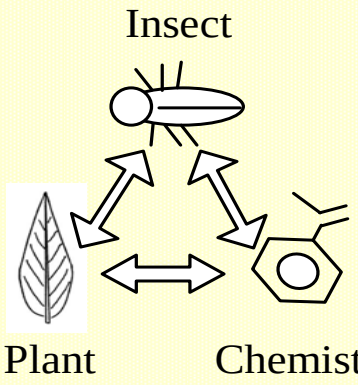
Performance Characteristics of Insecticides for Cherry Pest Management



John C. Wise, Ph.D.

MSU Department of Entomology

Trevor Nichols Research Complex

Toxicology 101

- Toxicology: The science of dealing with the dose and antidotes of poisons

- Paracelsus (1492-1541) is the father of toxicology
  - Formulated revolutionary views on toxicology
  - Realized that poisons were chemicals, not “spirits”
    - Toxicon = toxic agent = chemical agent
    - Determined there were dose-response relationships

“Only the dose is what makes something not a poison”

What makes something a poison?

"All substances are poisons; there is none which is not a poison. The right dose differentiates a poison...."

Paracelsus

(1493-1541)

Which is a true example of a poison?

Woman Dies from Drinking Water.

SACRAMENTO, California (AP) — A woman in a radio station's contest to see how much water she could drink without going to the bathroom died of water intoxication, the coroner's office said Saturday.

44 Toxic Chemicals Pollute Blood of Canadians

Ottawa , Ontario - A cocktail of harmful toxic chemicals has been found inside every person tested in a Canada-wide study, released today by Environmental Defense.

What is a Pesticide?

Historical definition:

"all inclusive word meaning killer of pests."

- The ending "*cide*" comes from the latin "*cida*" meaning killer.

Modern legal definition:

"any substance used for controlling, preventing, destroying, repelling, or mitigating any pest."

How are Pesticides Classified?

Pesticides are generally classified in 3 ways:

