HOW TO ENSURE YOU GET CREDITS

- Hold an IDAHO pesticide applicator license
- Be present for the duration of the presentation
- Registered each applicator you plan to request credit for (group viewing doesn’t work)
- Accurately entered each applicator’s license number

University of Idaho Extension

IPM WEBINAR SERIES PART 5: ROLE OF CHEMICAL CONTROL AND FORMULATING AN IPM PLAN

DESIREÈ WICKWAR

UI INTEGRATED PEST MANAGEMENT PROGRAM MANAGER

Topic Itinerary:

1. Chemical pest management
2. Case study
3. Creating an IPM plan

A pesticide is….

Any substance or mixtures of substances that is intended to:

Prevent, destroy, repel or mitigate a pest

Be used as a plant regulator, defoliant, or desiccant

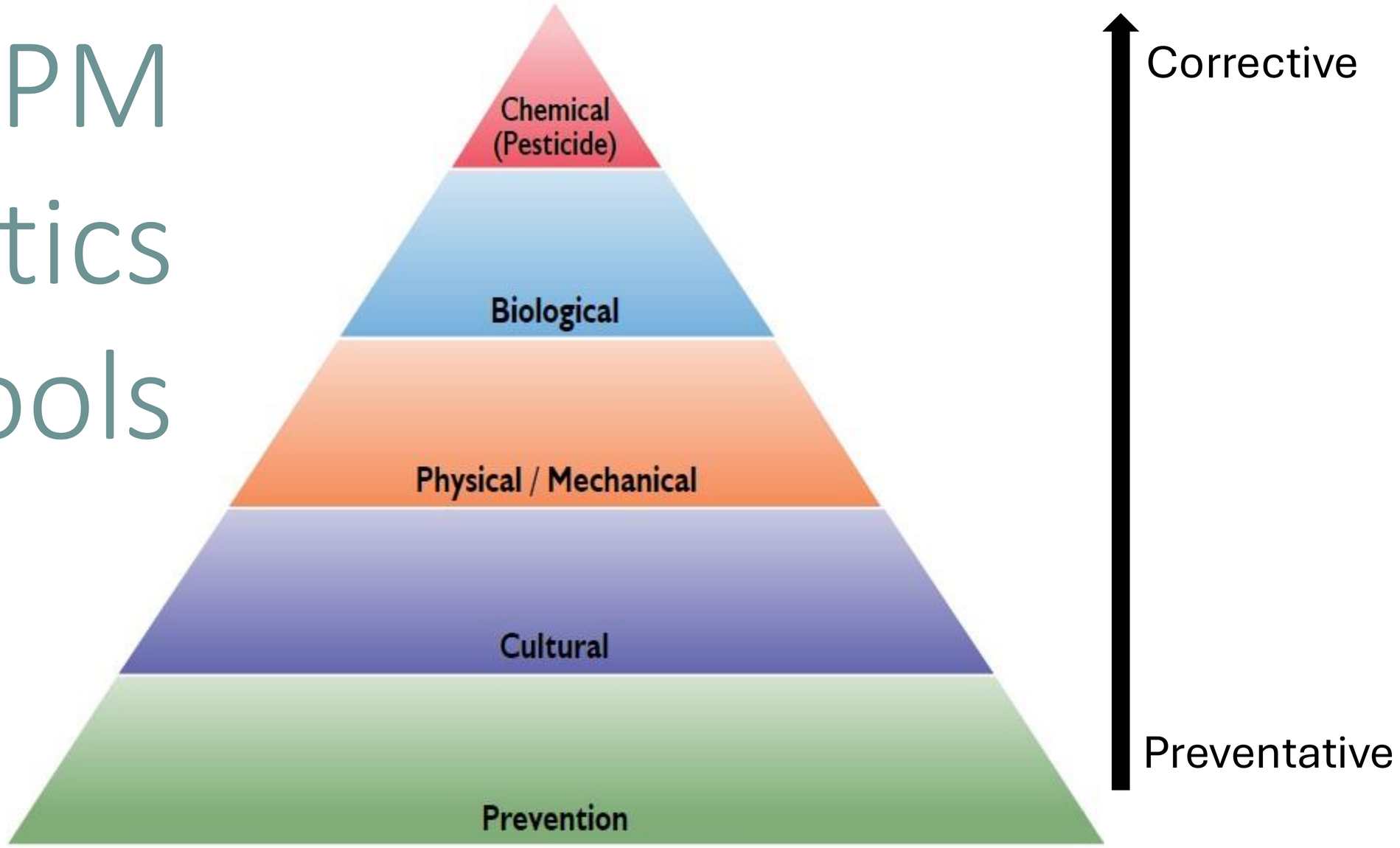
Act as a nitrogen stabilizer

(u) Pesticide

The term "pesticide" means (1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and (3) any nitrogen stabilizer, except that the term "pesticide" shall not include any article that is a "new animal drug" within the meaning of section 321(w) [1] of title 21, that has been determined by the Secretary of Health and Human Services not to be a new animal drug by a regulation establishing conditions of use for the article, or that is an animal feed within the meaning of section 321(x) [1] of title 21 bearing or containing a new animal drug. The term "pesticide" does not include liquid chemical sterilant products (including any sterilant or subordinate disinfectant claims on such products) for use on a critical or semi-critical device, as defined in section 321 of title 21. For purposes of the preceding sentence, the term "critical device" includes any device which is introduced directly into the human body, either into or in contact with the bloodstream or normally sterile areas of the body and the term "semi-critical device" includes any device which contacts intact mucous membranes but which does not ordinarily penetrate the blood barrier or otherwise enter normally sterile areas of the body.

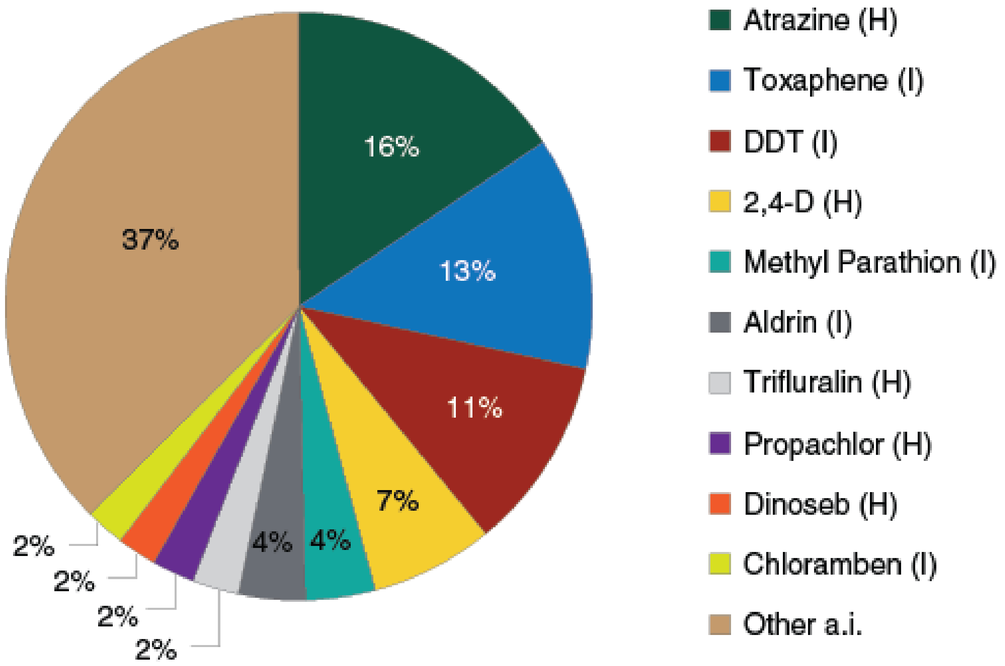
U.S. Code Title 7, Chapter 6, Subchapter II, Section 136 – Definitions - FIFRA

IPM Tactics and Tools



1968 Pesticide Use

The 10 most heavily used pesticide active ingredients in 1968 included 5 insecticides and 5 herbicides (percent total pounds active ingredient applied on 21 selected crops)

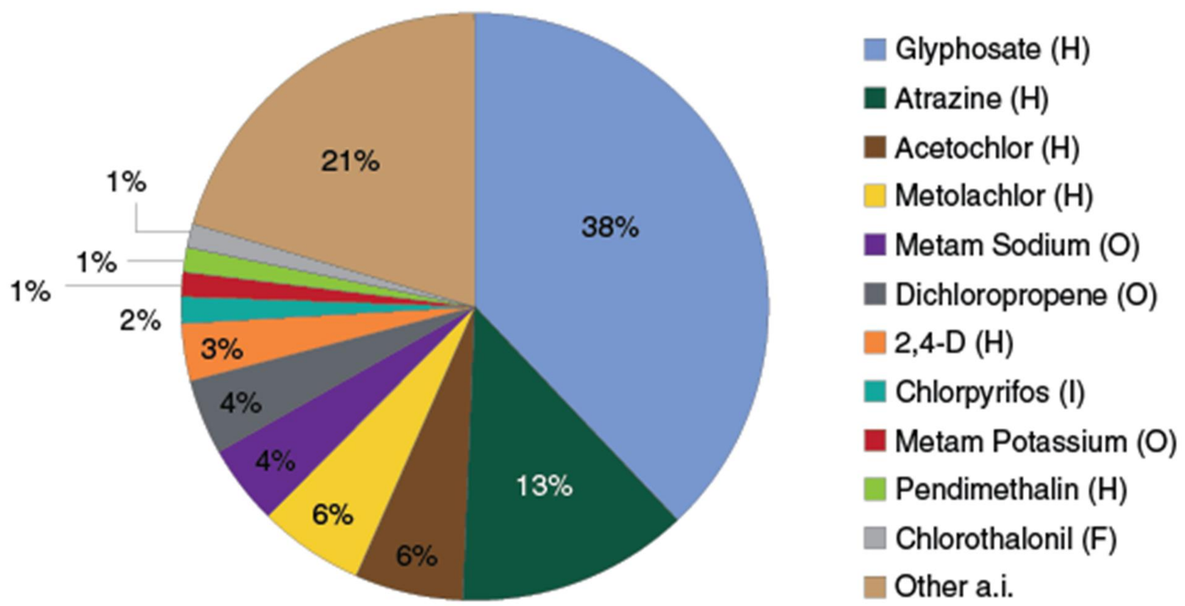


Note: H = herbicide, I = insecticide.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service and proprietary data.

