumafos	Perizin	Acaricide	3,000	9
Taufluvalinate	Apistan	Acaricide	2,000	14
Metiocarb	Mesuirol	Insecticide	230	117
Carbofuran	Curater	Insecticide	160	169
Lambda- cyhalothrin	Karate	Insecticide	38	711
Deltamethrin	Decis	Insecticide	10	2,700
Thiametoxam	Cruiser	Insecticide	5	5,400
Fipronil	Regent	Insecticide	4.2	6,429
Clothianidin	Poncho	Insecticide	4.0	6,750
Imidacloprid	Gaucho	Insecticide	3.7	7,297

Source: Dr. J.M. Bonmatin, CNRS (France)

Neonicotinoids are more toxic than DDT to bees

LD50 DDT ... 27,000 ng/bee

LD50 neonicotinoid insecticides

Imidacloprid4 ng/bee....40 ppb

Clothianidin4 ng/bee....40 ppb

Dinotefuran4 ng/bee....40 ppb

Thiamethoxam5 ng/bee....50 ppb

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

What pesticides are killing bees? All of them

- **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, chlorothalonil**

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
Bumble bee workers forage at any age.
- Honeybee bread=pollen+ nectar+ saliva+
+hypo pharyngeal secretion, detoxifies
- Bumble bees do not make bee bread.

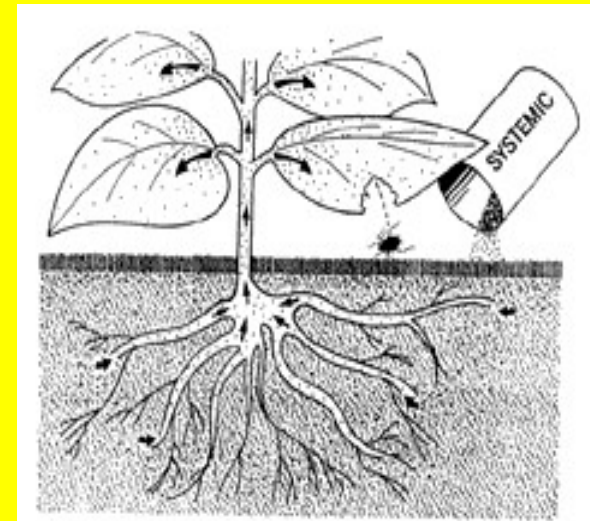
Why are neonicotinoids so much more toxic to bees compared to other insecticides?

- **Receptors in bees not in mammals**
- **Adjuvants increase toxicity**
- **Alters behavior +foraging at sublethal doses**
- **Water soluble**
- **Binds with soil**

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 last for months to years, unknown
- Flowers that open will have the insecticide in pollen and nectar for months to years, unknown

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**

20 years of neonicotinoid issues

- **1996 French beekeepers protest use of imidacloprid seed dressing+effects on honeybees**
- **2000 NYC neonics RUP**
- **2016 EPA states 25 ppb is NOEL for bees (research)**
- **2016 Maryland neonic legislation March 9 2016 over ruled Aug 3 2016**
- **2018 2018 Massachusetts considering legislation**
- **2018 Connecticut makes neonics “restricted use pesticide (RUP) ” not available to consumers**
- **2013-2017 EU bans nenic use on some crops**
- **2018 EU complete ban**

Recent legislation on neonics

- The Quebec government has banned, for personal use, the five most dangerous pesticides: Atrazine, Chlorpyrifos, three neonicotinoids, clothianidin, imidacloprid and thiamethoxam, as well as treated seeds. **Neonics never registered in NYC and surrounding areas.**
- Agricultural producers will only be allowed to purchase these pesticides if it is justified by an agronomist with the Ordre des agronomes du Quebec (OAQ). Farmers will also have to keep a pesticide registry. Jan 2018

