Entomology and Integrated Pest Management

Eddie Kyle Slusher

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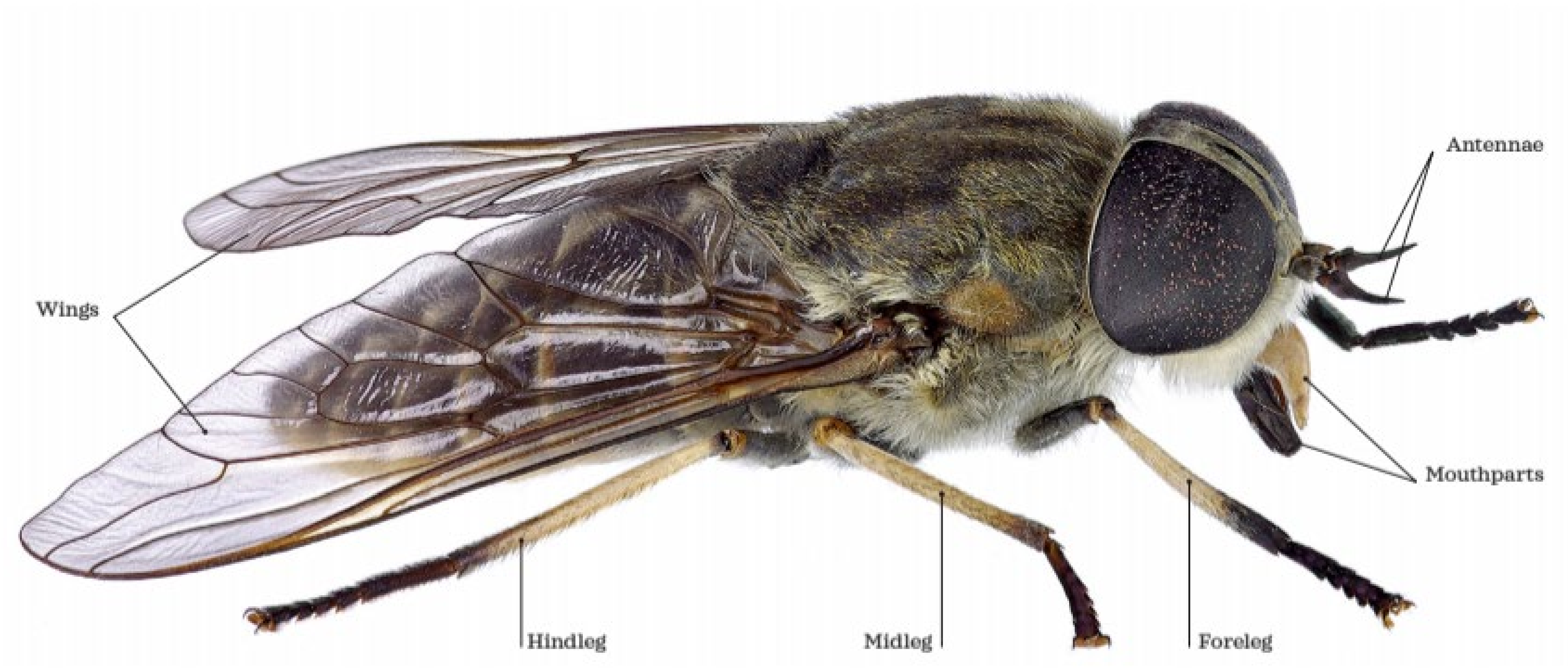
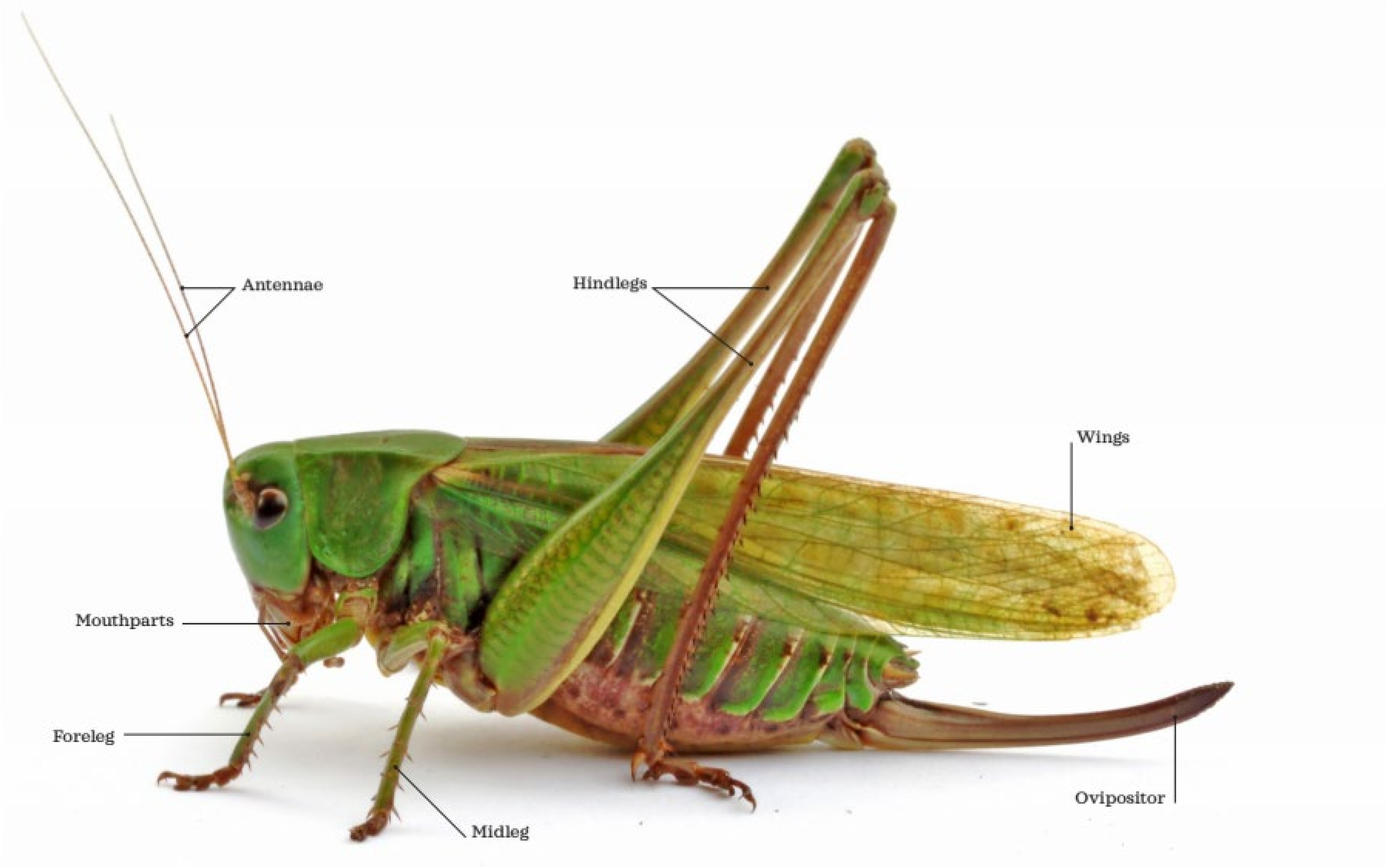
Daniel Prudek/Shutterstock.
Grimaldi, David A.. The Complete Insect: Anatomy, Physiology, Evolution, and Ecology (p. 367). Kindle Edition.

Marcouliana/Dreamstime;
Grimaldi, David A.. The Complete Insect: Anatomy, Physiology, Evolution, and Ecology (p. 367). Kindle Edition.



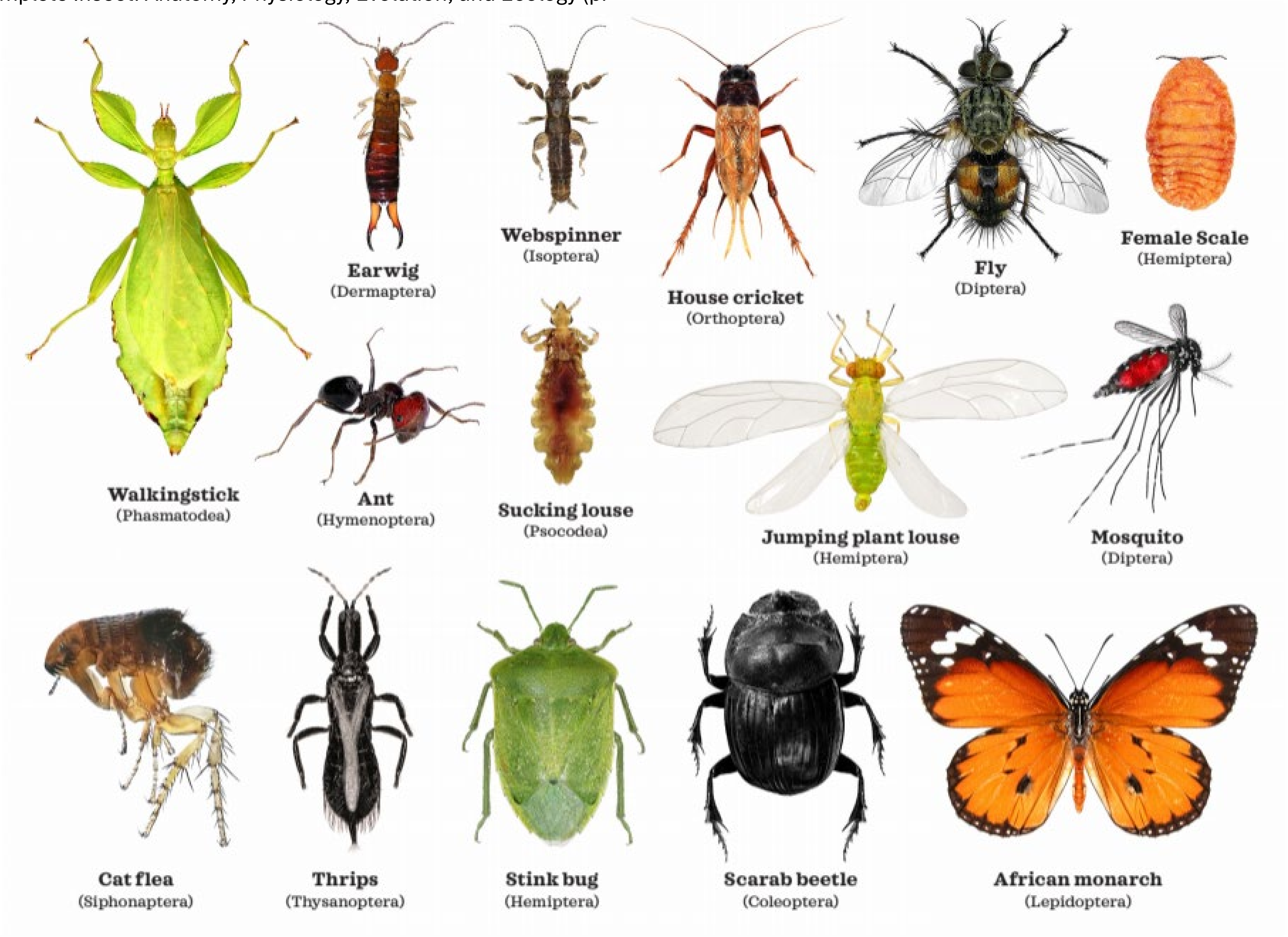
Knorre/Shutterstock;
Grimaldi, David A.. The Complete Insect: Anatomy, Physiology, Evolution, and Ecology (p. 367). Kindle Edition.