2008 Pesticide Use

The four most heavily used pesticide active ingredients in 2008 were herbicides (percent total pounds active ingredient applied on 21 selected crops)



Note: H = herbicide, I = insecticide, F = fungicide, and O = other.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service and proprietary data.

PESTICIDE

Manufacturers conduct tests for…

- Toxicity
- Efficacy (% kill)
- Degradation
- Mobility
- Residue
- Effects on non-target species and the environment

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How much do you think it costs to bring a new pesticide to market (discovery, development, research & registration)?

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How much do you think it costs to bring a new pesticide to market (discovery, development, research & registration)?

~$400 million (and rising)

PESTICIDES

Pesticide labels exist to protect…

- the applicator
- organisms being treated
- surrounding environment (everything from adjacent plants to ground water)

PESTICIDES

READ THE LABELS (BEFORE)

- Buying the pesticide
- Storing the pesticide
- Mixing and applying the pesticide
- Disposing of unused pesticide and empty containers

LET'S TALK ABOUT THE "PESTICIDE TREADMILL" R^4

THE FOUR "R'S" OF THE PESTICIDE TREADMILL:

RESURGENCE

REPLACEMENT

RESISTANCE

RESIDUE

1. RESURGENCE

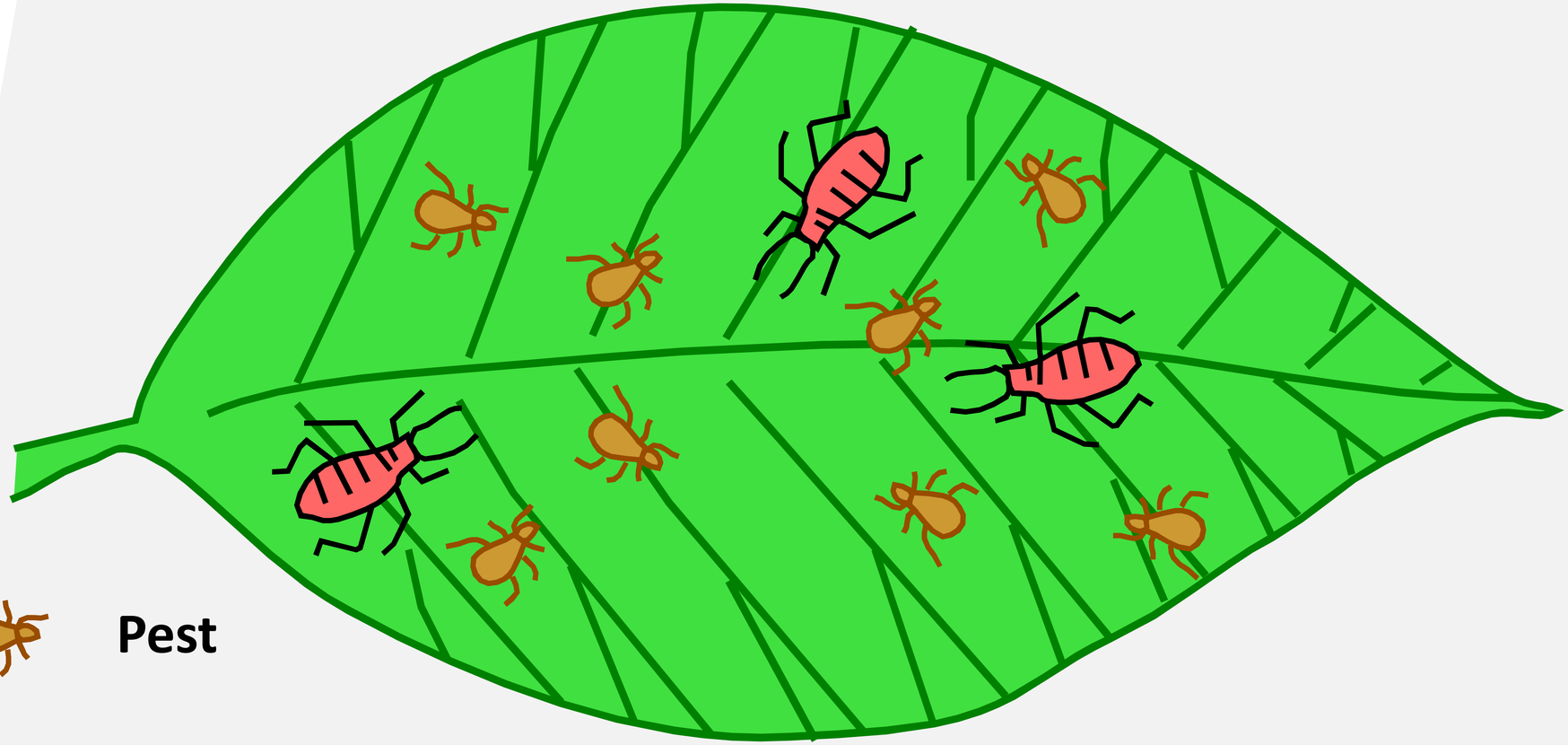
TARGET PEST POPULATION REDUCED WITH INSECTICIDE APPLICATION

BUT THEN…

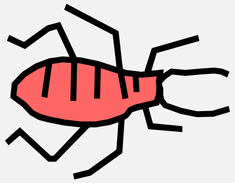
REBOUNDS THE SAME OR HIGHER DENSITY

GOOD EXAMPLE: SPIDER MITES

1. RESURGENCE

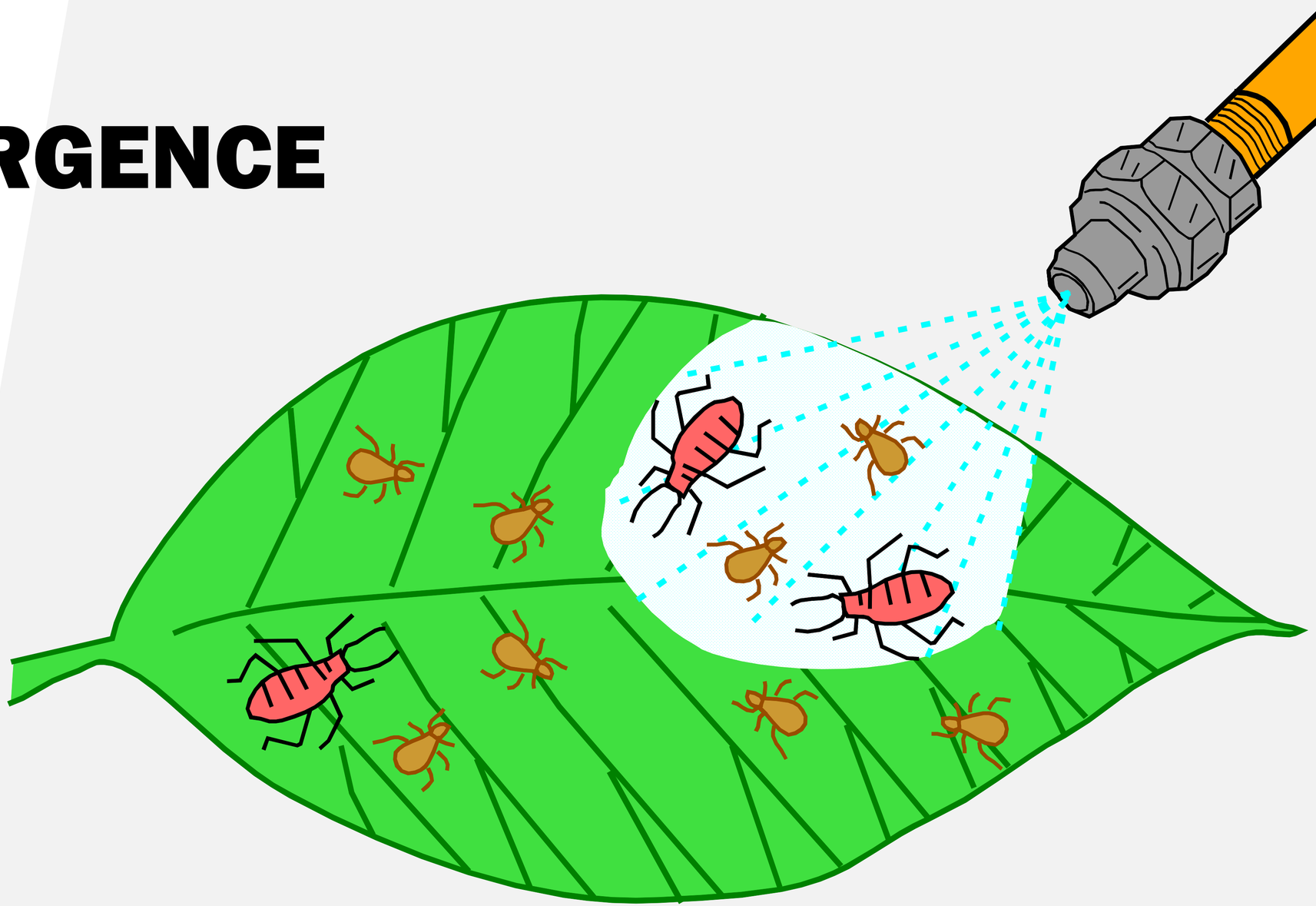


Pest



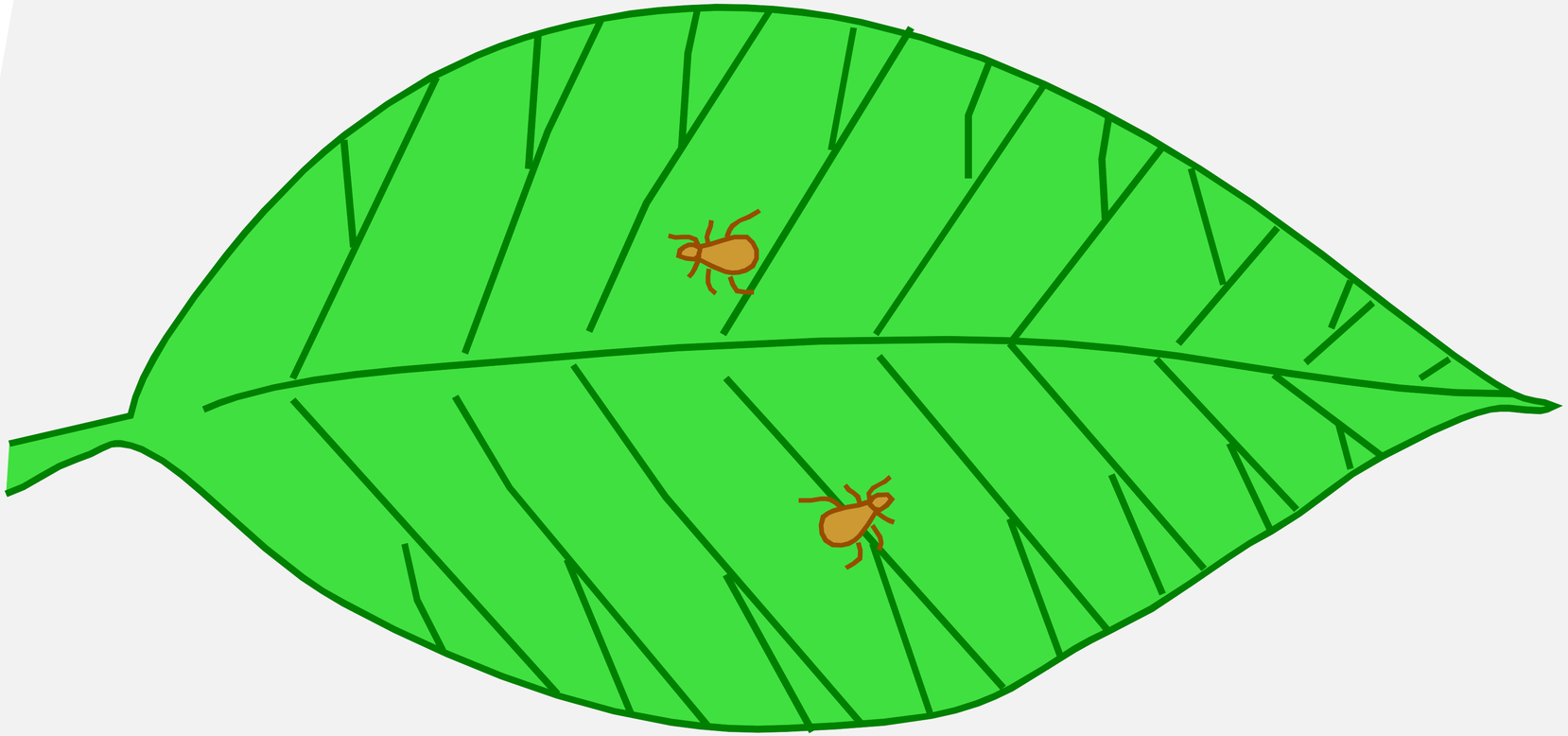
Natural Enemy

RESURGENCE

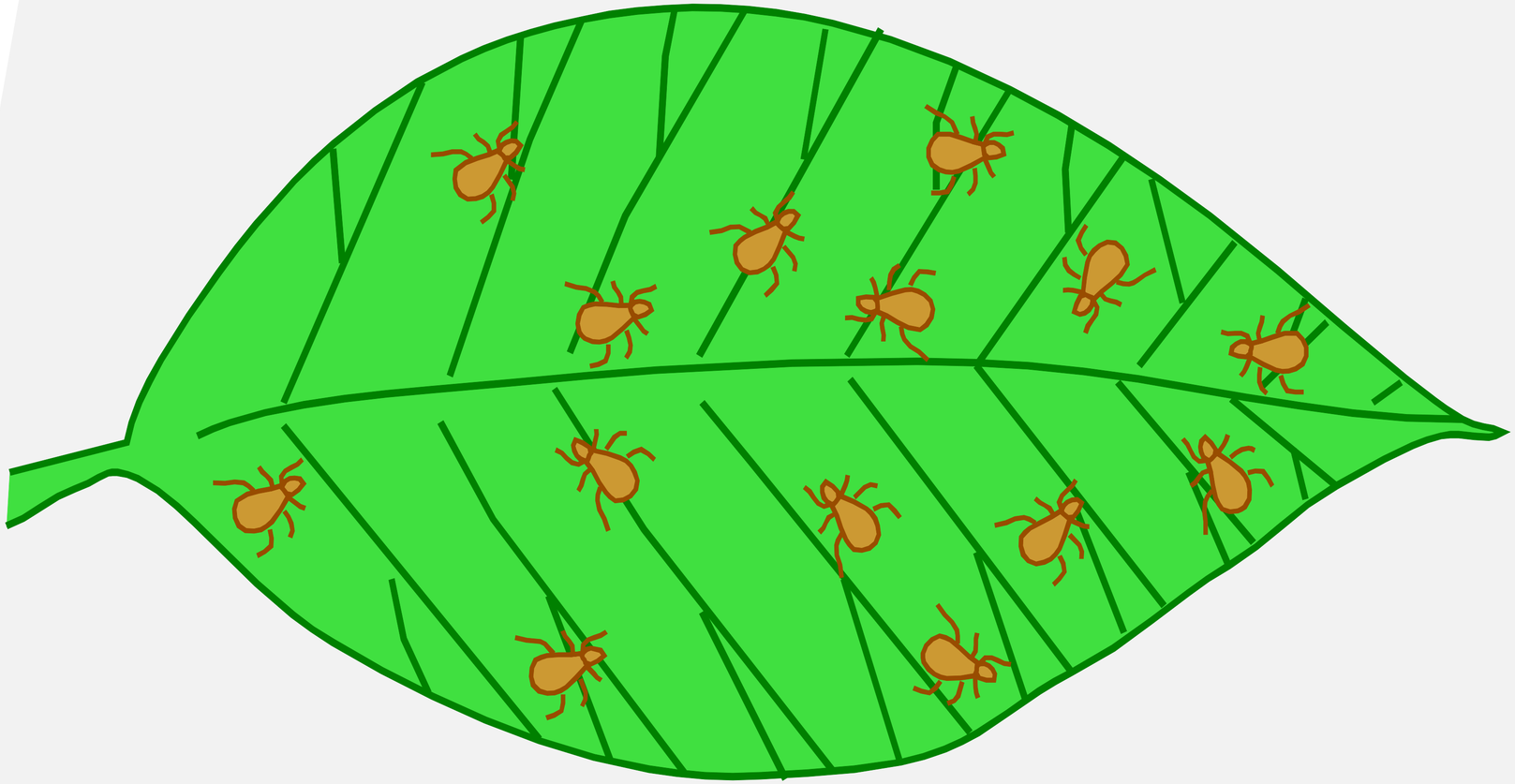


What do you expect to occur to pest population?
Natural enemy population?