1. Based on chemical structures
2. According to their mode of action
3. According to their mode of entry

   i.e.; ingestion, inhalation, contact absorption

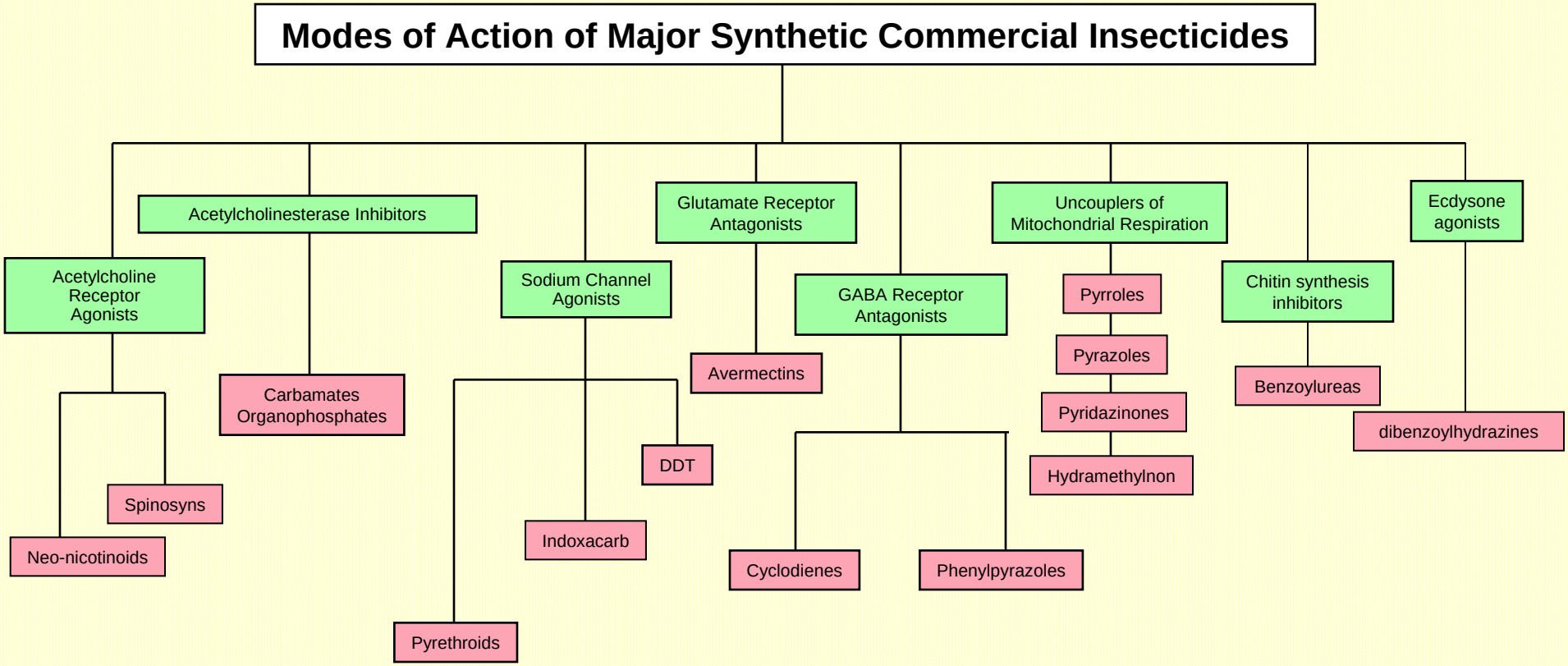
Old and New Insecticide Classes

Conventional Insecticides

- Chlorinated Hydrocarbons
- Organophosphates
- Carbamates
- Synthetic Pyrethroids

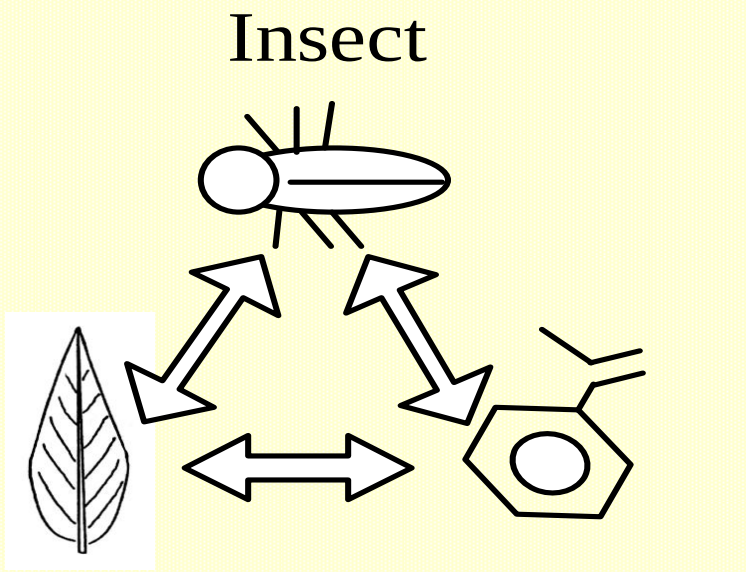
New Insecticides

- Insect Growth Regulators
- Microbials/Botanicals
- Spinosyns
- Neonicotinoids
- Anthranilic Diamides
- Particle Film



“mode of activity” - the field-assessable symptoms of an insecticide’s action on an organism that are responsible for control.

Performance Should be Considered in Relation to the PIC Triad



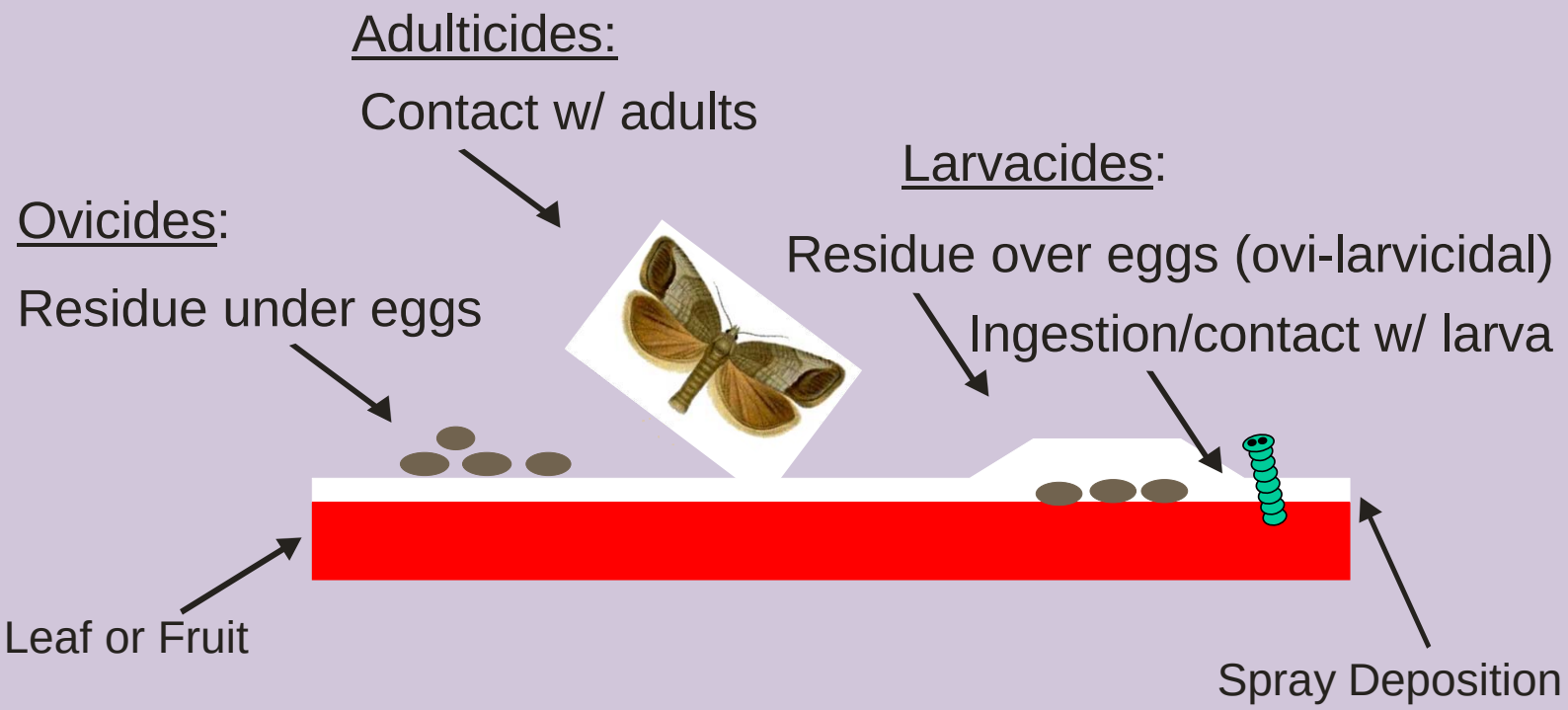
Key Characteristics Leading to Performance?