What percentage of insects are classified as pests?

~1 – 3% depending on the source

Protasov AN/Shutterstock;
Grimaldi, David A.. The Complete Insect: Anatomy, Physiology, Evolution, and Ecology (p. 367). Kindle Edition.



What is Integrated Pest Management?

- Reduce losses from pests in ways that are effective, economically sound, and ecologically compatible

Scouting/Monitoring

Identification

Implement Management Strategies

Evaluation Effectiveness

Scouting and Monitoring

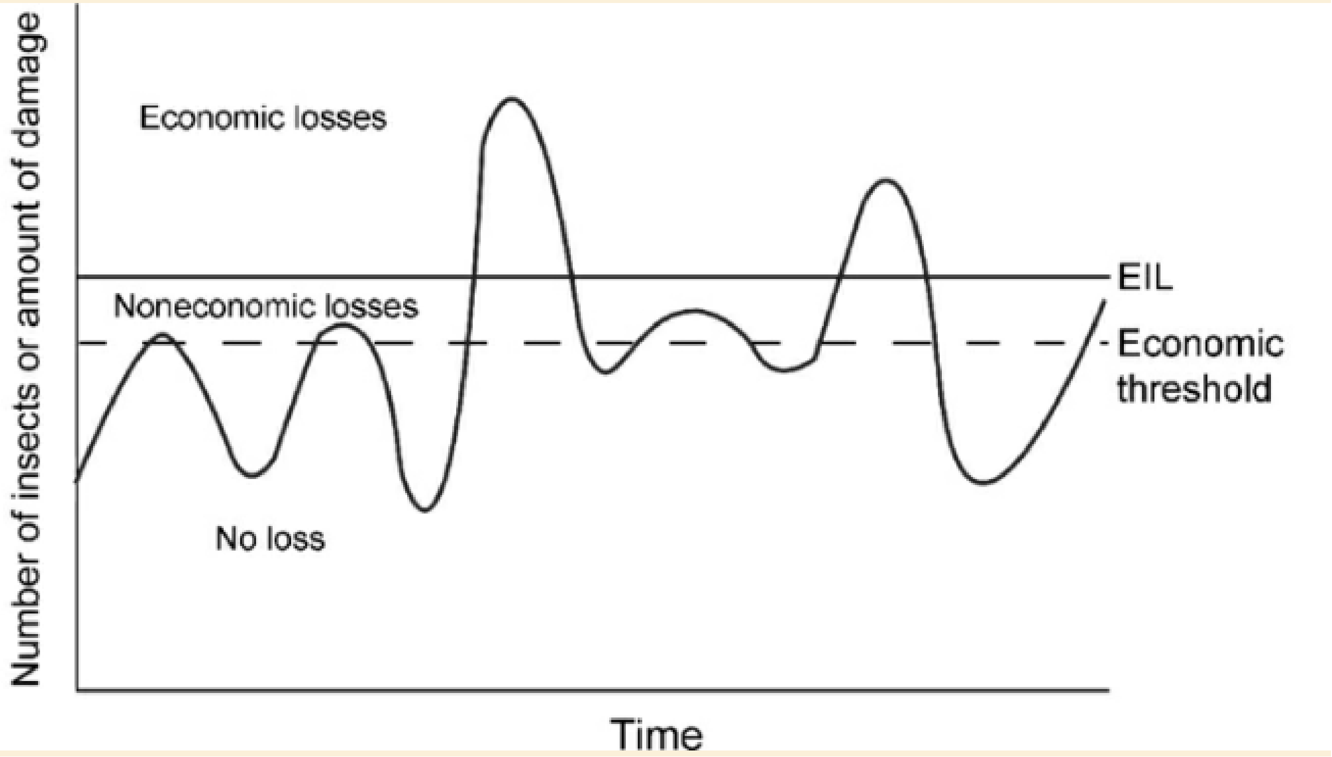
- Treat your farm like an ecosystem
- **Get a good scout or get good at scouting!**
- Who are my key pests?

Scouting and Monitoring

- Understand pest biology.
- Foliage feeding insects can often be spotted by careful examination of plants during pest windows – Aphids, Mites
- Some insects require more specialized methods
  - Pheromone traps: PNC
  - Circle Traps: Pecan Weevil

Scouting/Monitoring

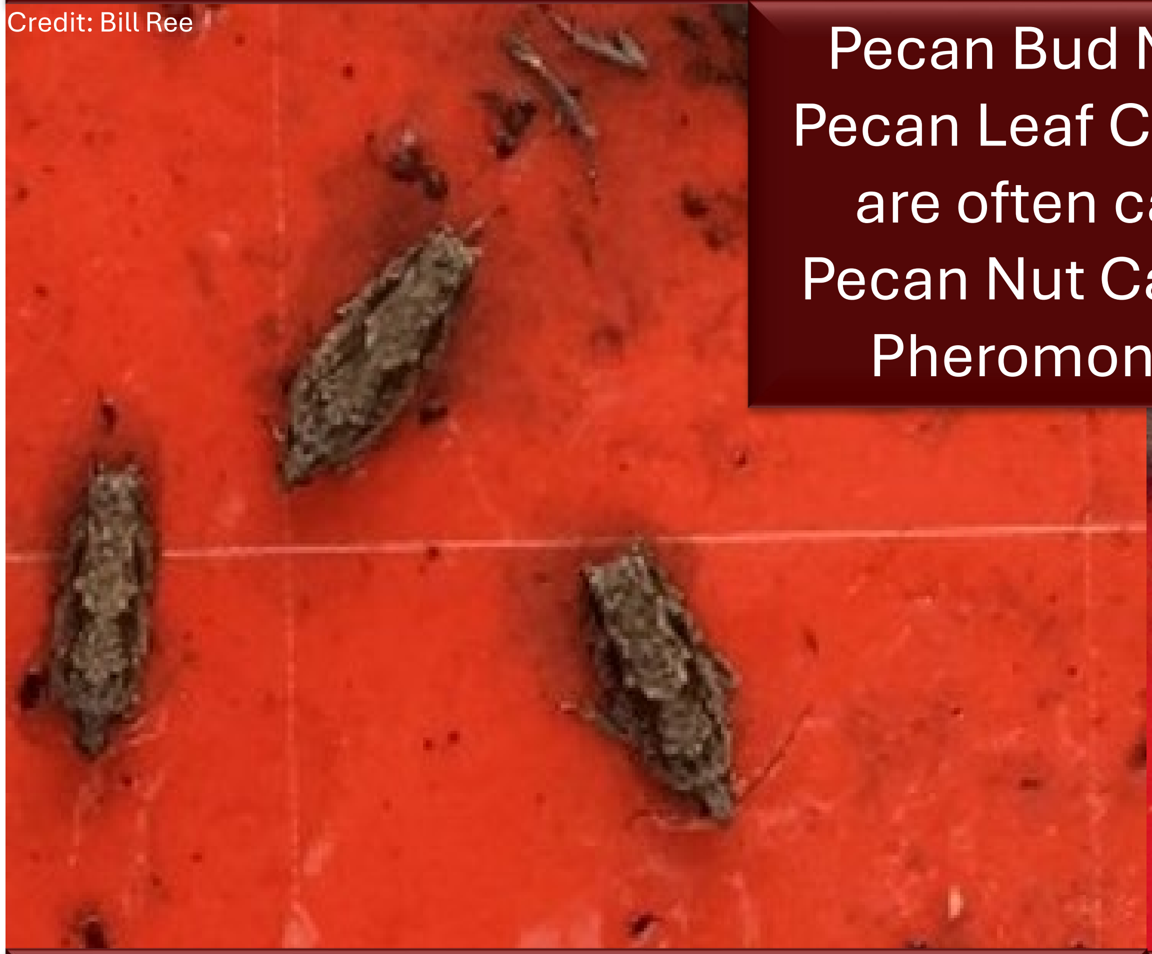
- Understanding Economic Thresholds
- Most pests have an established threshold, but this should be used more as guideline than as gospel.