RESURGENCE



RESURGENCE



1. RESURGENCE

A FEW MECHANISMS BEHIND RESURGENCE

1) DESTRUCTION OF NATURAL ENEMIES

DIRECT TOXICITY TO INSECTICIDE (PREDATOR/PARASITOID SPECIES COMPLEXES)

INDIRECT MORTALITY (E.G. NO FOOD FOR PREDATORS ☹)

2) HOMOLIGOSIS

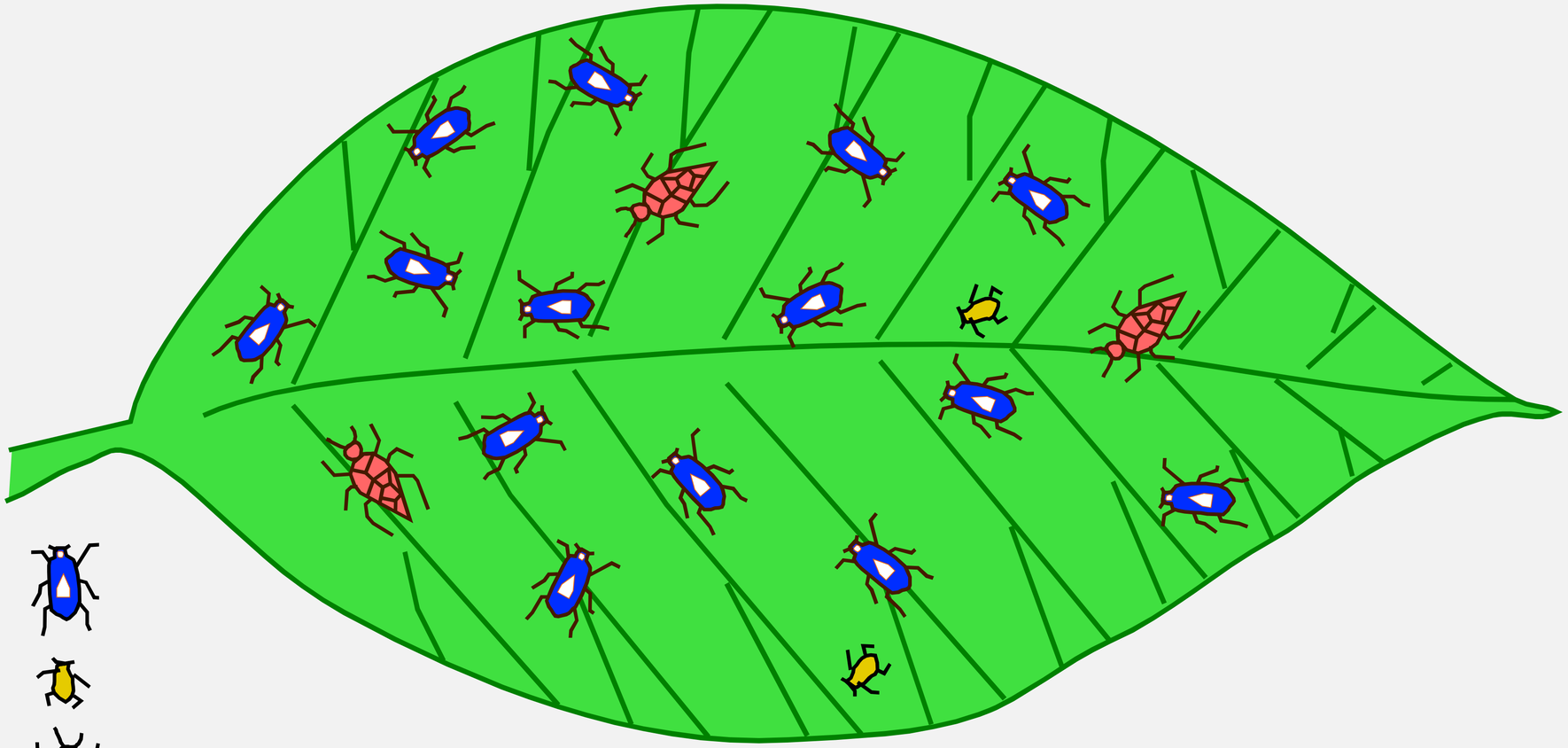
SUB-LETHAL DOSES TO PEST POPULATION (EXAMPLE: APHIDS/SPIDER MITES) STIMULATES REPRODUCTIVE RATE (CHEMICAL ACTS AS HORMONAL STIMULANT)

2. REPLACEMENT

AKA “SECONDARY PEST OUTBREAK”