- Insecticide Activity on Target Pest
- Mode of Exposure
- Physical and Chemical Properties of the Insecticide

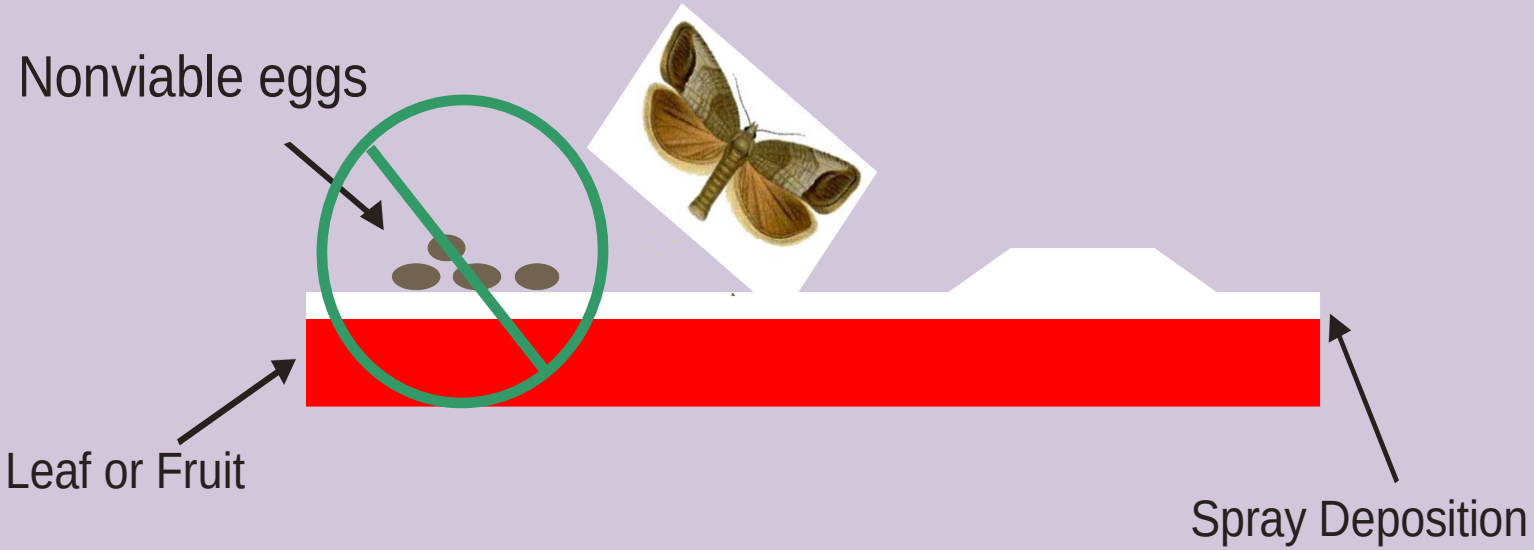
Key Performance Characteristics

- Insecticide Activity on Target Pest :
  - Lethal activity
  - Sub-lethal activity
  - Repellency, anti-feedant and oviposition deterrence