From: Pedigo, L. P., Rice, M. E., & Krell, R. K. (2021). *Entomology and pest management*. Waveland Press.

Identification

Pecan Bud Moth and Pecan Leaf Casebearer are often caught in Pecan Nut Casebearer Pheromone Traps

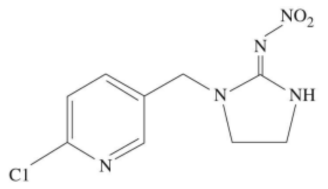


Pecan bud moth

Pecan nut casebearer

- So, now that we’ve determined our pest, and we’ve determined our population and thresholds. Now what?:
  1. Reduce Pest Population Numbers
  2. Reduce Crop Susceptibility
  3. Combine Steps 1+2

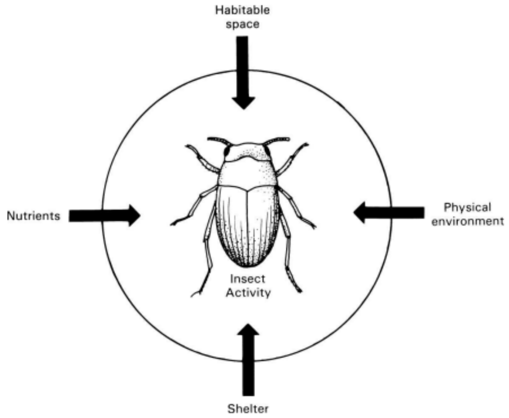
Chemical Management



1-[(6-chloro-3-pyridinyl)methyl]-*N*-nitro-2-imidazolidinimine

Marlin E. Rice

Cultural Management



Iowa State University of Extension Service

Biological Management

Marlin E. Rice

Marlin E. Rice

Photos From: Pedigo, L. P., Rice, M. E., & Krell, R. K. (2021). Entomology and pest management. Waveland Press.

Implement Management Tactics

In IPM, we focus on Biological, Cultural/Ecological, and Behavioral/Genetic Management first. We rely on Chemical management only when we have no other options.

Cultural/Ecological Management

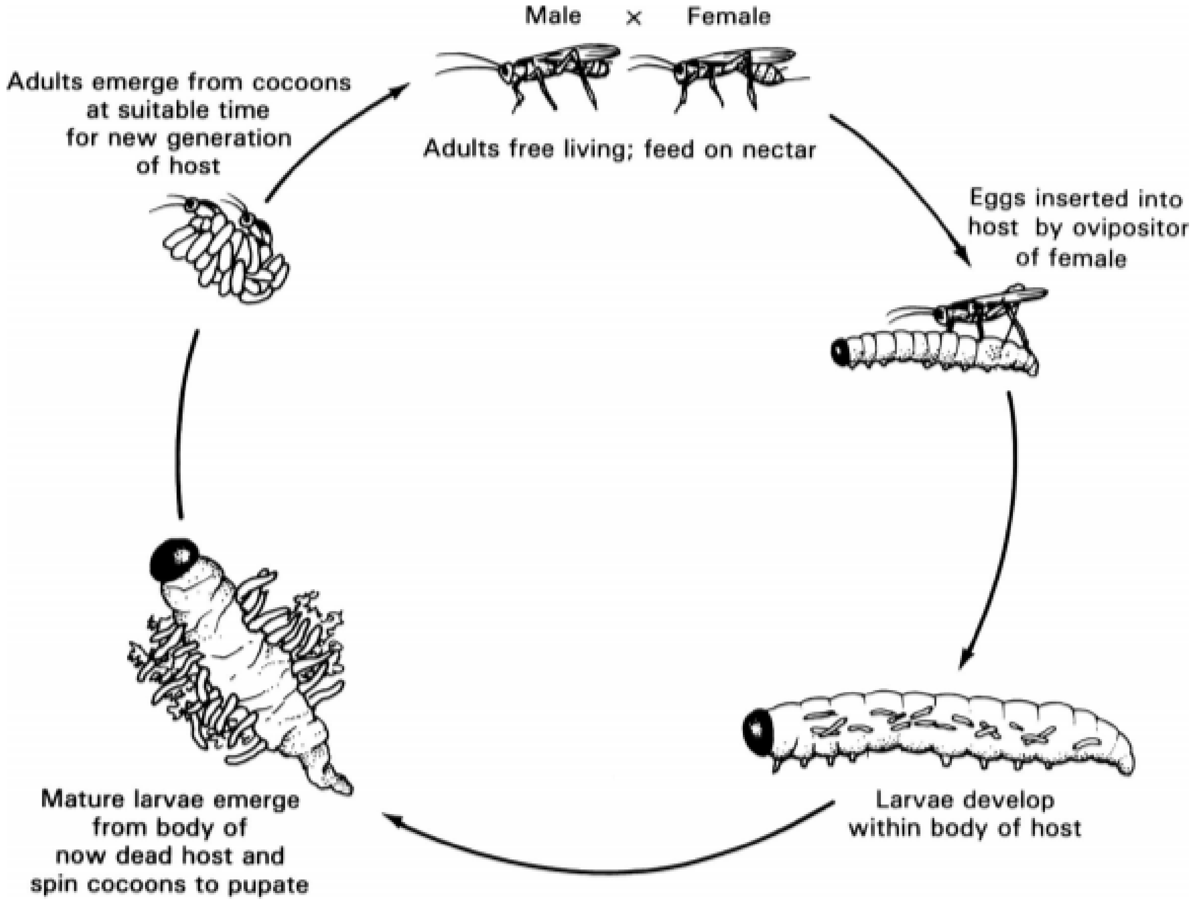
- **Site Selection** and **Variety Selection** are key.
- **Keep plants healthy** – pest are less apt to attack and overcome a healthy plant – Especially true for borers
- **Sanitation** – Crop residue removal (Hickory Shuckworm), Efficient storage and processing (Indian meal moth, red flour beetle)
- **Irrigation** and **Water Management**

Flatheaded Apple Borer

Biological Control

- Purposeful natural enemy manipulation to reduce pest populations.
- Types of Biological Control Agents
  - Parasitoids
  - Entomopathogens
  - Predators

Parasitoids



Photos From: Pedigo, L. P., Rice, M. E., & Krell, R. K. (2021). Entomology and pest management. Waveland Press.

Parasitoid Wasp attacking a waxworm

Table 4
Common Parasitoids *

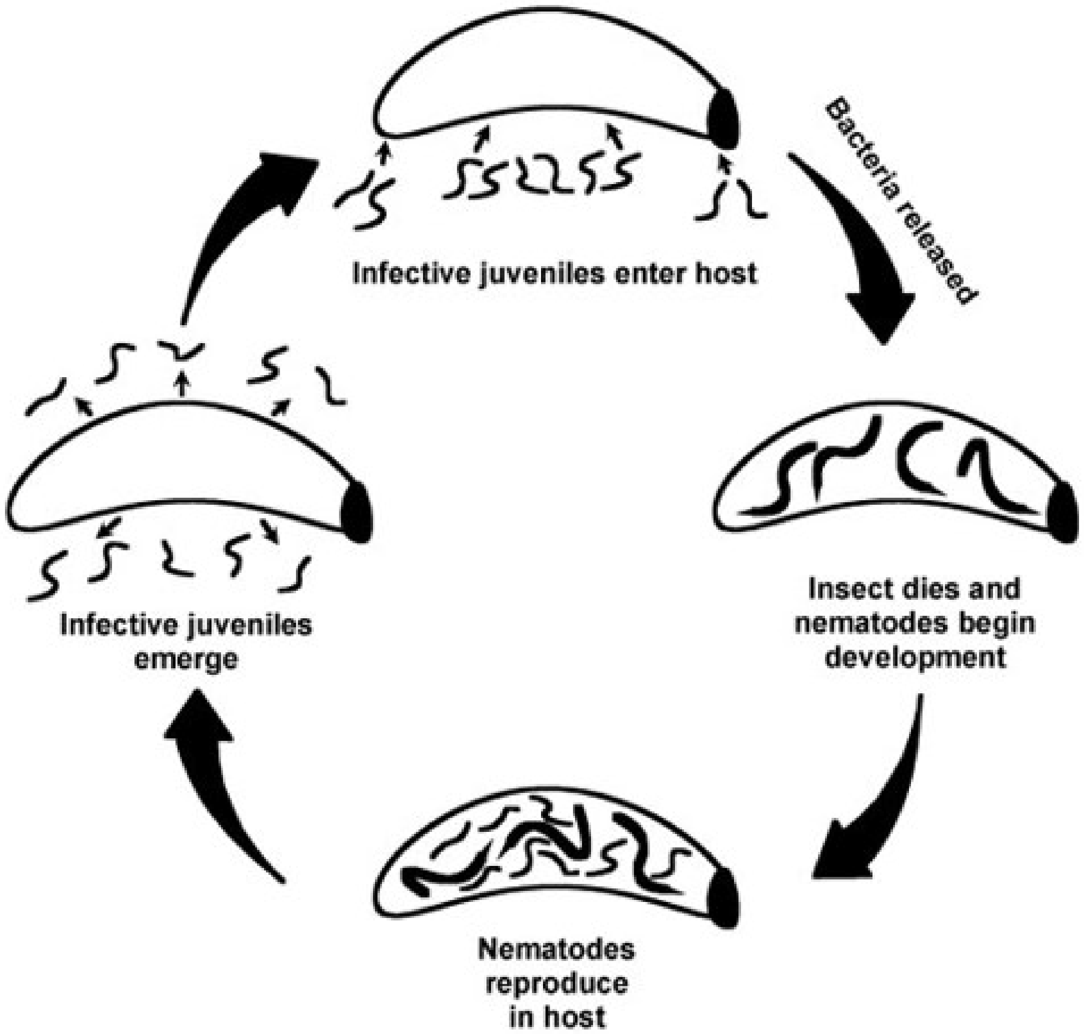
ORDER	FAMILY	HOST OR PREY	MODE OF ATTACK
Diptera	Tachinidae	Beetles, butterflies, moths	internal
(true flies)	Nemestrinidae	Locusts, beetles	internal
	Phoridae	Ants, caterpillars, termites, flies, others	internal
	Crytochaetidae	Scale insects	internal
Hymenoptera	Chalcididae	Flies and butterflies (larvae and pupae)	Internal or external
(ants, bees and wasps)	Encyrtidae	Aphids, scales, mealybugs, whiteflies	internal
	Eulophidae	Aphids, gall midges, sawflies, mealybugs	Internal or external
	Pteromalidae	Flies, including houseflies and stable flies	internal
	Pteromalidae	Boll weevils	External
	Aphelinidae	Whiteflies, scales, mealybugs, aphids	Internal or external
	Trichogrammatidae	Moth eggs	internal
	Mymaridae	True bugs, flies, beetles, leafhopper eggs	internal
	Scelionidae	Eggs of true bugs and moths	internal
	Ichneumonidae	Larvae or pupae of beetles, caterpillars, wasps	Internal or external
	Braconidae	Larvae of beetles, caterpillars, sawflies	Internal (mostly)