A SECONDARY (OFTEN NON-ECONOMIC) PEST REPLACES THE TARGET PEST AFTER AN APPLICATION

REPLACEMENT

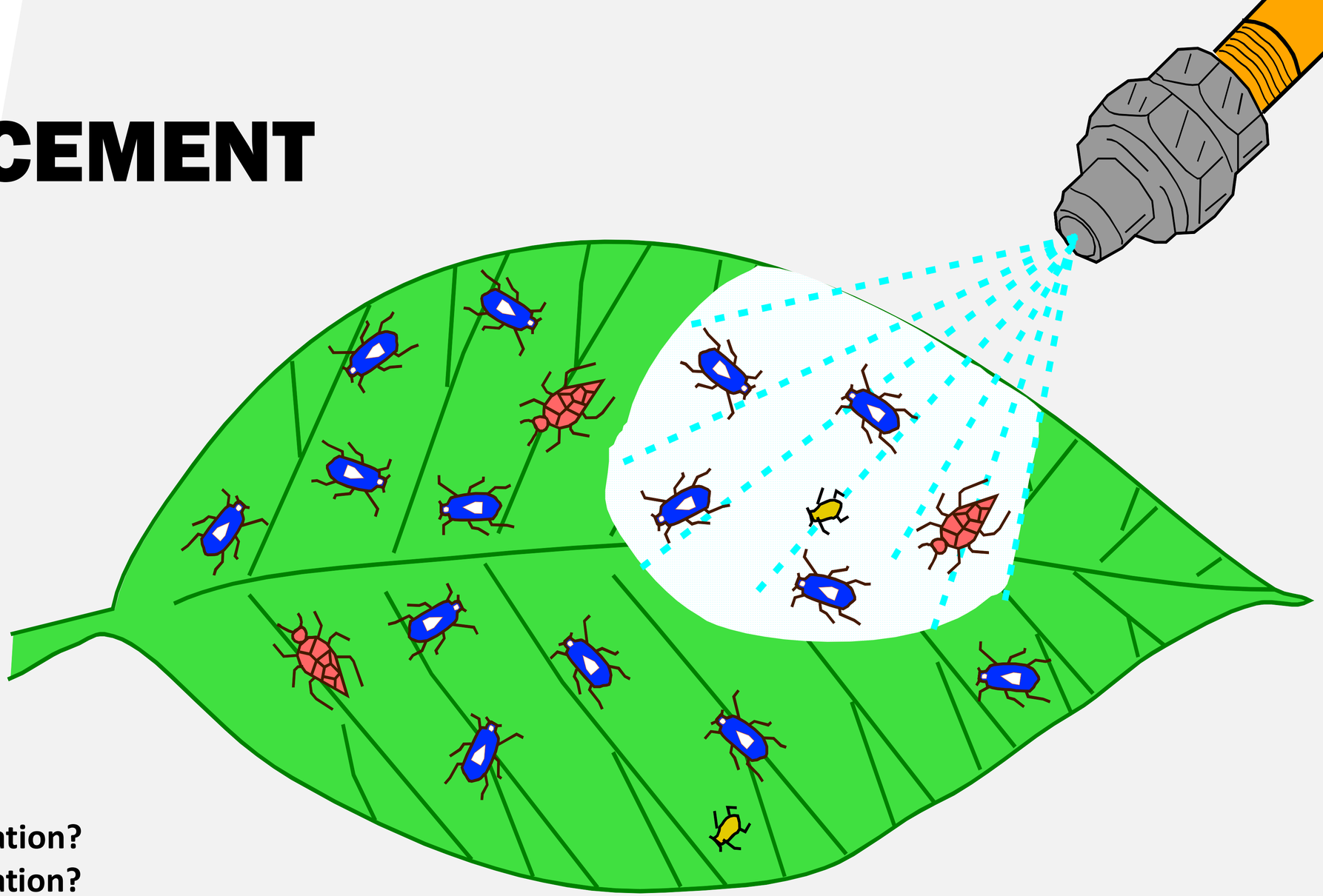


Main pest

Minor pest

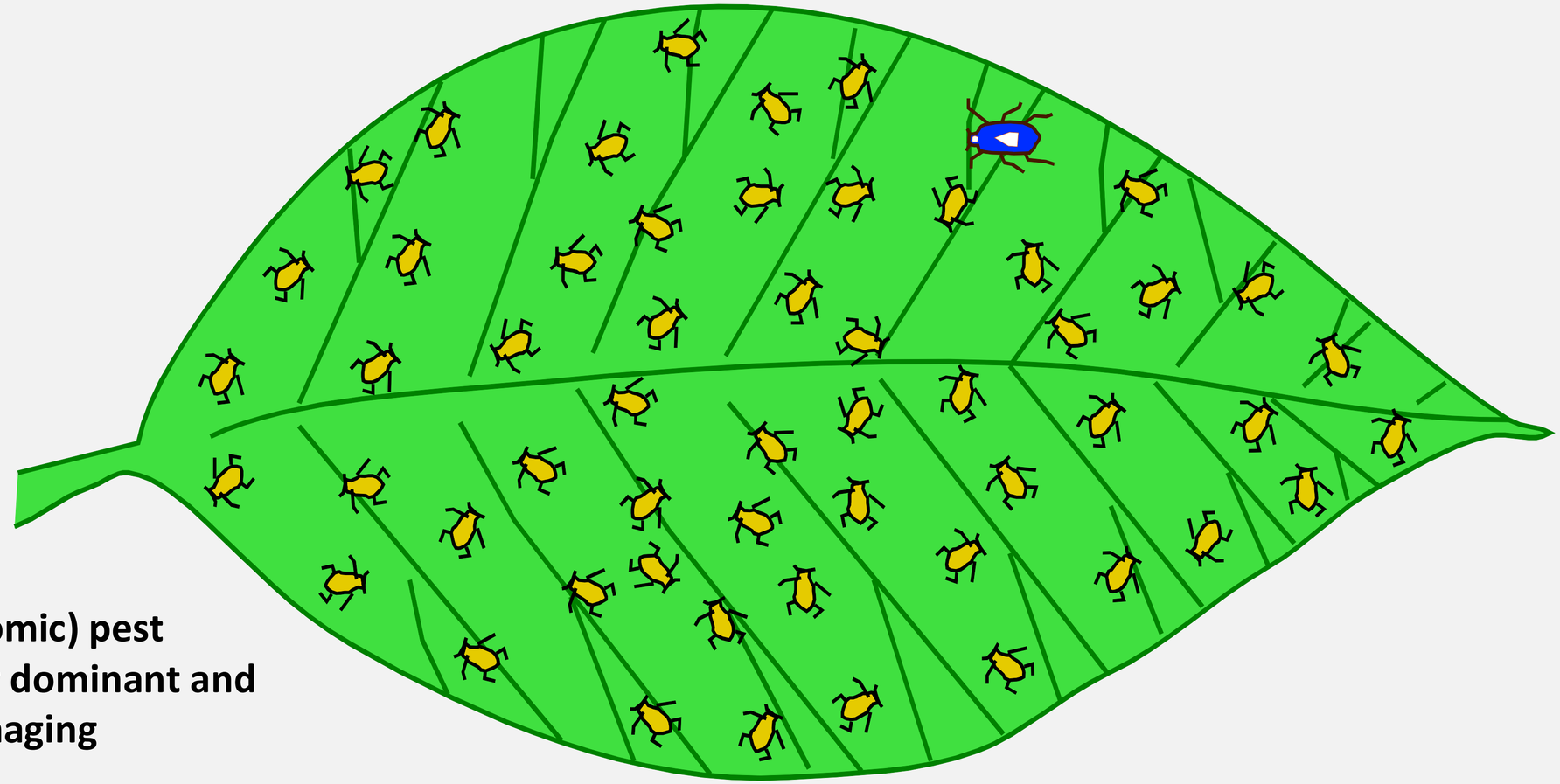
Natural enemy

REPLACEMENT



Target pest population?
Minor pest population?
Natural enemy population?

REPLACEMENT



Minor (non-economic) pest population is now dominant and economically damaging

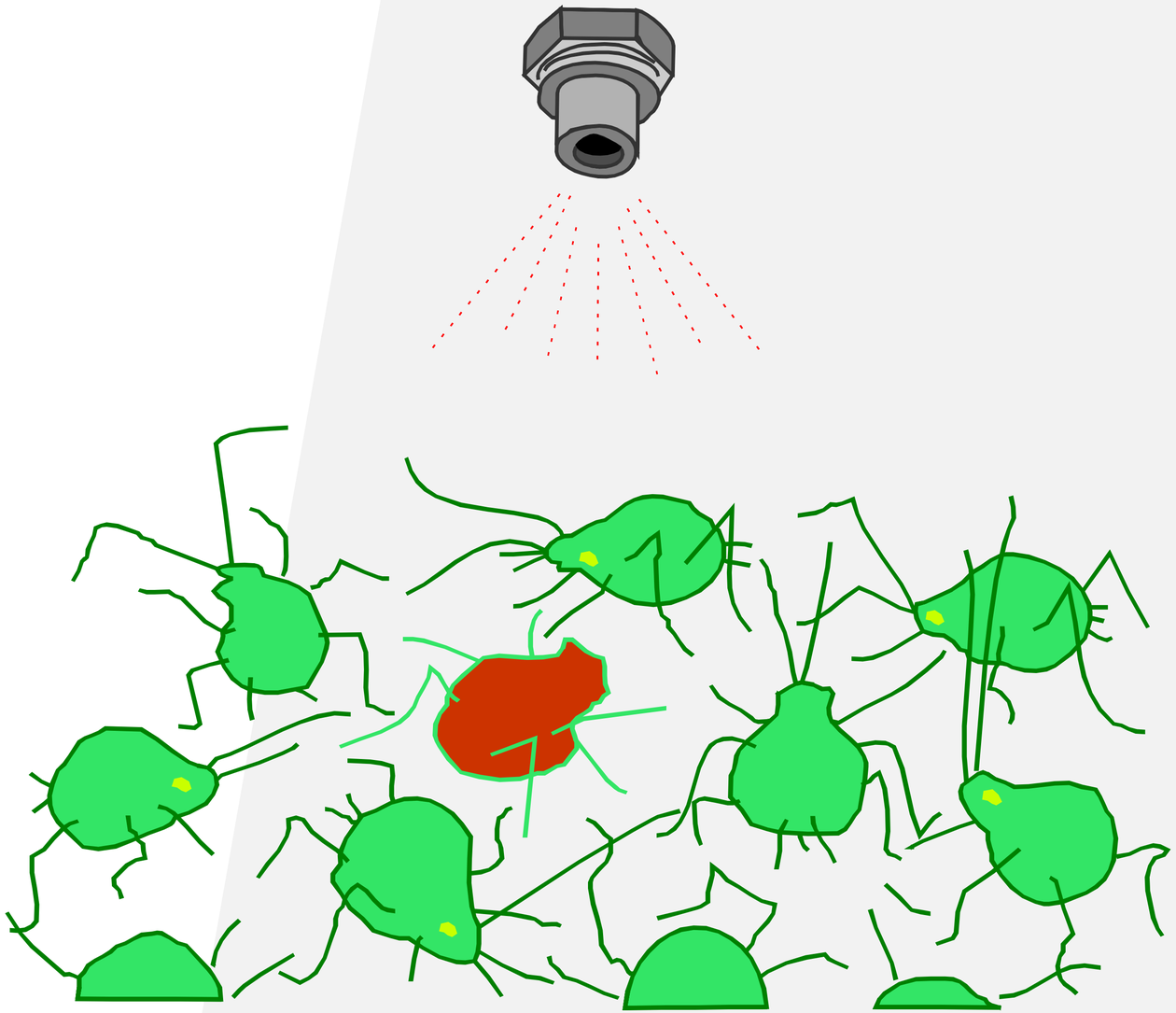
Why?

3. RESISTANCE

Resistance: heritable (genetically pre-determined) ability of a population to survive an insecticide dose that would be lethal to “normal” population