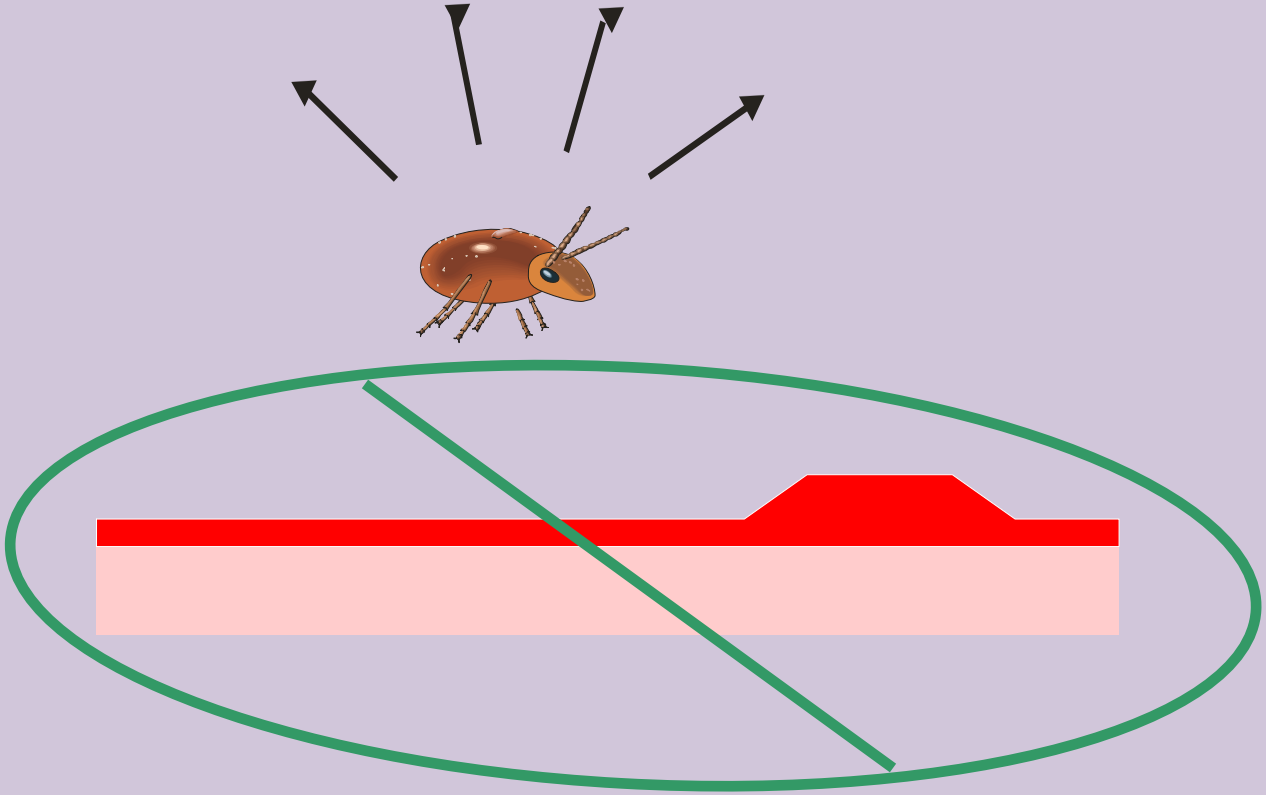
Lethal activity results in direct mortality of the pest