Recent legislation on neonics

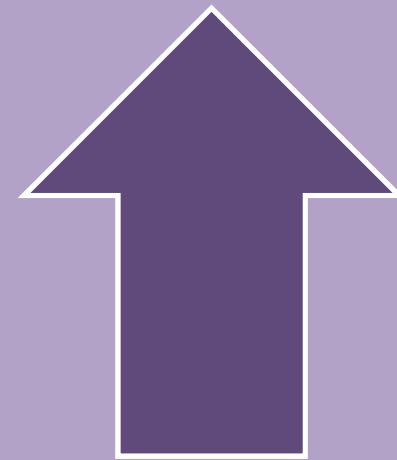
- **EFSA identifies high risk to bees comes from neonicotinoid contamination of the soil and water which leads to the pesticides appearing in wildflowers or succeeding crops.**
- **This is an important announcement that most uses of neonicotinoids are a risk to all bee species.**
- **The greatest risk to bees is from chronic exposure due to neonicotinoids persistence. Jan 2018**

Outline of talk: IPM, residues, effects on bees and beneficials of neonicotinoid insecticides

- **Most insecticides kill bees, why are neonicotinoids receiving so much scrutiny?**
- **What is the difference between IPM and organic control**
- **JB control w/o neonicotinoids**

Top 10 landscape pests

- 1. Japanese beetle; lindens, roses
- 2. emerald ash borer: ash
- 3. aphids
- 4. borers
- 5. scales
- 6. slugs
- 7. sawflies on conifers
- 8. conifer mites
- 9. caterpillars
- 10. galls



worst

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:
 - legal, cultural, physical,
 - genetic, biological, chemical



When should biological control be used?

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

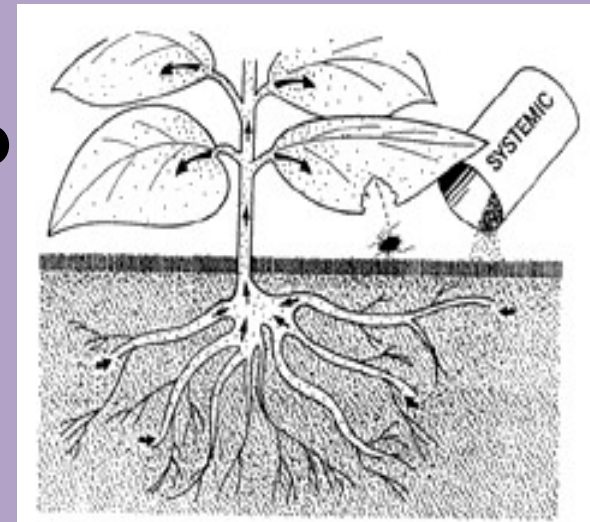
When using biological control agents in the greenhouse, it is important to avoid broad-spectrum pesticides; these may be detrimental to biological control agents. Carefully choose biorational insecticides to conserve biological control agents in the greenhouse.



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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 imidacloprid or dinotefuran for borers.



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.

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.

Characteristics of organic pesticides

- 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.

Organic OMRI=natural sources pesticide?

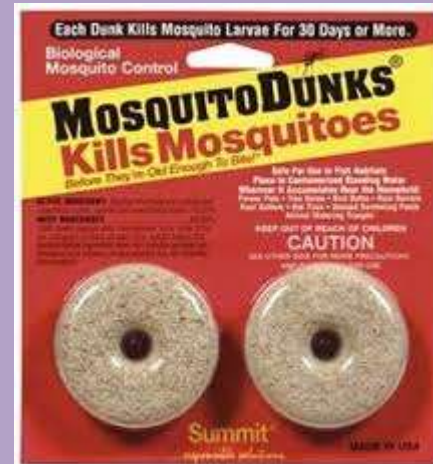


- OMRI approved
- *Bacillus thuringiensis*, *Beauveria bassiana*, Boric acid, *Cydia pomonella granulosis*, diatomaceous earth (HT), garlic, Koalin clay, limonene, neem oil, azadiractin, horticultural oil, pyrethrins (HT), spinosad (HT), pheromone, boric acid

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

Types of BT



- BT is a protein crystal that puts an 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.**

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, **Dyna-Gro, Triact70**
- Azadirachtin (*Azadirachtin 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 cinerariaefolia*
- 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)

