**Biorational Insecticides in the Landscape and Options for Turf Insect Pest Management**

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**Learning Objectives**
- Define “biorational insecticide”
- Know the differences between conventional & biorational insecticides
- Know the strengths / weaknesses of the different biorational insecticides
- Be able to give a range of control options to your clients

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**Traditional Insecticides (Organophosphates & Carbamates)**
- Broadly toxic
- Affect systems common to both insects and vertebrates (e.g., nervous system)
- Risk to non-target organisms (e.g., beneficial insects, fish, birds, humans)
- Secondary pest outbreaks
- Pest resurgences and resistance

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**What is a “Biorational” Insecticide?**
- An insecticide of natural origin that has little or no adverse effects on the environment or non-target organisms

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**How are Biorationals Different from Conventional Insecticides?**
- Different modes of action
- Low use rate
- More selective
- Short residual activity
- Low risk to humans, wildlife, and environment

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**Types of Biorational Insecticides**
- **Botanicals**
  - Azadirachtin/neem, rotenone, sabadilla, pyrethrins/pyrethrum, nicotine
- **Microbials**
  - Bacteria, fungi, nematodes
  - Protozoa and viruses – not commercially available
- **Others**
  - Insect growth regulators, molt accelerating compounds, soaps, oils
Botanical Insecticides

Azadirachtin / Neem
- From seeds of the tropical neem tree
- Broad spectrum (e.g., caterpillars, leafminers, thrips, whiteflies, mealybugs)
- Active by contact or ingestion
- Feeding deterrent, interferes with molting in young insects,
- Trade names: Margosan-O, Azatin, Bio-neem (used in greenhouses, landscapes)

Rotenone
- Toxic alkaloid extracted from roots of a tropical legume
- Used in garden dusts, flea powders
- Very toxic to fish

Sabadilla
- From seeds of the sabadilla lilly
- Trade names: Red Devil, Natural Guard
- No residue; breaks down quickly in light
- Target pests: caterpillars, leafhoppers, stink bugs, squash bugs, thrips
- Crop: vegetables, citrus, avocado, mango

Pyrethrum, Pyrethrins
- Derived from chrysanthemum flowers
- Low mammalian toxicity
- Rapid “knockdown” of flying insects; paralyzes CNS
- Synergized by piperonyl butoxide (PBO)
- Breaks down quickly in sunlight; no residual
- Expensive, but widely used

Pyrethroids (Group 3)
- Synthetic versions of pyrethrum, but with enhanced properties
- Fast-acting, good knockdown
- Low mammalian toxicity; target selective for insect nerves
- Broadspectrum contact insecticides used against surface-feeding insects and mites (not systemic)
- Usually applied at low rates on foliage or as root drenches in nurseries
Pyrethroids
- Pyrethroids are generally not compatible with biocontrol programs (toxic to hymenopterans)
- Pyrethroids have been associated with secondary pest outbreaks (e.g., spider mites), which results in more pesticide use to control those outbreaks
- Pyrethrins and older pyrethroids exhibit greater toxicity at cooler temperatures

Movement of Pyrethroids
- Not very water soluble
- Pyrethroids will bind to surfaces rather than run off
- However, with their widespread use, several pyrethroids have been detected in California surface waters (Weston et al. 2004)

Microbial Insecticides
- Products that contain pathogens or microbially-derived toxins or by-products that kill insects
  - Bacteria
  - Fungi
  - Nematodes (not really a microbe…)
    - Protozoa
    - Viruses

Bacterial Insecticides
- Spore-forming, rod-shaped bacteria in the genus Bacillus
- Commonly occur in soils
- Must be eaten to be effective

*Bacillus thuringiensis (Bt)*
- Bt var. kurstaki - used since 1950’s to control leaf-eating caterpillars
- Produced commercially by fermentation
- Very low vertebrate toxicity
- Short residual in sunlight
- Works better against small larvae than vs. larger ones

Other Bt strains are active against insects other than Lepidoptera (e.g., M-one for Colorado potato beetle control – Bt var. san diego; Bt var. israelensis to kill mosquito, fungus gnat, and black fly larvae)
**Milky Spore Disease**
*(Bacillus popilliae)*

Diseased (left) and normal (right) grubs

**Conserve® SC (Spinosad)**
- Soil-dwelling bacterium, *Saccharopolyspora spinosa*
- Contact and stomach poison
- Residual up to 2 weeks
- Caterpillars, thrips, fire ants
- Labeled for use on greenhouses, nurseries, and all turfgrasses

**Avid® (Avermectin)**
- Produced from *Streptomyces avermitilis*
- Slow acting
- Low mammalian toxicity
- Leaf systemic
- Mites and leafminers

**Fungi**
- Spores grow on the insect cuticle, then hyphae penetrate the cuticle and grow inside the body, soon killing the insect