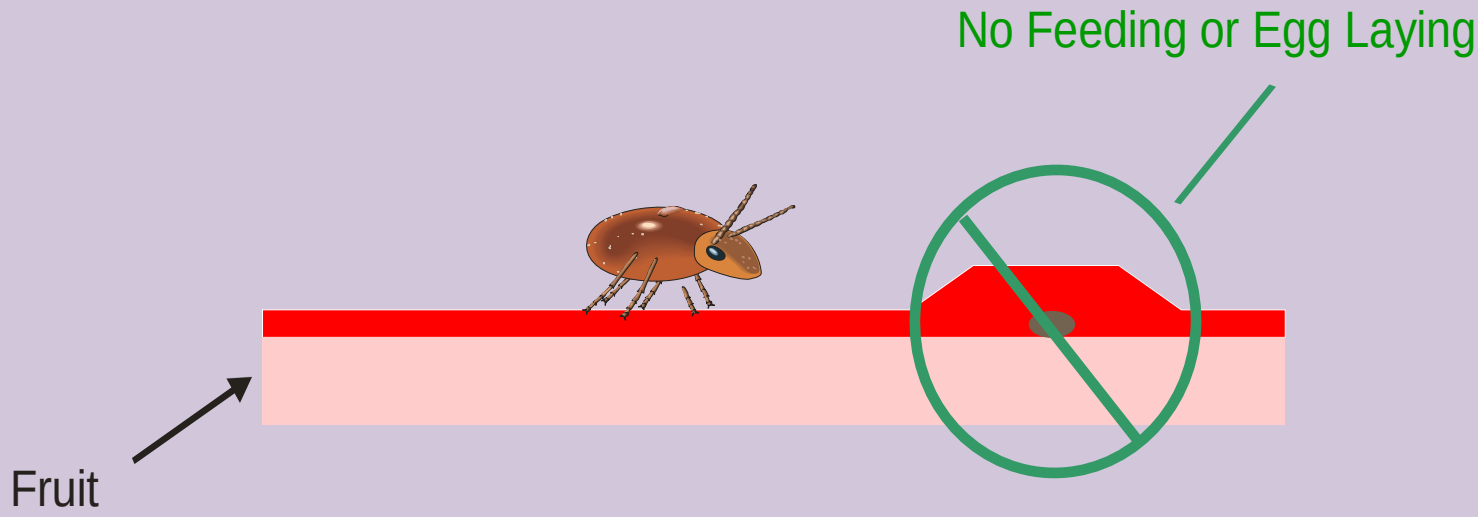
Sub-lethal activity affects the subsequent generation of the pest



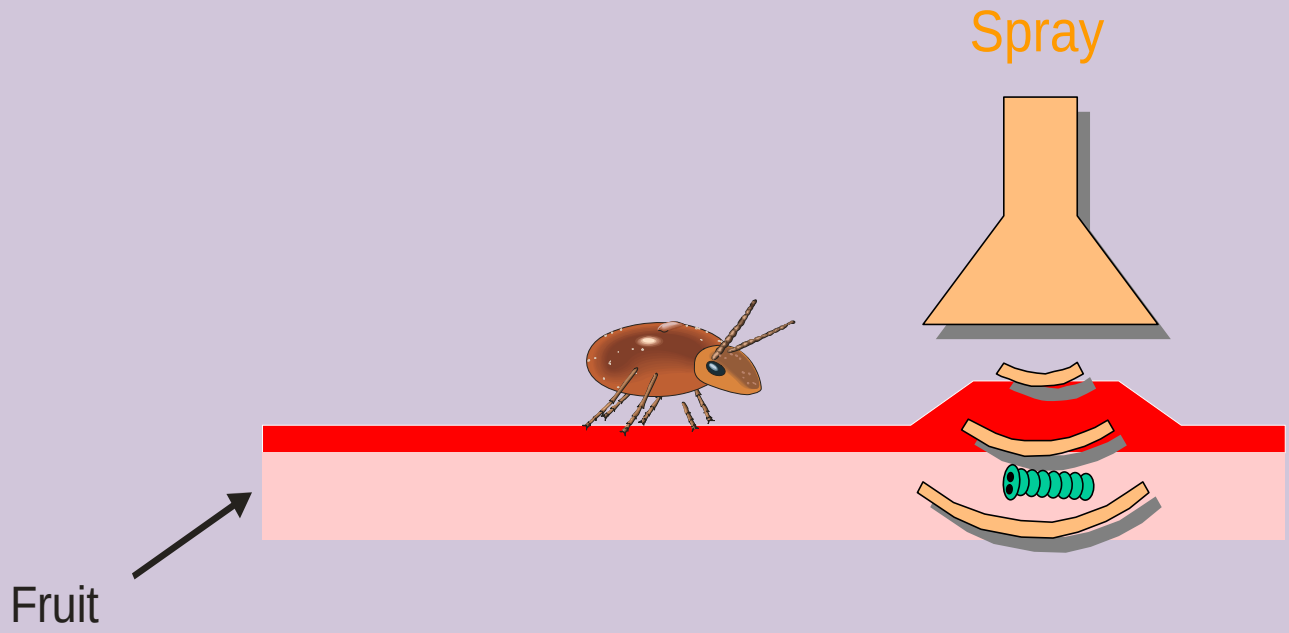
Repellents cause the pest to actively avoid the treated substrate



Antifeedants and Oviposition Deterrants reduce the desirability of the crop as a food source or egg laying host for the pest



Curative activity is lethal action on a pest post-infestation resulting from the transitory penetration of the insecticide into plant tissue.