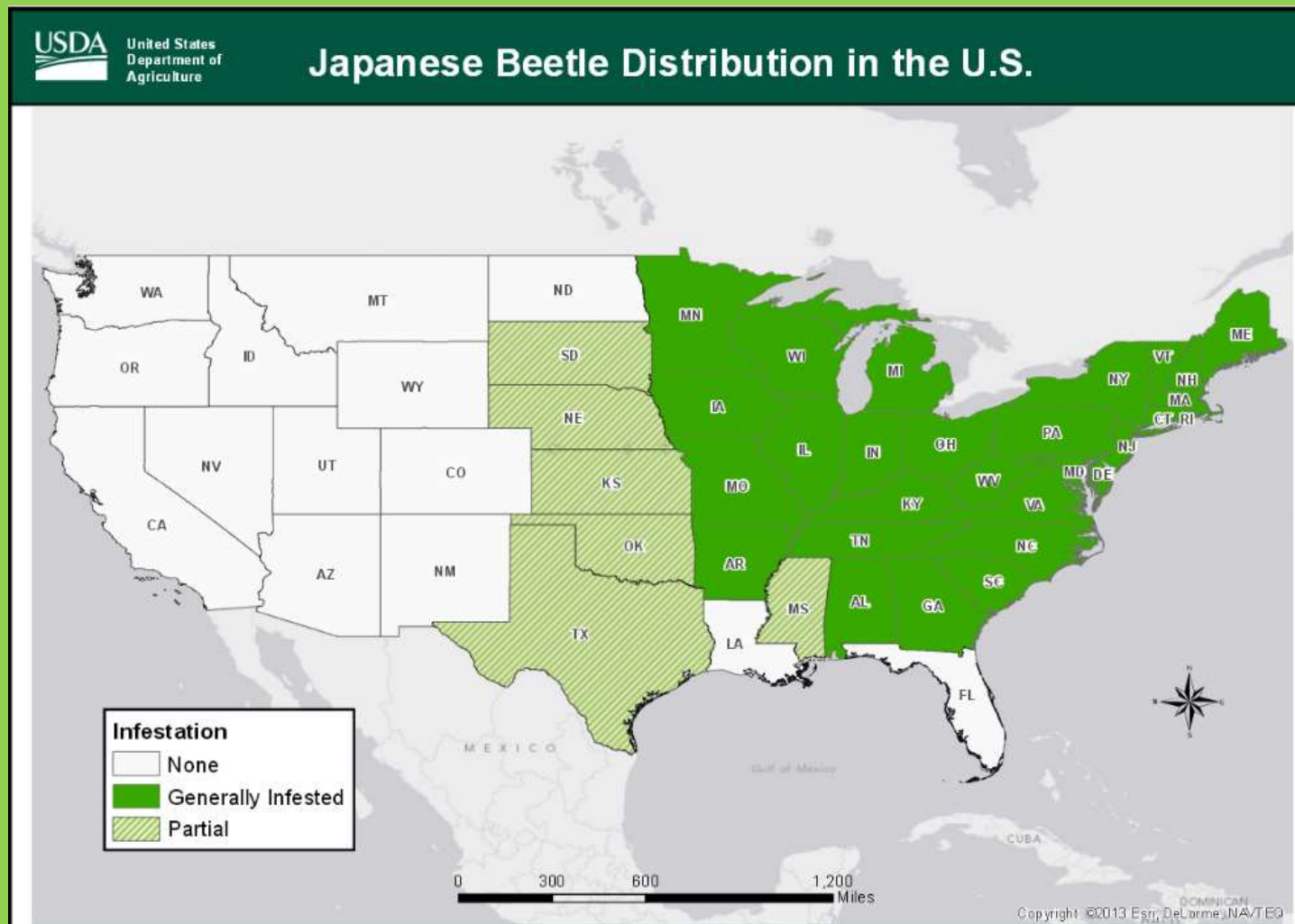
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- **Why do plants make flowers?**
- **Most insecticides kill bees, why are neonicotinoids receiving so much scrutiny?**
- **JB control w/o neonicotinoids**

Japanese beetle was accidentally 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