**Metarhizium anisopliae**
- Called “green muscardine disease”
  - The cadaver’s cuticle becomes red. In high humidity, a white mold grows on the cadaver, which turns green as spores are produced.
  - Fungus is naturally in soil & infects insects
  - Infects ~200 arthropod species (used for ticks, beetles, flies, gnats, thrips), but is safe for use around mammals

**Beauveria bassiana**
*(Naturalis T, Botanigard)*
- Called “white muscardine disease”
- Used for aphids, whiteflies, mealybugs, mealybugs, ticks, beetles, flies, gnats, thrips
- Greatest mortality in hot and humid conditions
- Fungi do not need to be ingested to work
- Infected insects die within a few days to a week
- Avoid tank-mixing with fungicides
Improving the Chance of Infection

- Use of an abrasive (e.g., diatomaceous earth) along with *Beauveria* may increase insect mortality by weakening the insect cuticle

Entomopathogenic Nematodes

- Microscopic, unsegmented worms
- Attack various insects (e.g., soil insects, wood borers)
- Enter host's body through mouth and spiracles, release and feed on bacteria, reproduce inside insect body
- Don't damage plants – have different mouthparts

Entomopathogenic Nematodes

- Several species (*Steinernema* spp., *Heterorhabditis* spp.) occur naturally in the soil, but some can be purchased
- Some insecticides, like imidacloprid (Merit), may slow grub behavior down and make them more susceptible to nematode infection

Molt-Accelerating Compounds

- Mimic the action of the insect molting hormone, ecdysone (Mach 2®, Confirm®)
- Low vertebrate toxicity
- Ingestion forces a premature, lethal molt of turf grubs and caterpillars

Chitin Synthesis Inhibitor

- Talus® IGR (buprofezin)
- Active by contact, ingestion, or vapor
- Target pests: mealybugs, whiteflies, scales, leaf- and plant hoppers
- Sites: greenhouse, nurseries, ornamentals, fruit and nut trees

Horticultural Oils

- Highly refined petroleum-based oils
- Useful vs. small or slow-moving, soft-bodied pests, (aphids, leafhoppers, scales, overwintering eggs, mites)
- May prevent gas exchange through egg membranes, clog insect mouthparts, deter feeding or egg-laying
Horticultural Oils

Advantages:
- Non-toxic to vertebrates
- No resistance

Disadvantages:
- Must contact insect with spray
- No residual
- Potential for phytotoxicity

Phytotoxicity

Insecticidal Soaps
- Made from salts in the fats and oils of animals and plants (very safe)
- Kill by disrupting insect cuticle
- Contact toxicity only – no residual
- Good vs. small, soft-bodied insects (aphids, caterpillars, crawlers)
- M-Pede, Rose and Flower Insect Control, and Safer Yard & Garden

Insecticide Options for Turf Pests

Caterpillar Control Options

<table>
<thead>
<tr>
<th>Neonicotinoids</th>
<th>Arena, Meridian, Merit</th>
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<tbody>
<tr>
<td>Combination products</td>
<td>Allectus (Talstar + Merit) Aloft (Talstar + Arena)</td>
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<tr>
<td>Pyrethroids</td>
<td>Talstar / Onyx, Astro, Scimitar, Tempo</td>
</tr>
<tr>
<td>IGRs/Molt Accelerating Compounds</td>
<td>Dimilin, Mach2</td>
</tr>
<tr>
<td>Organophosphates</td>
<td>Dylox, Sevin</td>
</tr>
<tr>
<td>Carbamates</td>
<td>Acelepryn</td>
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<tr>
<td>Anthranilic diamides</td>
<td>Provaunt</td>
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<tr>
<td>Oxadiazine</td>
<td>B.t. var. kurstaki, Conserve</td>
</tr>
<tr>
<td>Microbials</td>
<td>Beauveria, Metarhizium</td>
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Chinch Bug Control Options

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<tr>
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*Trade names are only used as examples and are not intended as endorsements. Other products may be labeled against this pest group.
**Grub Control Options**

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<td>Anthranilic diamides</td>
<td>Acelepyrin</td>
</tr>
<tr>
<td>Microbials</td>
<td>Milky spore disease</td>
</tr>
<tr>
<td>Insect parasitic nematodes</td>
<td>Steinernema spp., Heterorhabditis spp.</td>
</tr>
</tbody>
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**Mole Cricket Control**

**Preventive:**
- Treat young nymphs in May/June, soon after peak egg hatch
  - Chipco Choice/TopChoice, pyrethroids, neonicotinoids, combination products

**Curative:**
- Treat after damage occurs, usually summer, fall, or spring
  - Baits (Dursban, Advion)
  - Spot treatments (Orthene, others)

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If a tree falls in the forest and no one is around to hear it, does it make a sound?

Do insecticides work if there are no insects present to control?

What should we recommend?
- Determine the client’s goals and any site limitations (e.g., proximity to water, lack of irrigation, steep slope)
- Rule out or consider non-chemical options first
- Several products may have similar efficacy against certain pests
- Product cost is a major factor