Chemical Activity Properties

Compound	Mode of Action	Mode of Entry	Insecticidal Activity	Speed of Activity
Organophosphates	Nerve Poison	Contact/Ingest	Lethal	Fast
Carbamates	Nerve Poison	Contact/Ingest	Lethal	Moderate
Pyrethroids	Nerve Poison	Contact/Ingest	Lethal / Repellent	Fast
Insect Growth Regulators	Hormonal	Ingestion / egg contact	Lethal / Sublethal	Slow
Spinosyns	Nerve Poison	Ingestion	Lethal	Fast
Oxadiazines	Nerve Poison	Ingest/contact	Lethal	Slow
Neonicotinoids	Nerve Poison	Contact/Ingest	Lethal / Antifeedant Ovipos deterrence	Moderate
Anthranilic Diamides	Ryanodine Receptor Modulators	Ingestion	Lethal	Slow

Factors Influencing Performance

- Mode of Exposure: The necessary contact in time and space between the insecticide and target pest to attain activity.
- Two Dimensions:
  - Spatial
  - Temporal

Mode of Exposure

- Spatial contact
  - Where on the crop must the compound be to attain effective contact with the pest?
  - Varies depending on:
    - Insect pest's biology; life stage, behavior, etc.
    - Insecticide mode of activity
    - Crop stage and tree canopy – spray coverage

Spray Coverage Necessary to Control Mobile Adult Life-stage of a Pest

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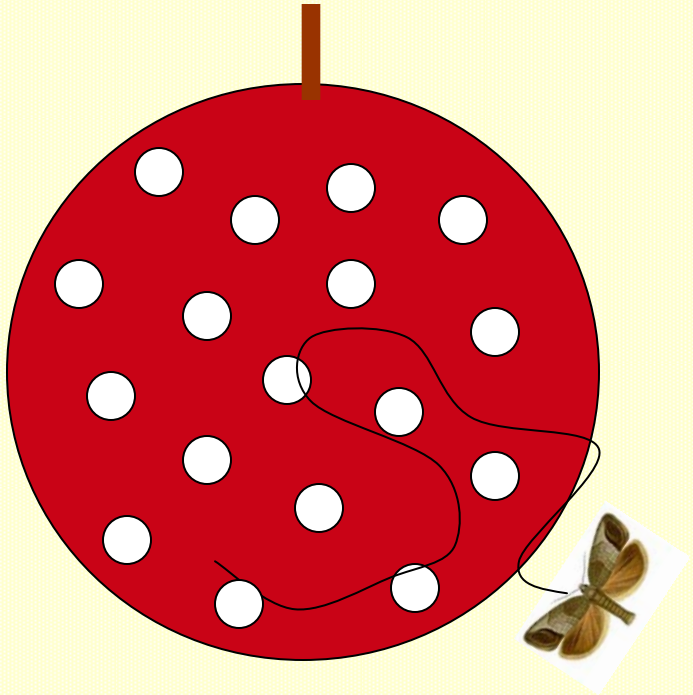
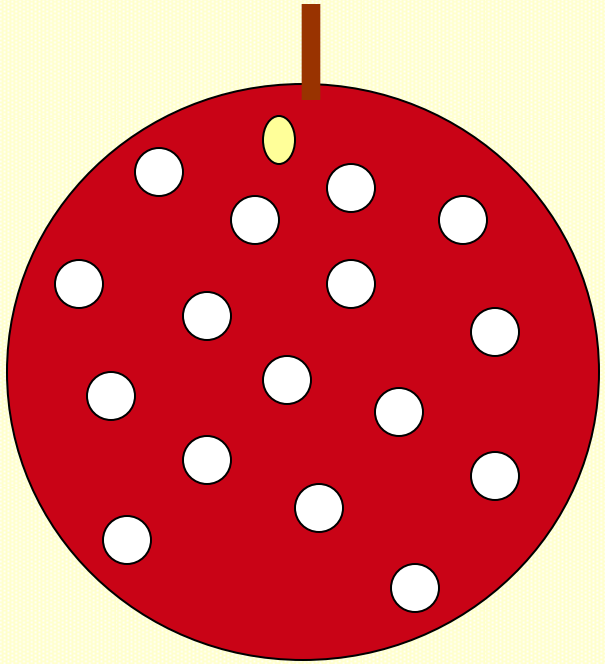
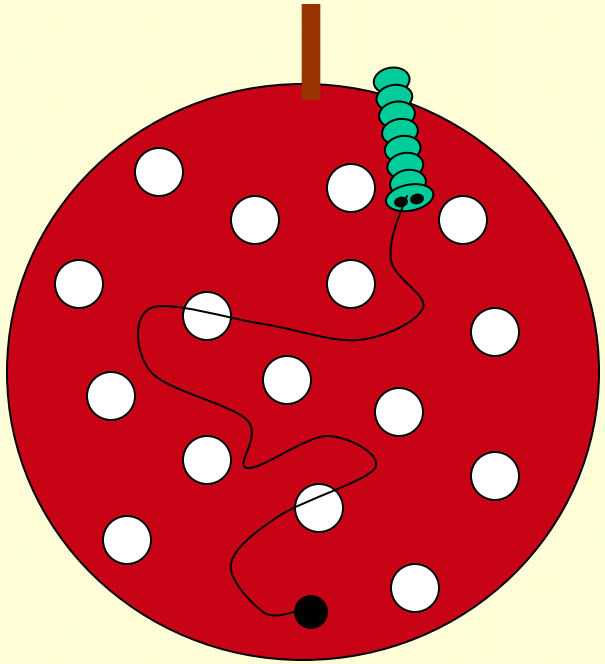