From: Altieri, M.A., Nicholls, C.I., Fritz, M.A. Manage Insects on Your Farm: A guide to Ecological Strategies. SARE Handbook Series Book 7.

Stephen Bonk/Shutterstock;
Grimaldi, David A.. The Complete Insect: Anatomy, Physiology, Evolution, and Ecology (p. 367). Kindle Edition.

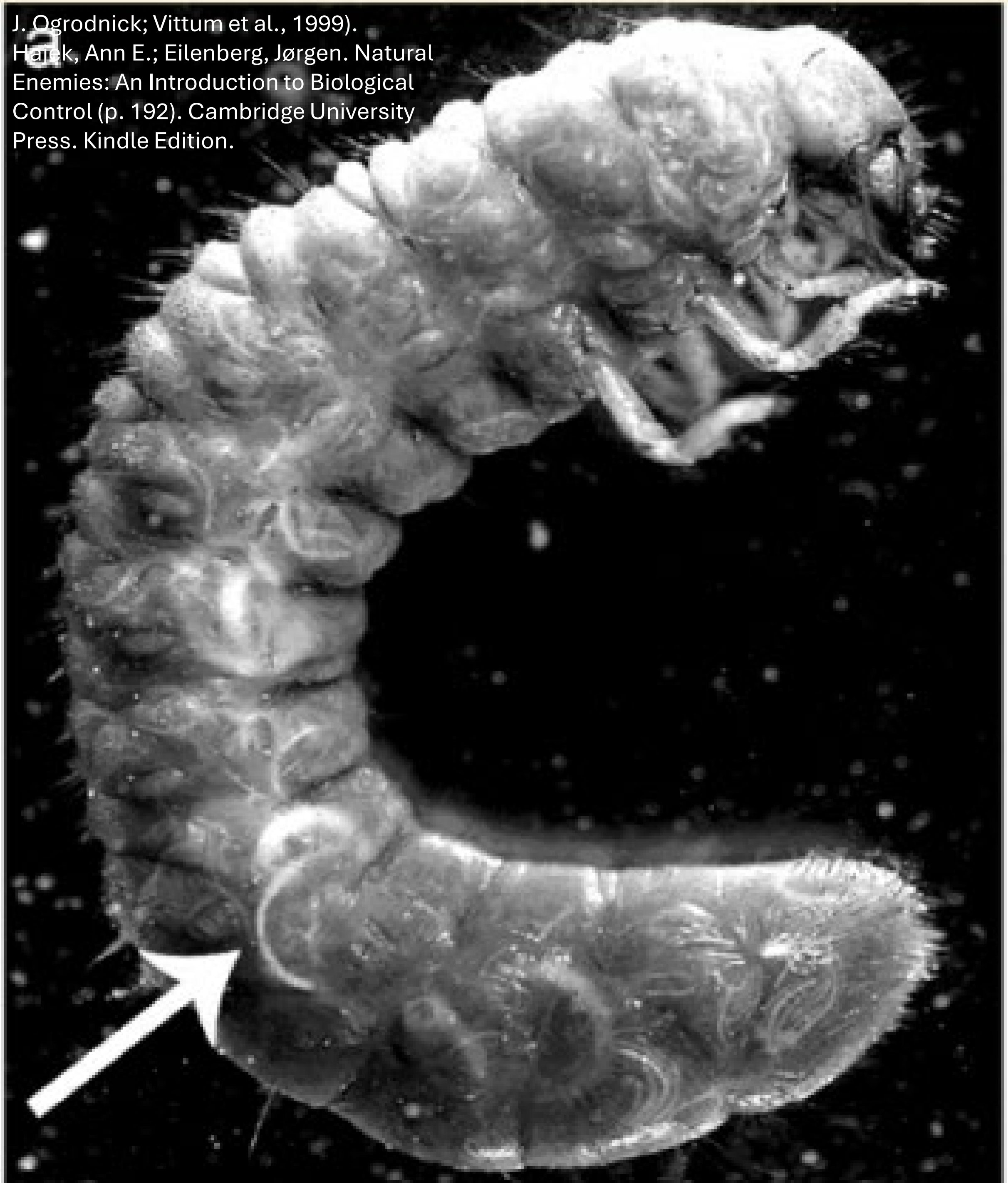
Eileen Kumpf/ Shutterstock;
Grimaldi, David A.. The Complete Insect: Anatomy, Physiology, Evolution, and Ecology (p. 367). Kindle Edition.

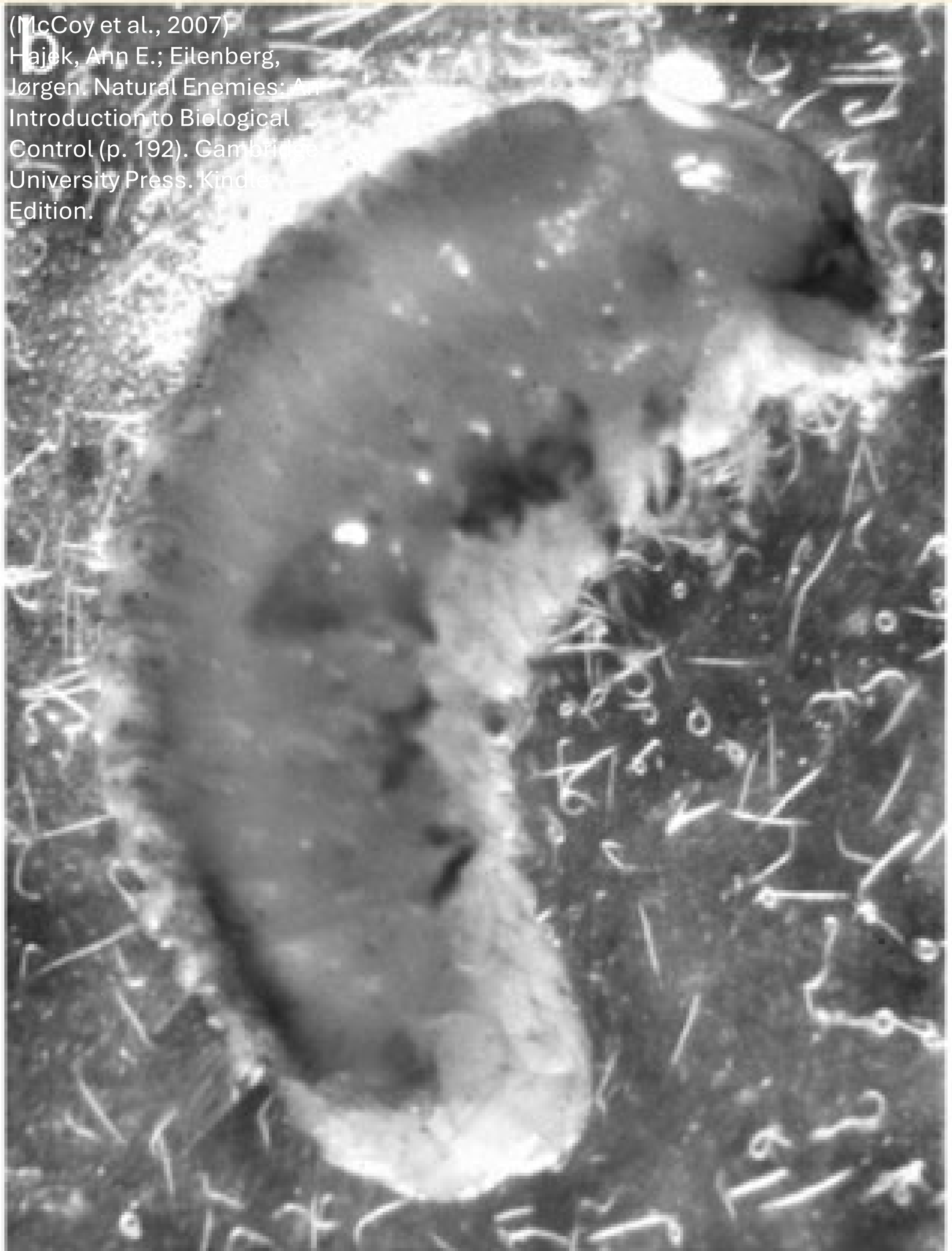
Entomopathogens



Pest, Common name	Pest, Scientific name	Nemas
Artichoke plume moth	*Platyptilia carduidactyla*	Sc
Banana moth	*Opogona sachari*	Hb, Sc
Banana root borer	*Cosmopolites sordidus*	Sc, Sf, Sg
Black cutworm	*Agrotis ipsilon*	Sc
Black vine weevil	*Otiorhynchus sulcatus*	Hb, Hm
Borers	*Synanthedon* spp.	Hb,Sc, Sf
Codling moth	*Cydia pomonella*	Sc
Corn earworm	*Helicoverpa zea*	Sr
Diamondback moth	*Plutella xylostella*	Sc
Fungus gnats	Diptera: Sciaridae	Sf, Hb
Japanese beetle	*Popillia japonica*	Hb, Sg
Leafminers	*Liriomyza* spp.	Sc
Mole crickets	*Scapteriscus* spp.	Sc, Sr, Ss
Plum curculio	*Conotrachelus nenuphar*	Sr