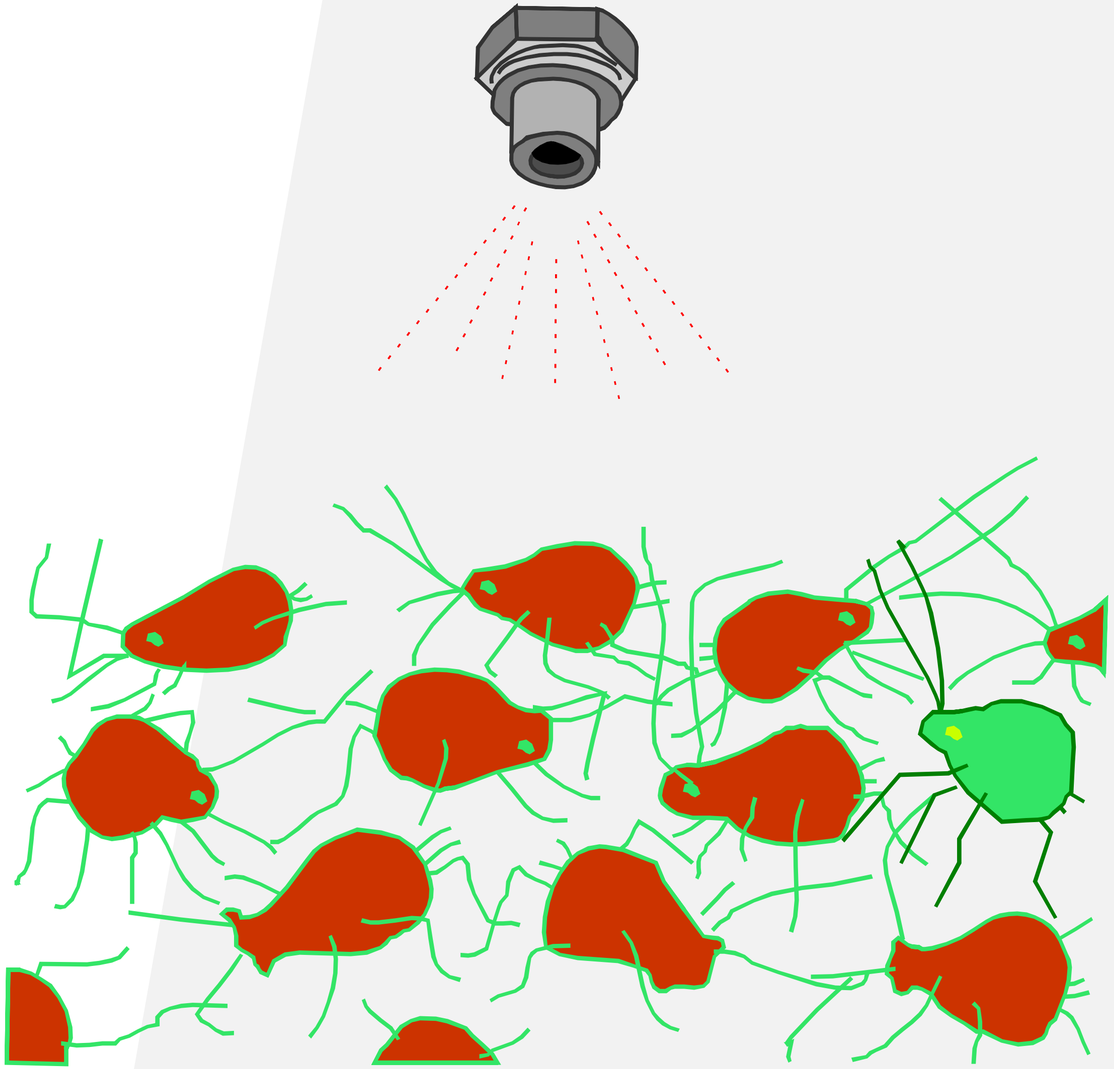
RESISTANCE – HOW DOES IT HAPPEN?

RESISTANCE – HOW DOES IT HAPPEN?



Repeated use of the same mode of action

RESISTANCE – HOW DOES IT HAPPEN?



We are selecting for those resistant individuals who reproduce… increasing the resistant population and the genetics being passed on

RESISTANCE – MECHANISMS

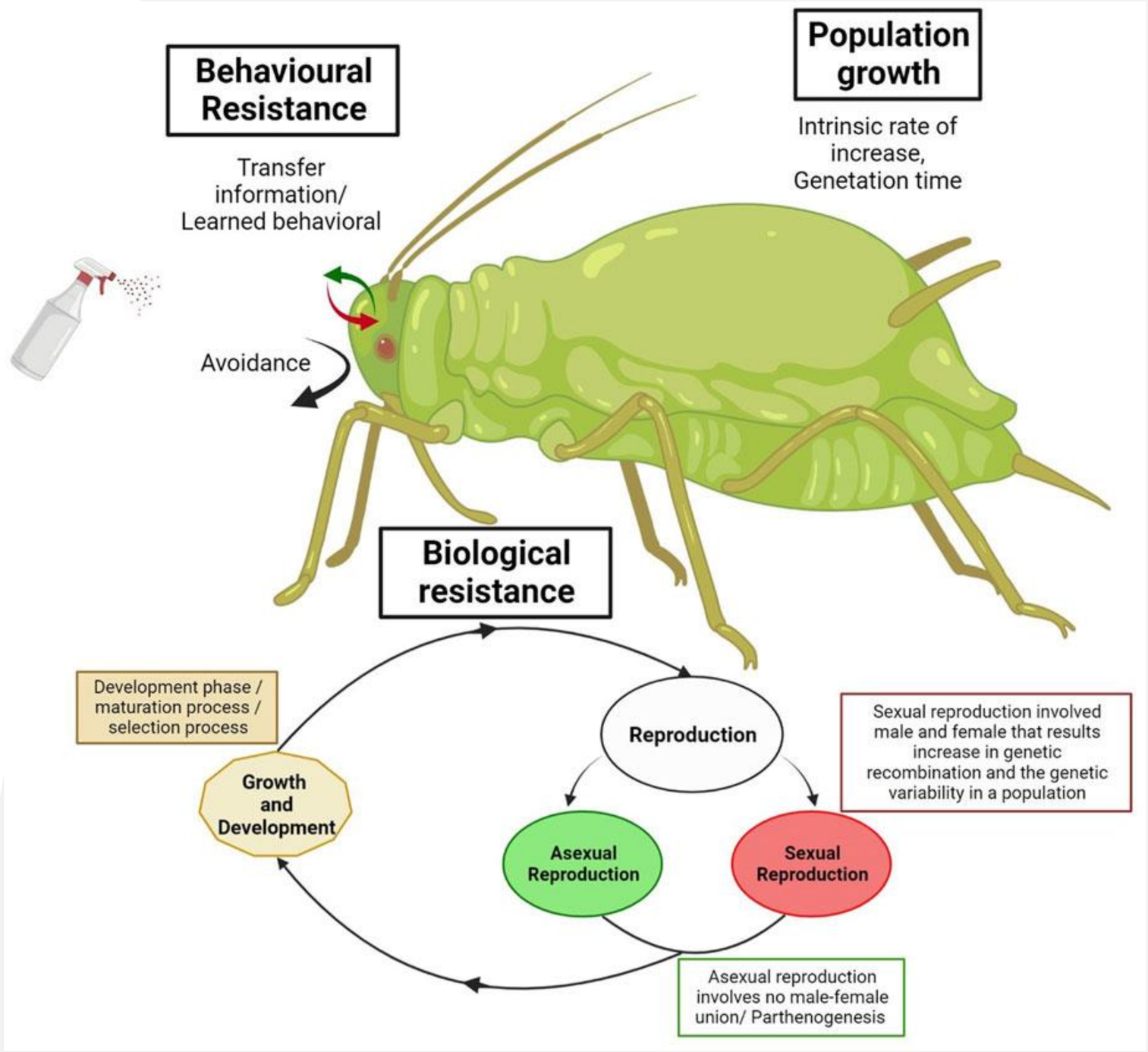


FIGURE 1. Schematic diagram of the biological and behavioral mechanisms of insecticide resistance in invasive insects.

Siddiqui et al. 2023

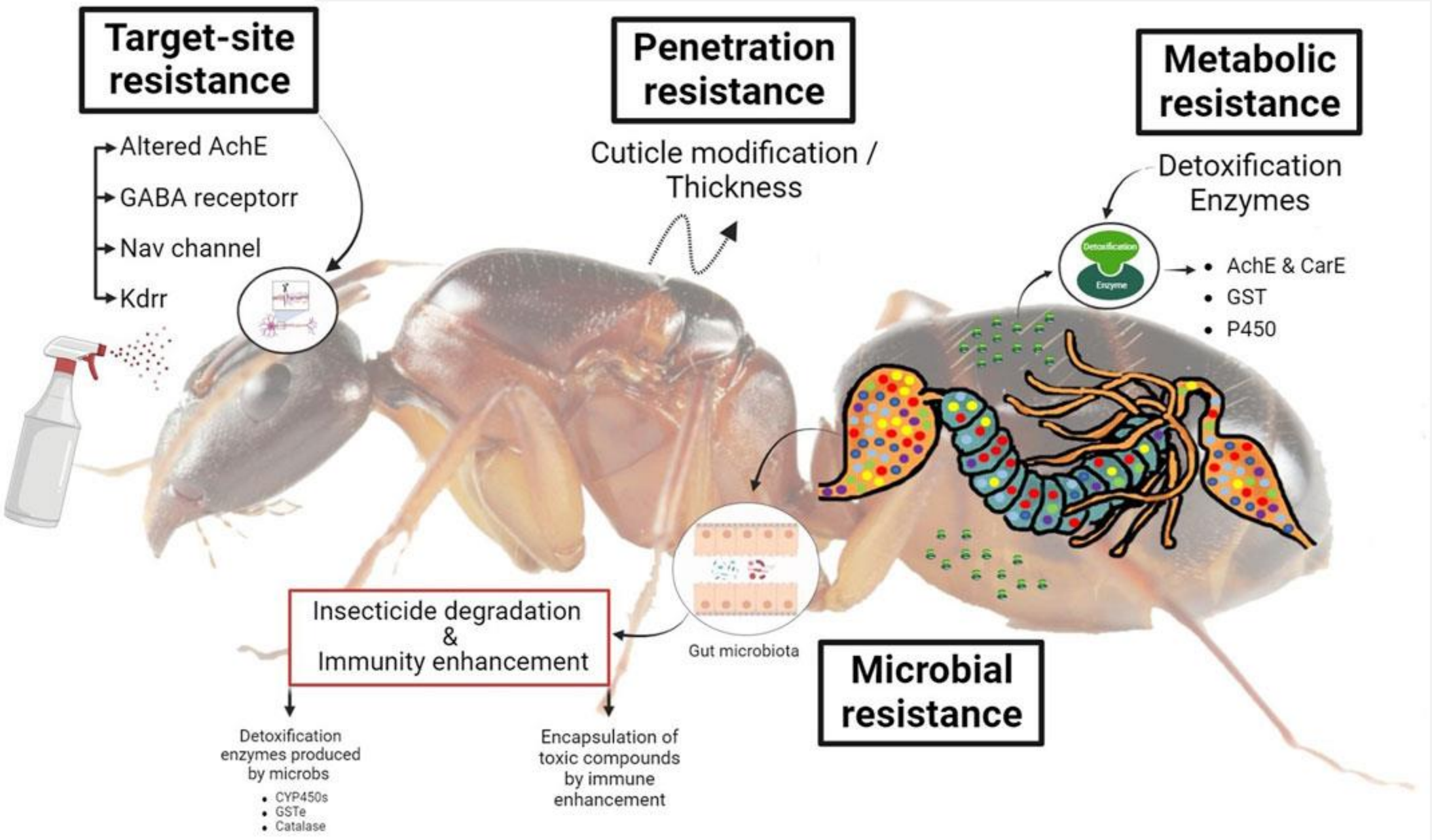


FIGURE 2. A schematic diagram represents the role of enzymes and gut microbiota in pesticide detoxification in invasive ants.