Spray Coverage Necessary to Control the Egg Life-stage of a Pest



Spray Coverage Necessary to Control the Larva Life-stage of Codling Moth



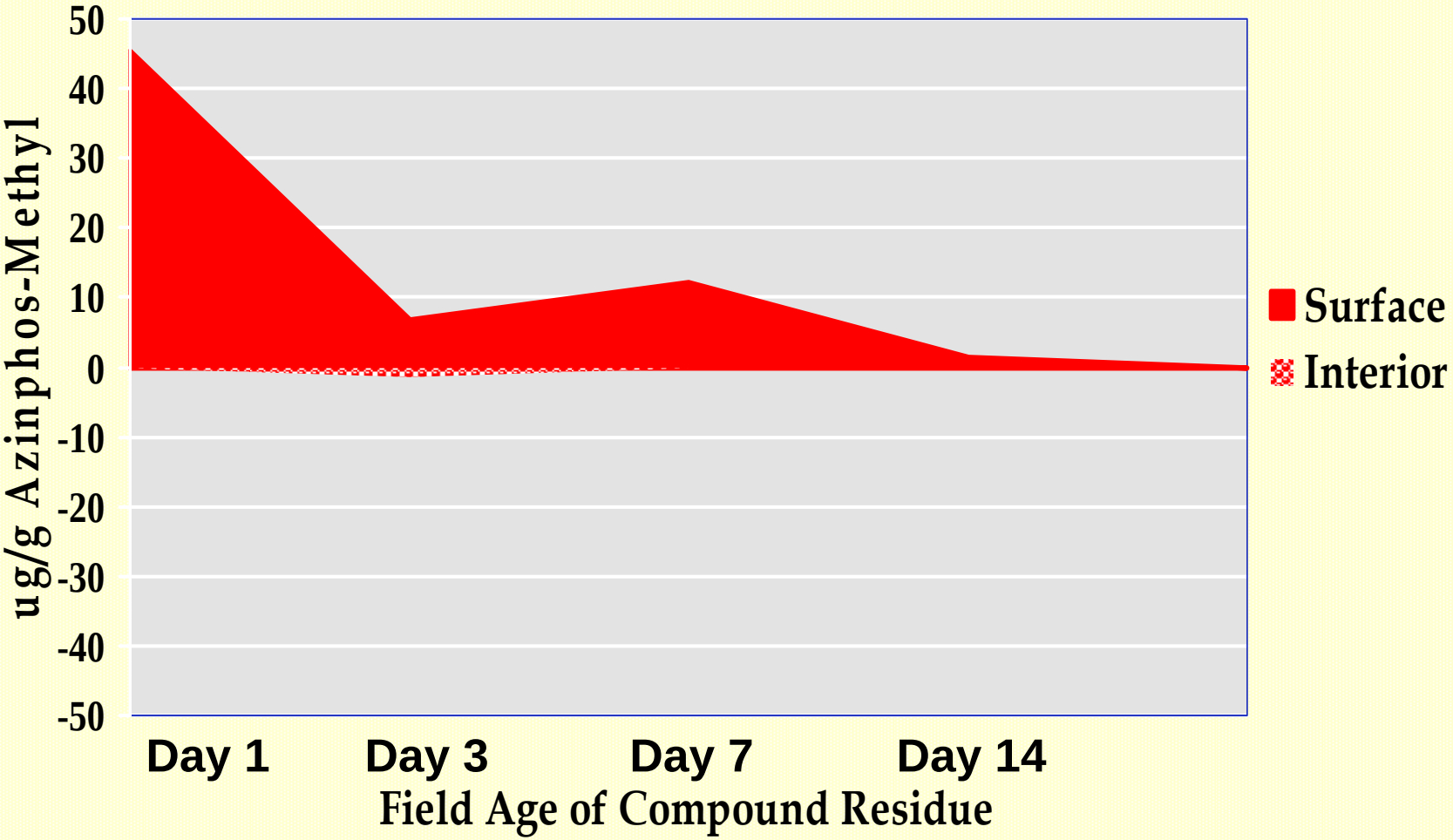
Mode of Exposure

- Temporal contact
  - The fate of the insecticide in relation to a changing environment (plant, climate, etc.)
  - Persistence of residue on the crop over time.
    - Environmental fate (half-life)
    - Chemodynamic behavior
    - Growth dilution
    - Rainfastness