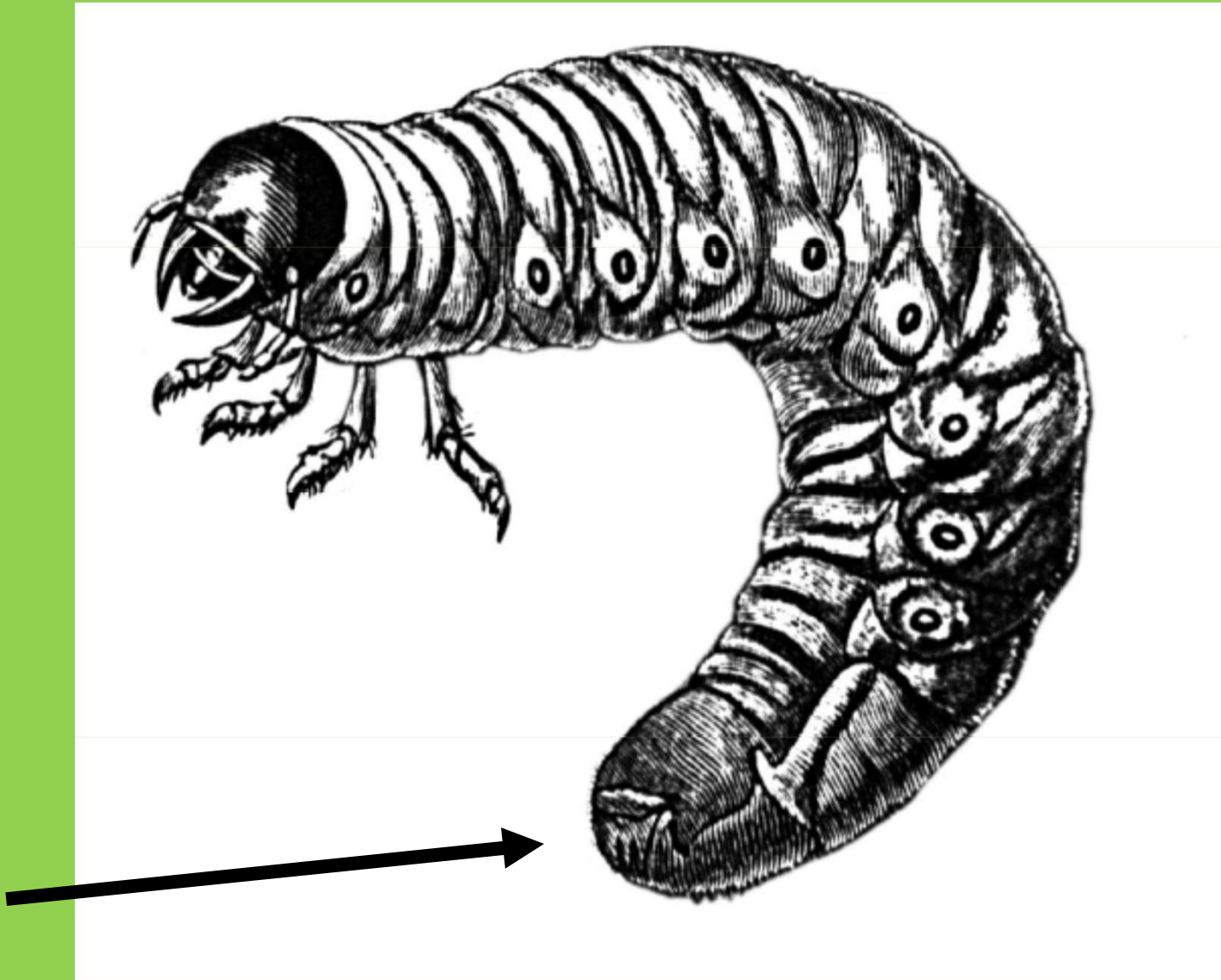


They feed on >300 plants in about 80 families

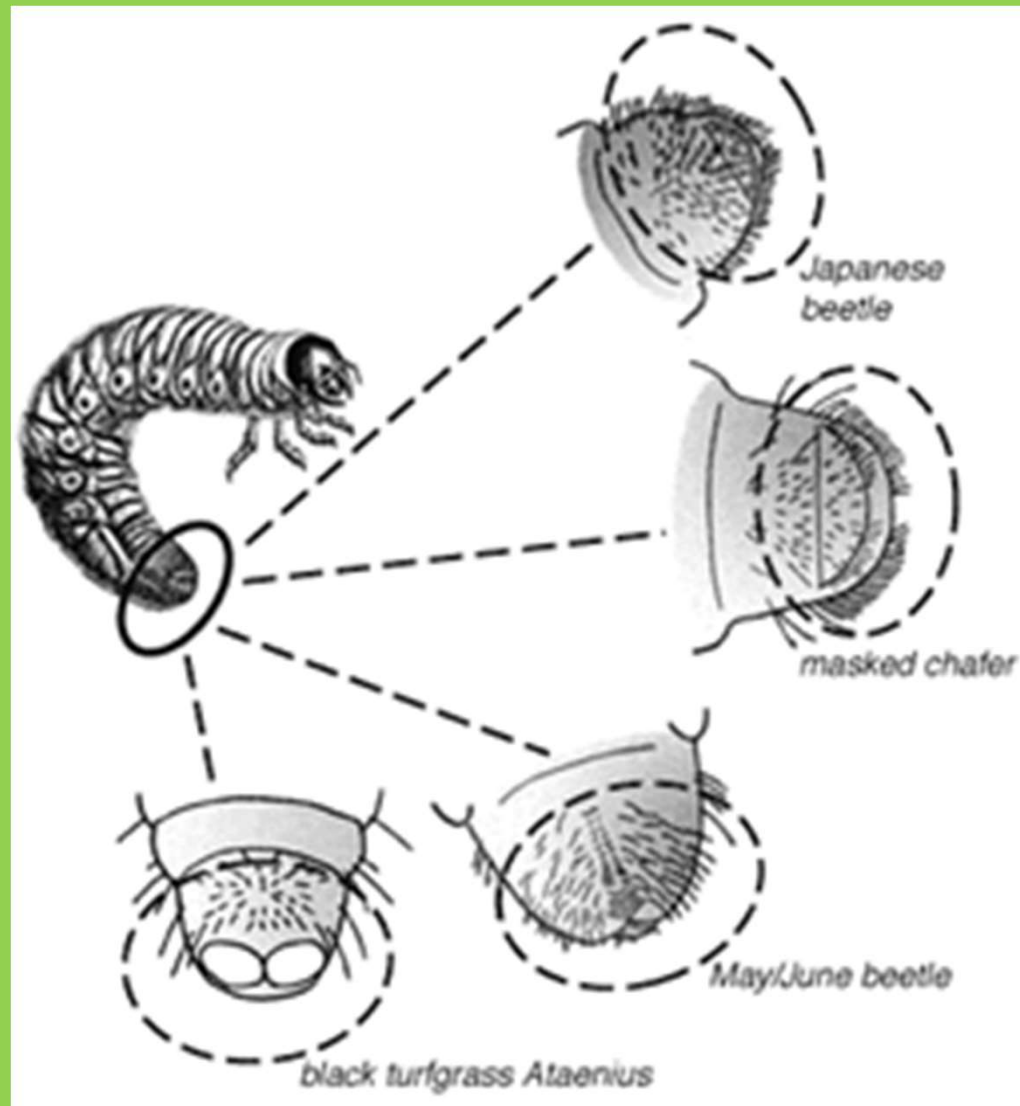
Japanese Beetle Damage to Linden Tree



Raster



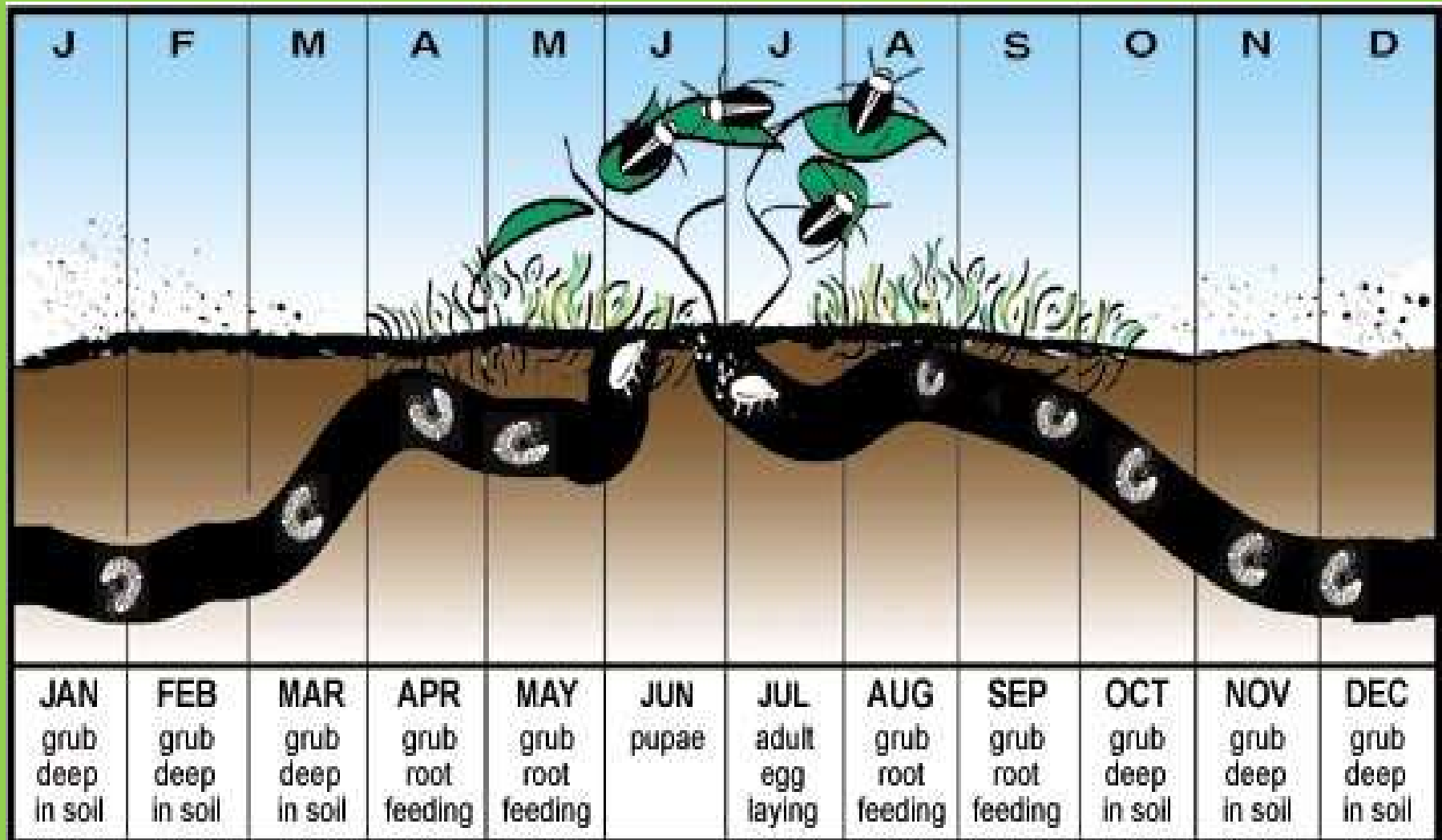
ID white grubs to species by rastral pattern, Why? Damage potential



Life history of scarabs in turf

species	species	years	larval food	adult food
	JB	one year	turf	adults feed on grape, linden, rose
	false JB	one year	unknown	adults feed on grape, linden, rose
	rose chafer	one year	unknown	adults feed on grape, linden, rose
	masked chafer	one year	turf	adults do not feed; do not leave turf
	<i>Ataenius</i> <i>Aphodius</i>	3 gen. year June, July, Sept	turf, manure	adults feed on turf; adults overwinter in woodlots
	Large June beetle	three years	turf	adults feed on grape, linden, rose

One year life cycle of Japanese beetle



Use different insecticides for JB adults or grubs



Japanese beetle is the worst white grub.