Siddiqui et al. 2023

RESISTANCE

PESTS MAY ALSO HAVE CROSS-RESISTANCE OR MULTIPLE RESISTANCE MECHANISMS

CROSS-RESISTANCE: RESISTANCE TO PESTICIDES W/ SAME MODE OF ACTION

MULTIPLE RESISTANCE: RESISTANCE TO PESTICIDES W/ DIFFERENT MODES OF ACTION… MORE THAN 1 RESISTANCE MECHANISM AT PLAY

Gould F. et. al. 2018. Wicked evolution: Can we add the sociobiological dilemma of pesticide resistance? Science. Vol. 360: 6390, pp. 728-732.

RESISTANCE

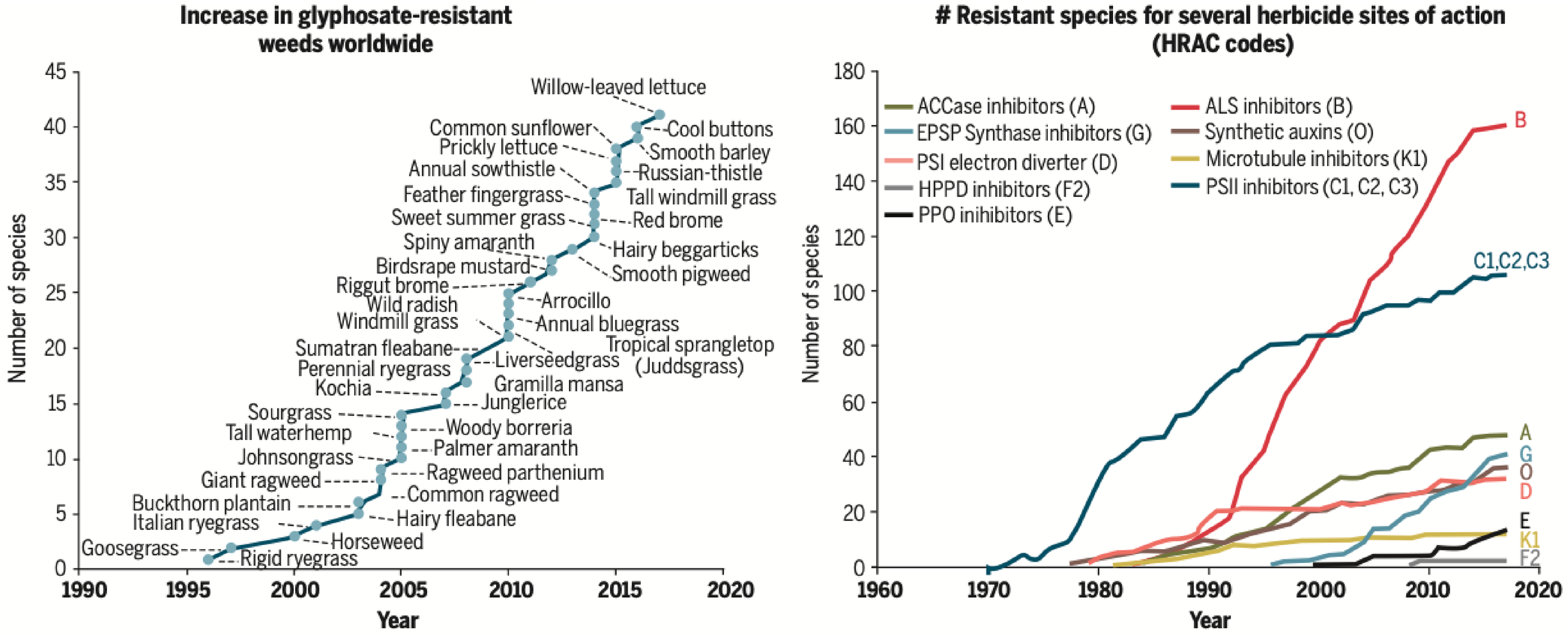


Fig. 1. Weed species with resistance to herbicides. (**Left**) Cumulative number of weed species with resistance to glyphosate. (**Right**) Cumulative number of weed species with resistance to herbicides in the major mechanism of action groupings.

RESIDUES – THE "4TH" R IN THE PESTICIDE TREADMILL

PESTICIDE FATES IN THE ENVIRONMENT… THE RESIDUES:

BIOCONCENTRATION

BIOACCUMULATION

BIOMAGNIFICATION

BIOCONCENTRATION

LONG-TERM STORAGE AND INCREASING CONCENTRATIONS OF A CHEMICAL WITHIN THE BODY FAT OF INDIVIDUAL ORGANISMS VIA DIRECT UPTAKE FROM THE ENVIRONMENT

(EXAMPLE: ORGANOCHLORINES)

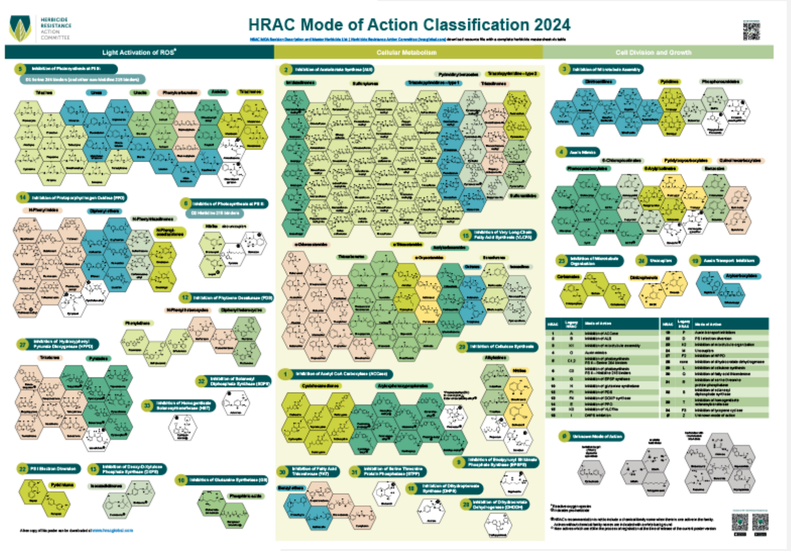
BIOACCUMULATION

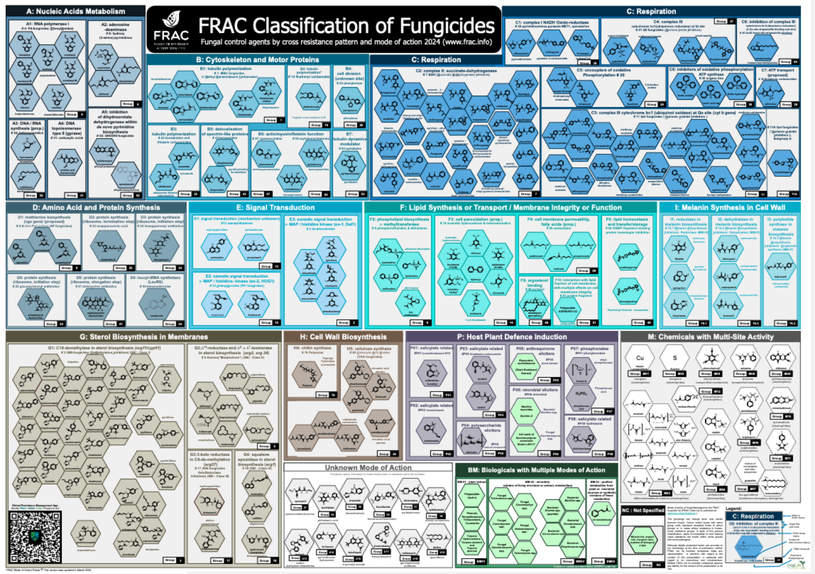
LONG-TERM STORAGE AND INCREASING CONCENTRATIONS OF A CHEMICAL WITHIN THE BODY FAT OF INDIVIDUAL ORGANISMS VIA UPTAKE FROM FOOD