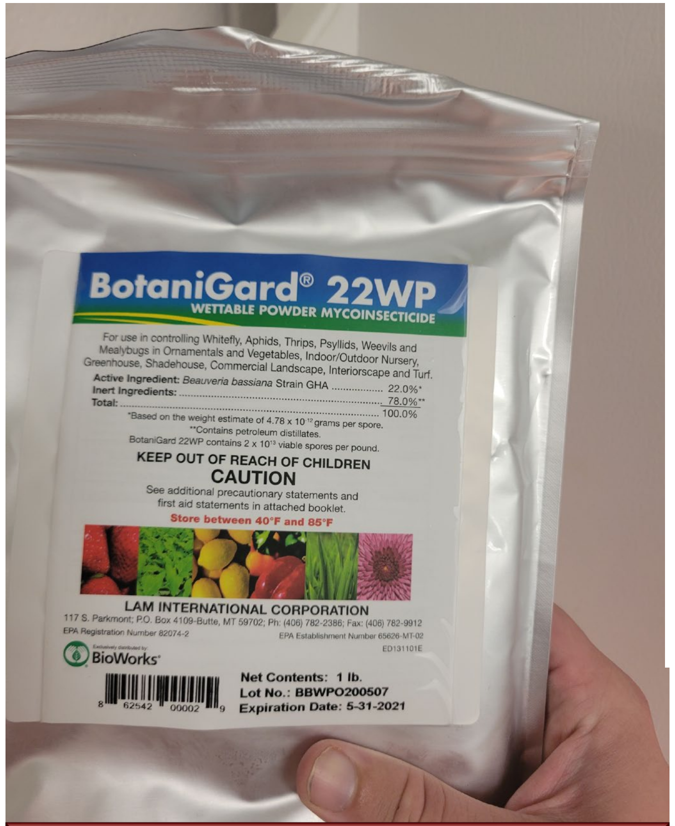
Entomopathogenic nematodes


J. Ogrodnick; Vittum et al., 1999).
Hajek, Ann E.; Eilenberg, Jørgen. Natural Enemies: An Introduction to Biological Control (p. 192). Cambridge University Press. Kindle Edition.


(McCoy et al., 2007)
Hajek, Ann E.; Eilenberg, Jørgen. Natural Enemies: An Introduction to Biological Control (p. 192). Cambridge University Press. Kindle Edition.

Entomopathogens

Weevil infected with *B. bassiana*



BotaniGard, a commercial version of *B. bassiana*

Table 12.1 Selected Registered Microbial Insecticides

Organism	Trade Name	Manufacturer	Target Pest
		Bacteria	
Bacillus popilliae	Milky Spore	St. Gabriel Organics	Japanese beetle
B. thuringiensis var. *kurstaki*	Dipel	Valent	Several moths
	Biobit	Valent	
	Thuricide	Valent	
	Condor	Certis	
B. thuringiensis var. *kurstaki* plus beta-exotoxin	Javelin	Certis	Armyworm and other moths
B. thuringiensis var. *aizawi*	Agree	Certis	Wax moth
B. thuringiensis var. *tenebrionis*	Novodor	Valent	Colorado potato beetle
B. thuringiensis var. *israelensis*	VectoBac	Valent	Mosquitoes, black flies
		Fungi	
Beauveria bassiana	Naturalis	Troy Biosciences	Whiteflies, scales, aphids
	Mycotrol	BioWorks for Mycotrol	
		Viruses	
Spodoptera exigua NPV	Spod-X	Certis	Beet armyworm
Helicoverpa NPV	Gemstar	Certis	Corn earworm, tobacco budworm
Cydia pomonella GV	ViroSoft	Biotepp	Codling moth
		Microsporidian	
Nosema locustae	Nolo Bait	M&R Durango, Inc.	Grasshopper nymphs, Mormon crickets

From: Pedigo, L. P., Rice, M. E., & Krell, R. K. (2021). Entomology and pest management. Waveland Press.

Predators

TABLE 3
Common Predators*

COMMON NAME	ORDER	FAMILY	HOST OR PREY
Praying mantids	Orthoptera	Mantidae	Large and small insects
Earwigs	Dermaptera	Labiduridae	Caterpillars, many others
Predaceous thrips	Thysanoptera	Aleolothripidae	Spider mite eggs
Minute pirate bugs	Hemiptera	Anthocoridae	Insect eggs, soft-bodied insects, small insects
Big-eyed bugs		Lygaeidae	Insect eggs, soft-bodied insects, small insects
Plant bugs		Miridae	Insect eggs, soft-bodied insects, small insects
Damsel bugs		Nabidae	Insect eggs, small insects
Assassin bugs		Reduviidae	Small insects, caterpillars
Predaceous stink bugs		Pentatomidae	Small caterpillars
Lacewings	Neuroptera	Chrysopidae	Aphids, soft-bodied insects
Lady beetles	Coleoptera	Coccinellidae	Aphids, soft-bodied insects, insect eggs
Ground beetles		Carabidae	Insect eggs, soft-bodied insects, caterpillars
Rove beetles		Staphylinidae	Small insects
Soft-winged flower beetles		Melyridae	Insect eggs, soft-bodied insects, small caterpillars
Predaceous midges	Diptera	Cecidomyiidae	Aphids
Syrphid/hover flies		Syrphidae	Aphids, soft-bodied insects
Ants	Hymenoptera	Formicidae	Insect eggs, soft-bodied insects, small insects
Hornets, yellow jackets		Vespidae	Caterpillars, small insects
Digger wasps, mud daubers		Sphecidae	Caterpillars, small insects

From Entomology and Pest Management

Crab Spider

Lacewing Larva

Agustiar/Dreamstime;
Grimaldi, David A.. The Complete Insect: Anatomy, Physiology, Evolution, and Ecology (p. 367). Kindle Edition.

Musat/istockphoto;
Grimaldi, David A.. The Complete Insect: Anatomy, Physiology, Evolution, and Ecology (p. 367). Kindle Edition.

Types of Biological Control

- Classical – Identify a natural enemy from a host's origin and introduce it into a new location.

Anagyrus lopezi parasitizing a mealy bug

Vedalia Beetle attacking a cushion scale

Types of Biological Control

- Augmentative – Any activity that increases natural enemy numbers or effectiveness.

Trichocaps

Commercial Lacewing eggs

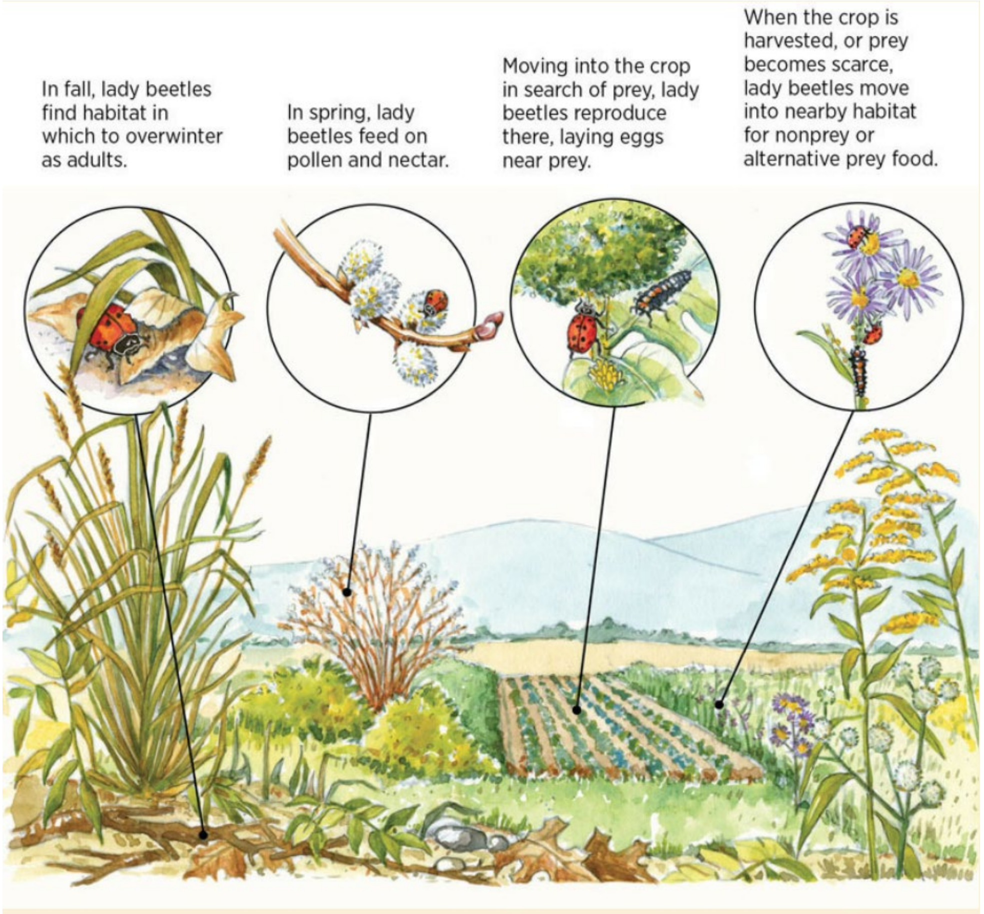
Commercial Beneficial Nematodes

Types of Biological Control

- Conservation – Protect and maintain natural populations using habitat management.