Neonicotinyl insecticides are safer for people

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

highly toxic (< 2µg/bee)

moderately toxic (2 - 10.9 µg/bee)

slightly toxic (11 - 100µg/bee)

non-toxic (>100µg/bee)

but NOT for bees...

JB grub control

Neonicotinoids

imidacloprid

clothianidin

Anthranilic Diamides,
bee friendly



Acelepryn[®]



thiamethoxam

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



Active Ingredient=Azadirachtin

- 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**



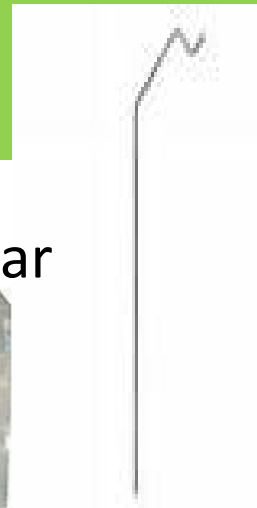
trap



lure in trap



**double lure:
pheromone and rose scent**



stand or rebar



complete trap

Ecosystem management

susceptible

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

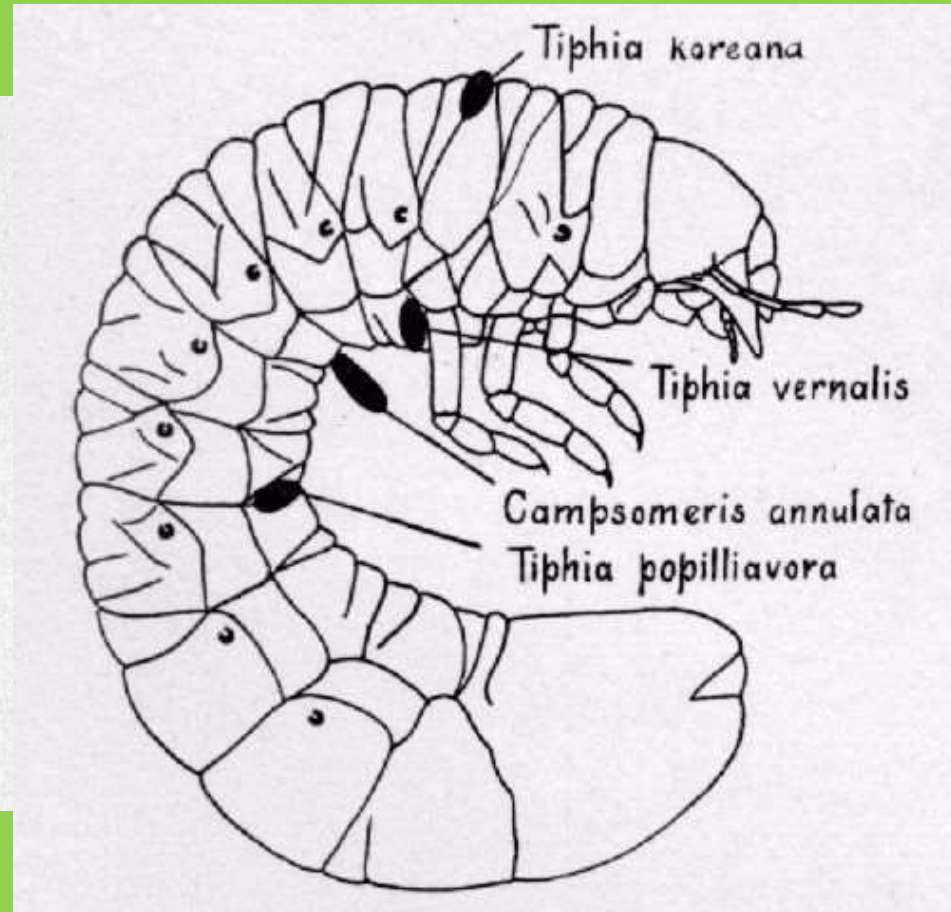
resistant

- 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 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