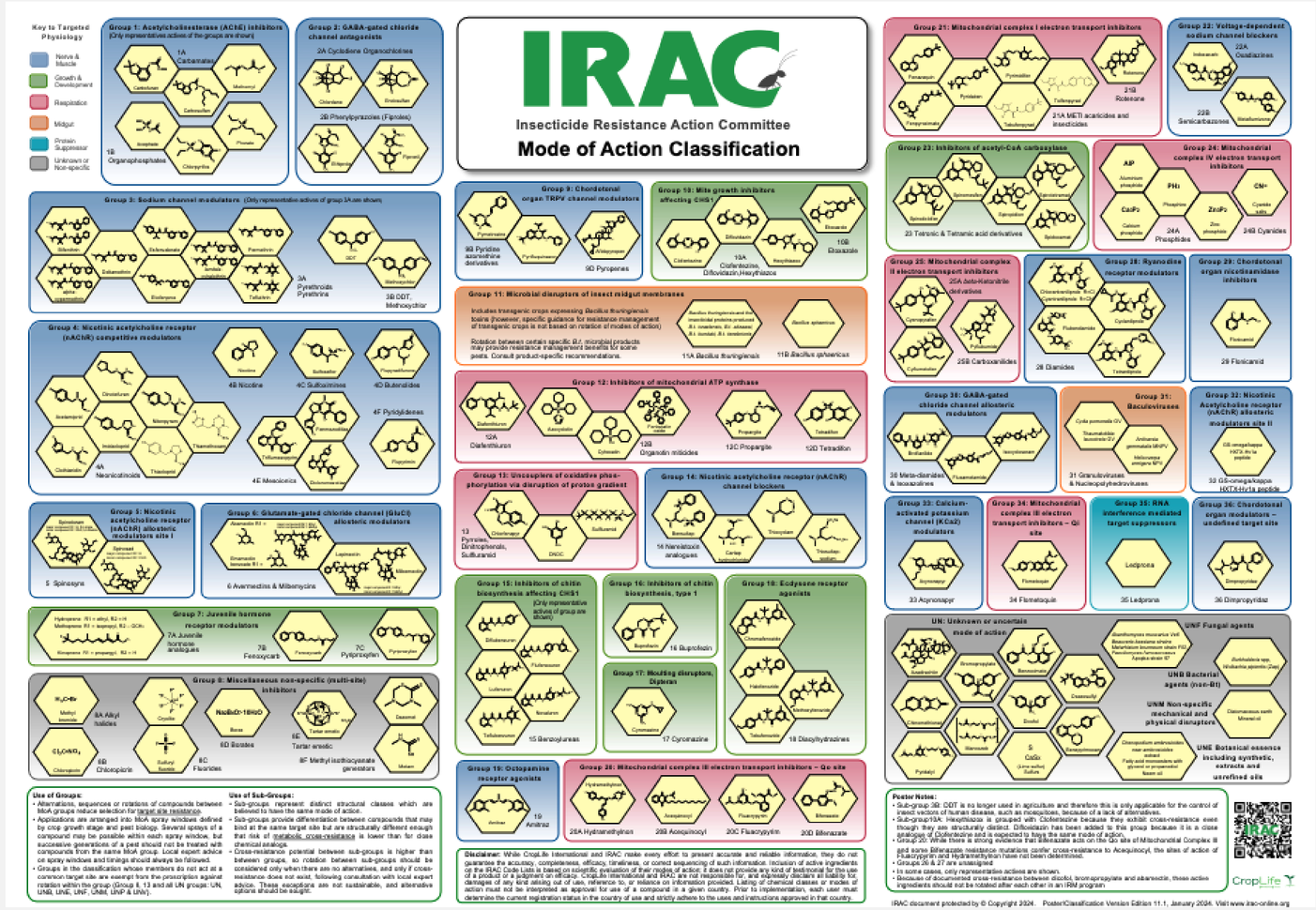
BIOMAGNIFICATION

EVER-INCREASING BIOACCUMULATION IN POPULATIONS ORGANIZED AS ECOLOGICAL FOOD CHAINS

RESISTANCE AND ORGANIZATIONS…







HRAC, FRAC & IRAC Switch MOA's!

CASE STUDY & FORMULATING AN IPM PLAN

You

STEP 1: MONITORING PESTS

1.1 MAKE A LIST OF COMMON PESTS FOR YOUR CROP, AND PESTS YOU HAVE OBSERVED IN THE AREA IN THE PAST.

UNSURE? SEE PNW HANDBOOK

- **Codling Moth (Cydia pomonella)**: The most destructive pest, causing damage to apples by laying eggs on the fruit, which hatch into larvae that burrow into the apple.
- **Aphids (Aphis pomi)**: Aphids suck sap from the leaves and can transmit viruses, while also causing curling and stunting of leaves.
- **Apple Maggot (Rhagoletis pomonella)**: The larvae of this fly feed on the fruit, creating tunnels that degrade fruit quality.
- **Spider Mites (Tetranychus urticae)**: These tiny arachnids feed on the undersides of leaves, leading to yellowing and premature leaf drop.
- **Scale Insects (Various species)**: These pests suck sap from tree trunks and branches, weakening the trees and reducing vigor.

STEP 1: MONITORING PESTS

1.2 SELECT MONITORING TACTICS

1. **Pheromone Traps**: These are used to capture adult codling moths. The number of moths caught per week is monitored to predict the timing of egg-laying and the potential risk to the fruit.
2. **Sticky Traps**: These traps monitor aphid and apple maggot populations by trapping flying insects.
3. **Visual Inspections**: Regular walk-throughs by the orchard staff involve checking trees for signs of pest damage, such as fruit with entry holes (codling moth), yellowing leaves (spider mites), or sticky residue (aphids).
4. **Degree-Day Calculations**: For codling moths, degree-day calculations help predict when larvae will emerge and when control measures should be applied.

STEP 2: DETERMINING THRESHOLDS

For each pest species, economic thresholds are based on several factors, including the pest's life cycle, damage potential, and cost of treatment.

- **Codling Moth**: The economic threshold for codling moths is typically set at 5-8 moths per trap per week during the growing season. If trap counts exceed this threshold, it signals a potential risk to the crop and that treatment should be considered.
- **Aphids**: The economic threshold for aphids is usually 10-15 aphids per leaf, as aphid damage to apple trees can stunt growth and reduce yield.
- **Apple Maggot**: Economic thresholds for apple maggot may be 1-2 flies per trap per week. If trap counts reach or exceed this level, action should be taken before larvae infest the apples.
- **Spider Mites**: The threshold for spider mites varies based on environmental conditions, but typically, if more than 10-15% of leaves show signs of mite damage (stippling), treatment is necessary.
- **Scale Insects**: For scale insects, the economic threshold is often based on visual observations of damage, as well as a percentage of trees affected. If over 30% of trees show signs of scale infestation, control measures should be implemented.

STEP 3. SELECTING TREATMENTS

3.1 Non-Chemical Tactics

- **Cultural Practices**: These practices involve altering the environment to make it less favorable for pests. In the apple orchard, cultural practices might include:
  - **Pruning**: Regular pruning of apple trees to improve air circulation and sunlight penetration reduces the ideal environment for pests like aphids and mites.
  - **Sanitation**: Removing fallen apples and fruit debris to reduce the overwintering sites for pests such as codling moths and apple maggots.
  - **Trap Cropping**: Planting a “trap crop” (like a different variety of apple or another tree species) that is more attractive to pests, such as aphids, can help protect the main crop.

- **Biological Control**: Introducing or encouraging natural predators can help control pest populations. For example:
  - **Beneficial Insects**: Predators like ladybugs can help control aphid populations, while parasitic wasps may be used to target codling moth larvae.
  - **Nematodes**: These microscopic worms can be used to control soil-dwelling pests like root-feeding larvae.

STEP 3. SELECTING TREATMENTS

3.2 Chemical Tactics

Consider…

- **Pest Target**: Ensure that the pesticide targets the specific pest (e.g., codling moth or apple maggot) and does not harm beneficial insects.
- **Environmental Impact**: Choose chemicals that are less harmful to non-target species and the environment.
- **Resistance Management**: Rotate different classes of pesticides to prevent resistance buildup in pest populations.

- **Finding Specific Chemicals…**
  - https://pnwhandbooks.org/

4. FOLLOW UP AFTER TREATMENT

ADDITIONAL MONITORING IS PERFORMED TO DETERMINE THE EFFICACY OF TREATMENT, AND CONTINUE TO EVALUATE PESTS COMPARED TO TREATMENT THRESHOLDS.

REMEMBER! TIMING IS CRUCIAL WHERE TREATMENTS NEED TO COINCIDE WITH SPECIFIC DEVELOPMENTAL STAGES (SUCH AS EGG HATCH OR LARVAL EMERGENCE).

Example Timeline:

1. **May-June**: Monitor codling moth traps and aphid populations.
   - If codling moths exceed the threshold, apply a treatment like **spinosad** or **kaolin clay**.
   - If aphid populations are rising, use **neem oil** or introduce beneficial insects like ladybugs.
2. **July-August**: Continue monitoring apple maggot traps.
   - If apple maggot populations exceed the threshold, consider treatment options.
3. **September**: Evaluate spider mite damage.
   - If significant damage is observed, apply a miticide or increase the introduction of predatory mites.

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QUESTIONS?