Managing Beneficials

- Supplementation of nectar and pollen (flowering borders, intercropping, cover crops)
- Provide overwintering habitat (beetle banks, leaf litter, rock piles, brush piles
- Minimize broad-spectrum insecticides.



From Farming with Beneficial Insects.

Common Natural Enemies

Lady beetle

Eggs

Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Larva

Whitney Cranshaw, Colorado State University, Bugwood.org

Pupa

Susan Ellis, Bugwood.org

Adult

R.L. Croissant, Bugwood.org

Stink bug

Predatory

Photo: Hanna Royals, Museum Collections: Heteroptera, USDA APHIS PPQ, Bugwood.org

Plant-feeding

Photo: Lindsey Seastone, Museum Collections: Heteroptera, USDA APHIS PPQ, Bugwood.org

Spined soldier bug

Nymph

Photo: Andrew Sawyer, UGA

Adult

Photo: Andrew Sawyer, UGA

Lacewing

Eggs

Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Larva

Photo: Joseph Berger, Bugwood.org

Pupa

Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Adult

Photo: Whitney Cranshaw, Colorado State University, Bugwood.org

Assassin Bug

Parasitoid Wasp

BAYER

ADMIRE® PRO™

SYSTEMIC PROTECTANT

Net Contents:

1 GAL. 12 OZ. (140 FL. OZ.)

GROUP 4A INSECTICIDE

For uses in pest management and maintenance of plant health.

ACTIVE INGREDIENT:

Imidacloprid, 1-[(6-Chloro-3-pyridinyl)methyl]-*N*-nitro-2-imidazolidinimine 42.8%

OTHER INGREDIENTS: 57.2%

TOTAL: 100.0%

EPA Reg. No. 264-827

Contains 4.6 pounds of active ingredient per gallon or 550 grams AI/liter.

SHAKE WELL BEFORE USING

STOP - Read the label before use

KEEP OUT OF REACH OF CHILDREN

CAUTION

See Back Panel for First Aid Instructions and Booklet for Complete Precautionary Statements and Directions for Use.

For **MEDICAL** And **TRANSPORTATION** Emergencies **ONLY** Call 24 Hours A Day 1-800-334-7577

For **PRODUCT USE** Information Call 1-866-99BAYER (1-866-992-2937)

Produced for
Bayer CropScience LP
800 N. Lindbergh Blvd.
St. Louis, MO 63167

US61381188C 190917Cv2 09/23

TREE NUTS – SOIL

Crops of Crop Group 14 except Almond including: Beechnut, Brazil nut, Butternut, Cashew, Chestnut, Chinquapin, Filbert, Hickory nut, Macadamia nut, Pecan, Walnut [black and English]

Pests Controlled		Rate fluid ounces/Acre
Aphids Leafhoppers/Sharpshooters Mealybugs	Spittlebugs Termites Whiteflies	7.0 – 14.0
Pests / Diseases Suppressed		
Pecan scab (from reduction in honeydew deposition)		7.0 – 14.0
Thrips (foliage-feeding thrips only)		14.0

Tree Nuts – Soil Applications

Apply specified dosage prior to or at onset of pest infestation in one of the following methods:

1. Chemigation into root-zone through low-pressure drip, trickle, micro-sprinkler or equivalent irrigation equipment. Pre-wet soil prior to applications of ADMIRE PRO SYSTEMIC PROTECTANT and allow soil to dry following application and prior to subsequent irrigation;
2. Emitter or spot application in a minimum of 4 fluid ounces of mixture per emitter site;
3. Shank or subsurface side-dress, injected to a depth just above or just within the root zone and between the trunk and drip line of the tree canopy. Apply product in a minimum of 10 gallons per acre using multiple shanks on both sides of trees. Ensure product placement is below sod or orchard floor debris. Irrigation covering entire treated area should follow within 48 hours to promote uptake by root system.
4. For control of termites, apply specified dosage to slightly moist soil as a high-volume drench to the basal portion of the tree trunk and surrounding soil in the immediate vicinity of the tree trunk. Utilize sufficient carrier volume to penetrate the soil to a depth of 18 – 24 inches to obtain optimum control. Allow soil to dry following treatment and prior to applying any irrigation.

Tree Nuts – Soil Application Restrictions

Pre-Harvest Interval (PHI): **7 days**

Maximum ADMIRE PRO SYSTEMIC PROTECTANT allowed per year: **14.0 fluid ounces/Acre** (0.5 lb AI/Acre)

Do not apply pre-bloom or during bloom or when bees are foraging.

Tree Nuts – Soil Application Remarks

Use the higher rate within the specified rate range when applied by shank or subsurface sidedress, used on larger trees, soils with high clay content, for high plant populations, and/or where extended control is desired. Under some conditions, control may not occur for 14 or more days or until two (2) irrigations have been made. Applications made later in the season may result in reduced efficacy.

- The label is the law!
- Important Information to consider
  - Re-entry (REI)
  - Pre-Harvest (PHI)
  - M.O.A
  - Pest Listed
  - Amount per season

BAYER

ADMIRE® PRO

SYSTEMIC PROTECTANT

Net Contents:

1 GAL. 12 OZ. (140 FL. OZ.)

For uses in pest management and maintenance of plant health.

ACTIVE INGREDIENT:

Imidacloprid, 1-[(6-Chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine	42.8%
OTHER INGREDIENTS:	57.2%
TOTAL:	100.0%

EPA Reg. No. 264-827

Contains 4.6 pounds of active ingredient per gallon or 550 grams AI/liter.

SHAKE WELL BEFORE USING

STOP - Read

KEEP OU

OF C

CAUTION

See Back Panel for First Aid Instructions and Booklet for Complete Precautionary Statements and Directions for Use.

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mond including: Beechnut, Brazil nut, Butternut, Cashew, Chestnut, damia nut, Pecan, Walnut [black and English]

	Rate fluid ounces/Acre
tlebugs mites teflies	7.0 – 14.0
essed	
dew deposition)	7.0 – 14.0
	14.0

onset of pest infestation in one of the following methods:

gh low-pressure drip, trickle, micro-sprinkler or equivalent irrigation pplications of ADMIRE PRO SYSTEMIC PROTECTANT and allow soil to to subsequent irrigation;

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Pre-Harvest Interval (PHI): **7 days**

Maximum ADMIRE PRO SYSTEMIC PROTECTANT allowed per year: **14.0 fluid ounces/Acre** (0.5 lb AI/Acre)

Do not apply pre-bloom or during bloom or when bees are foraging.

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Use the higher rate within the specified rate range when applied by shank or subsurface sidedress, used on larger trees, soils with high clay content, for high plant populations, and/or where extended control is desired. Under some conditions, control may not occur for 14 or more days or until two (2) irrigations have been made. Applications made later in the season may result in reduced efficacy.

RESTRICTED USE PESTICIDE

DUE TO TOXICITY TO FISH AND AQUATIC ORGANISMS

FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS, OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

GROUP 3 INSECTICIDE

Warrior with Zeon Technology®

Insecticide

Active Ingredient:
Lambda-cyhalothrin[1]
[1α(S*),3α(Z)]-(±)-cyano-(3-phenoxyphenyl)methyl-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate 11.4%

Other Ingredients: 88.6%

Total: 100.0%

Warrior Insecticide with Zeon Technology contains 1 lb. of active ingredient per gal. and is a capsule suspension.

[1]Synthetic pyrethroid

KEEP OUT OF REACH OF CHILDREN.

WARNING/AVISO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

See additional precautionary statements and directions for use in booklet.

PULL HERE TO OPEN

RESTRICTED USE PESTICIDE

DUE TO TOXICITY TO FISH AND AQUATIC ORGANISMS

FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS, OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

GROUP 3 INSECTICIDE

Karate®

Insecticide

For Use to Control Certain Insects on Selected Crops

Active Ingredient:
Lambda-cyhalothrin[1]
[1α(S*),3α(Z)]-(±)-cyano-(3-phenoxyphenyl)methyl-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate 13.1%

Other Ingredients[2]: 86.9%

Total: 100.0%

Karate® Insecticide contains 1 pound of active ingredient per gallon and is an emulsifiable concentrate.

[1]Synthetic pyrethroid
[2]Contains petroleum distillates.

KEEP OUT OF REACH OF CHILDREN.

WARNING / AVISO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

EPA Reg. No. 100-1086 EPA Est. No. 39578-TX-1
Product of the United Kingdom
Formulated in the USA

SCP 1086B-L1A 1209
311387

1 gallon
Net Contents

syngenta®

PULL HERE TO OPEN

RESTRICTED USE PESTICIDE

DUE TO TOXICITY TO FISH AND AQUATIC ORGANISMS

FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS, OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

Sale, use and distribution of this product in Nassau and Suffolk counties in the state of New York is prohibited.

GROUP 3A 4A INSECTICIDES

Endigo® ZC

syngenta.

Insecticide

For control of listed pest infesting specified crops.

Active Ingredient:

Lambda-cyhalothrin[1,2]	9.48%
Thiamethoxam[3]	12.60%
Other Ingredients:	77.92%
Total:	**100.00%**

Endigo ZC contains 1.18 pounds thiamethoxam and 0.88 pounds lambda-cyhalothrin per gallon.

[1]Synthetic pyrethroid
[2]CAS No. 91465-08-6
[3]CAS No. 153719-23-4

KEEP OUT OF REACH OF CHILDREN.

WARNING / AVISO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

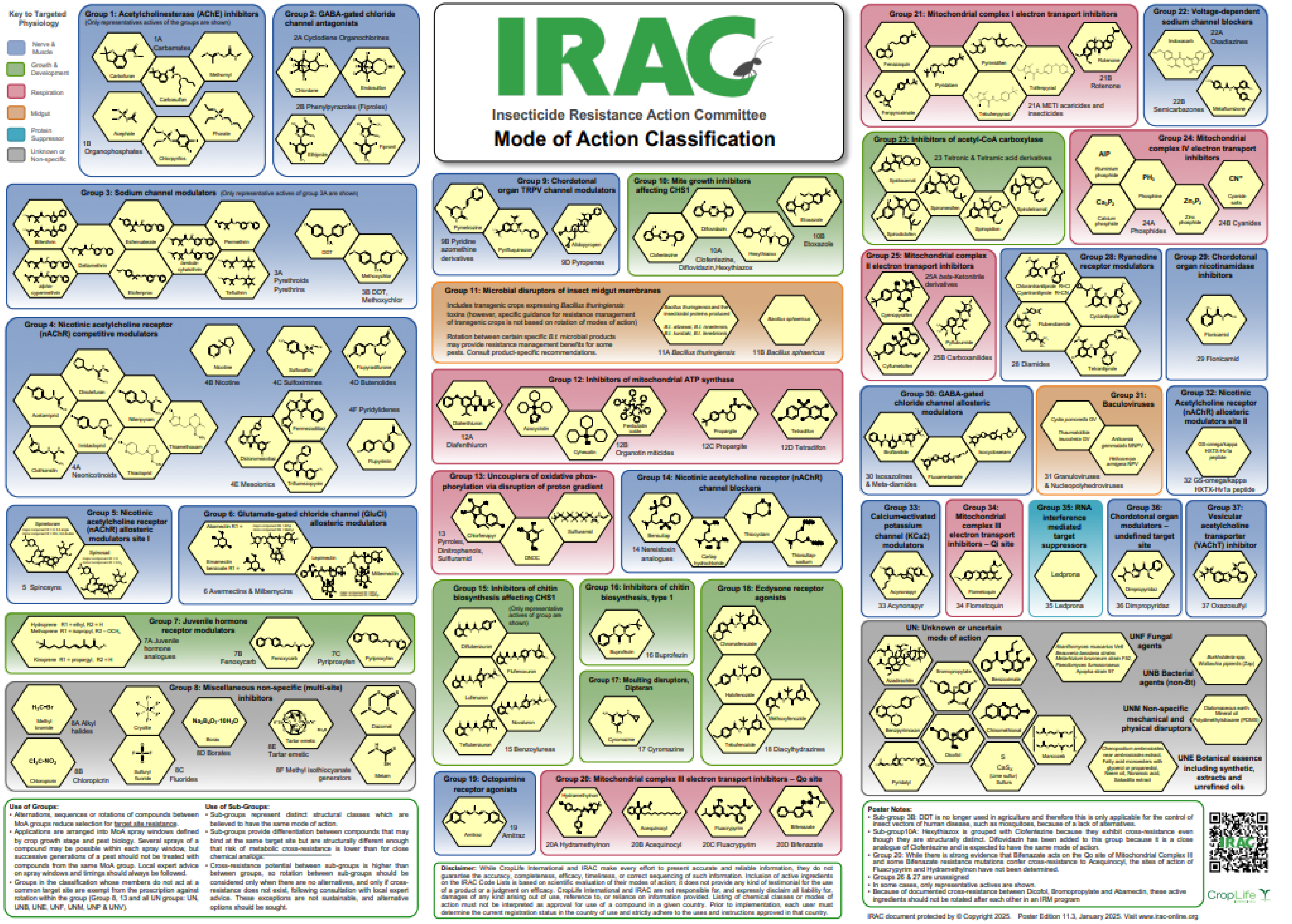
See additional precautionary statements and directions for use in booklet.

EPA Reg. No. 100-1276
EPA Est. 100-NE-001

SCP 1276A-L1F 0611 343398

1 gallon Net Contents

™



Mode of Action Classification | nsecticide Resistance Management | IRAC

37 Groups + Several Compounds with Unknown MOAs

Using IRAC Groups

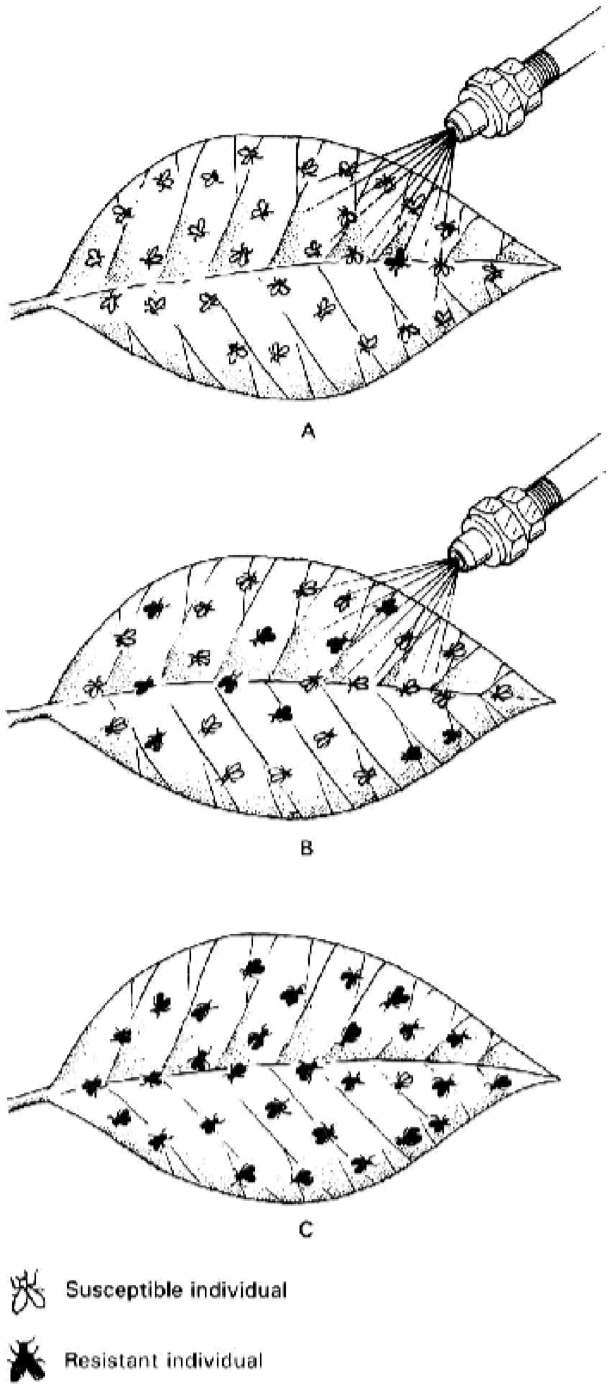
Pesticide	MOA
Acetamiprid (Assail)	4A
Afidopyropen (Sefina)	9D
Clothianidin (Belay)	4A
Flonicamid (Beleaf, Carbine)	9C
Flupyradifurone (Sivanto 200 SL)	4D
Imidacloprid	4A
Pesticide	**MOA**
Pymetrozine (Fulfill)	9B
Pyridaben (Nexter)	21
Pyrifluquinazon (PQZ)	9B
Sulfoxaflor (Closer, Transform)	4C
Thiamethoxam (Centric)	4A
Tolfenpyrad (Apta)	21A

Imidacloprid (4A)

Apta (21A)

Sefina (9D)

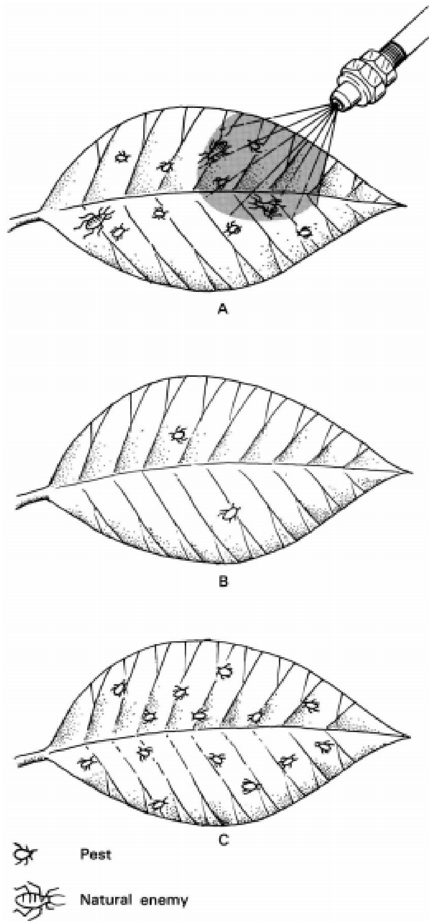
- Pecan Aphid resistance to Imidacloprid has been observed in some parts of the state.
- When we are spraying, we want to make sure we are targeting different generations with different insecticides.
- Some pest, such as pecan weevil, don't require as much rotation, as they only produce 1 generation a year.

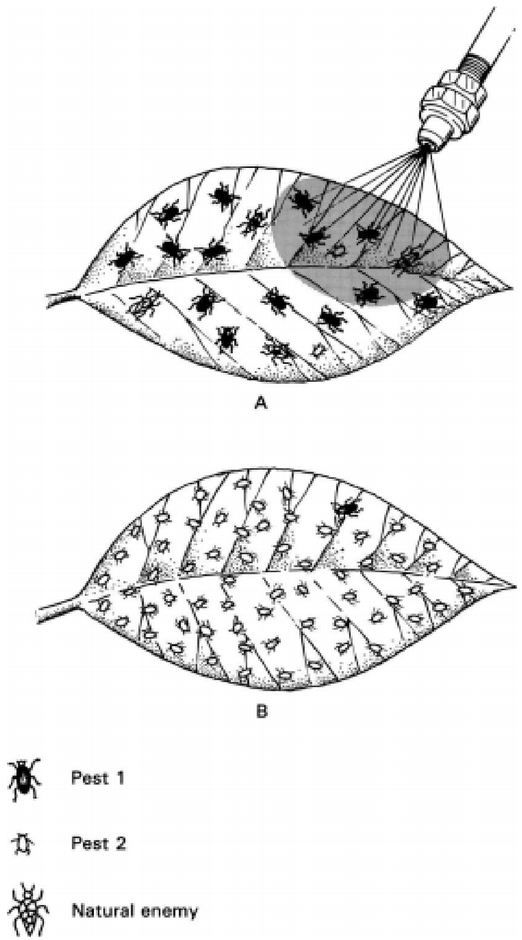


Insecticide Resistance

University of California Integrated Pest Management Publication 3303. From: *Entomology and pest management*

Pest Resurgence





University of California Integrated Pest Management Publication 3303. From: *Entomology and pest management*

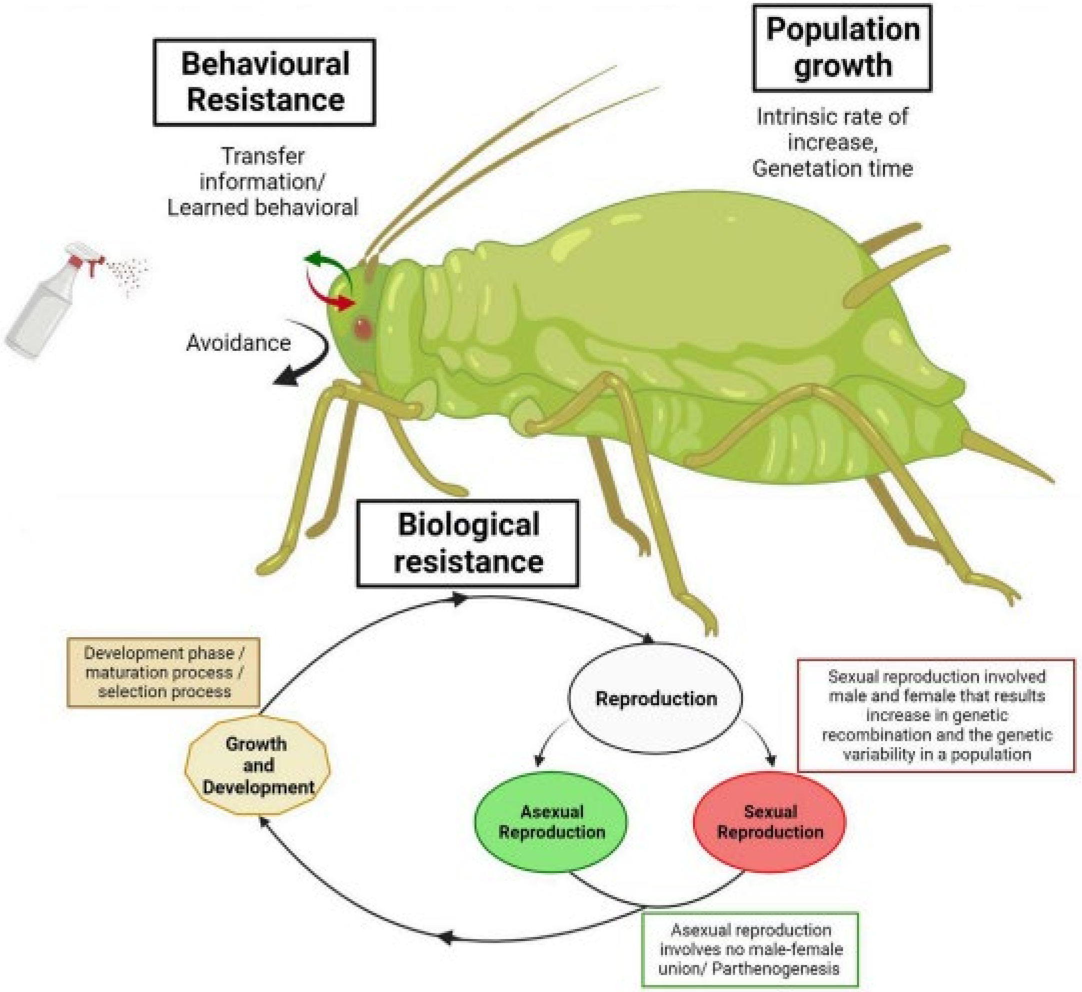


FIGURE 1
Schematic diagram of the biological and behavioral mechanisms of insecticide resistance in invasive insects.

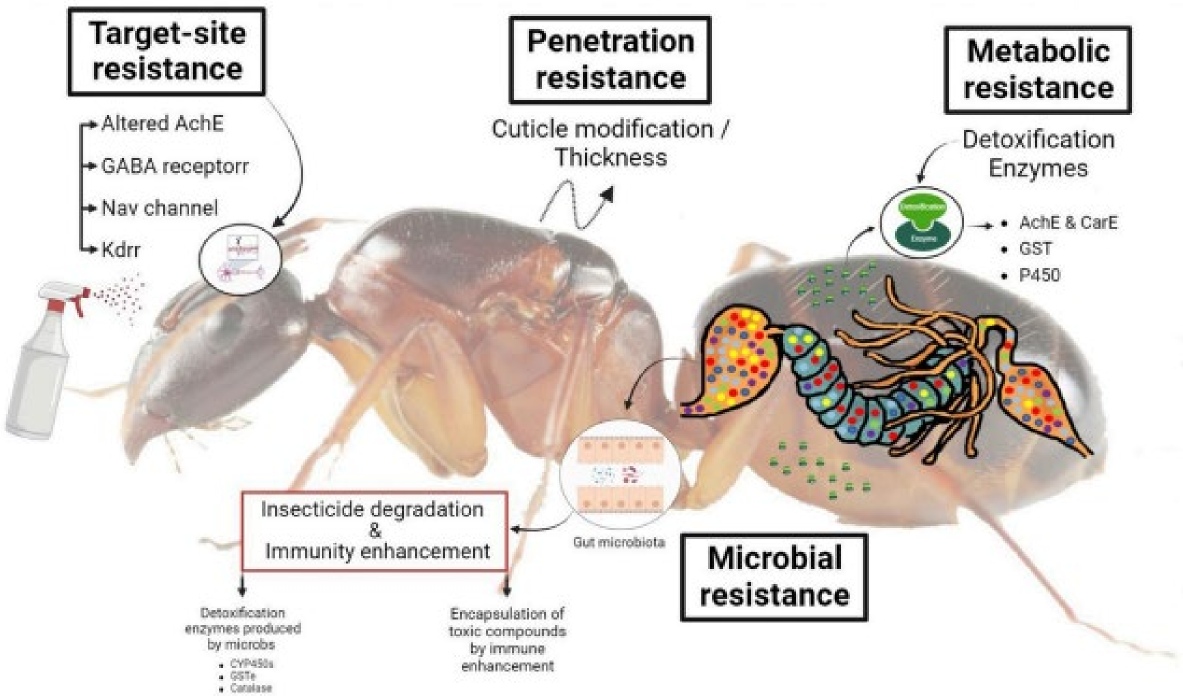


FIGURE 2
A schematic diagram represents the role of enzymes and gut microbiota in pesticide detoxification in invasive ants.

Siddiqui, J. A., Fan, R., Naz, H., Bamisile, B. S., Hafeez, M., Ghani, M. I., ... & Chen, X. (2023). Insights into insecticide-resistance mechanisms in invasive species: Challenges and control strategies. *Frontiers in Physiology*, *13*, 1112278.

Cross-Resistance

- Where an insect becomes resistant to multiple insecticides through resistance to one.
- Usually occurs **within** a class of insecticides
  - DDT and Methoxychlor (Chemform, Moxie) (Both IRAC Class 3B).
- However, **between** class resistance also occurs.
  - Carbamates (Carbaryl, Sevin) and Organophosphates (Chlroyrifos) (IRAC Class 1A and 1B).
  - Carbamates (1A), Organophostphates (1B), Pyrethroids (3A) (All three target nerves and muscles).

Table 17.2 Critical Instances of Cross Resistance in the United States.

Pest	Organo-phosphates OP	Carbamates C	Pyrethroids P	Other (includes microbials)
Twospotted spider mite (*Tetranychus urticae*)	X	X	X	X
Colorado potato beetle (*Leptinotarsa decemlineata*)	X	X	X	X
Southern house mosquito (*Culex quinquefasciatus*)	X	X	X	X
Little house fly (*Fannia canicularis*)	X		X	X
Sweetpotato whitefly (*Bemisia tabaci*)	X	X	X	
Greenhouse whitefly (*Trialeurodes vaporariorum*)	X	X	X	
Cotton aphid (*Aphis gossypii*)	X	X	X	
Pear psylla (*Cacopsylla pyricola*)	X	X	X	
Tobacco budworm (*Heliothis virescens*)	X	X	X	
Soybean looper (*Chrysodeixis includens*)	X	X	X	
Beet armyworm (*Spodoptera exigua*)	X	X	X	
Fall armyworm (*Spodoptera frugiperda*)	X	X	X	
Diamondback moth (*Plutella xylostella*)	X	X	X	X
German cockroach (*Blattella germanica*)	X	X	X	X
Cat flea (*Ctenocephalides felis*)	X	X	X	X

SOURCE: *Biologically Based Technologies for Pest Control.* 1995. U.S. Congress, Office of Technology Assessment.

From: *Entomology and pest management*

4. Evaluate Effectiveness

Did what I apply work? - Monitoring

YES!

NO! Start from Step 1

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