Mode of Exposure

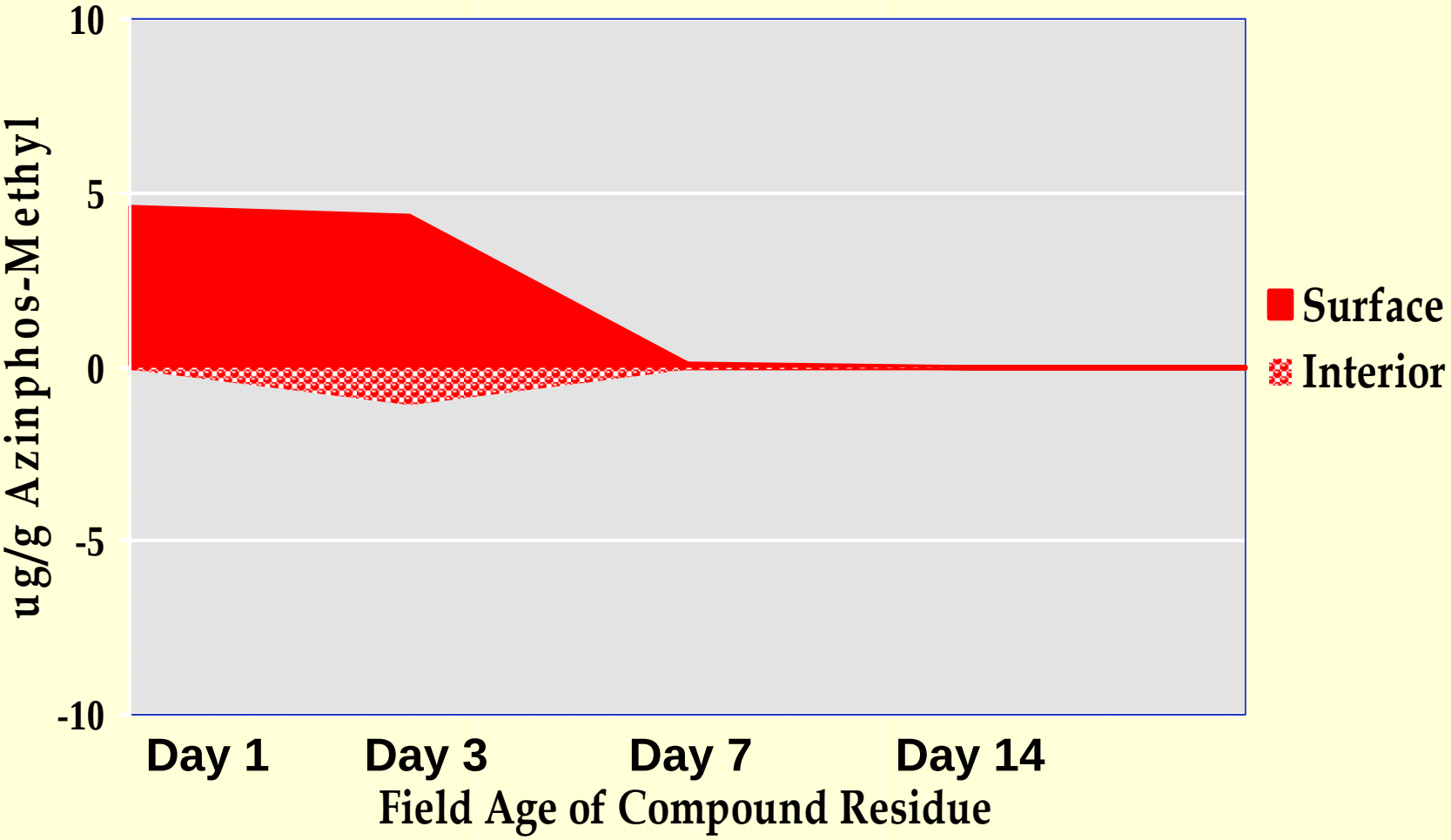
- Environmental fate of an insecticide:
  - photodegradation
  - evaporation
  - hydrolysis (wash-off)
  - biochemical metabolism

Guthion Residue Profile on Cherry Leaves



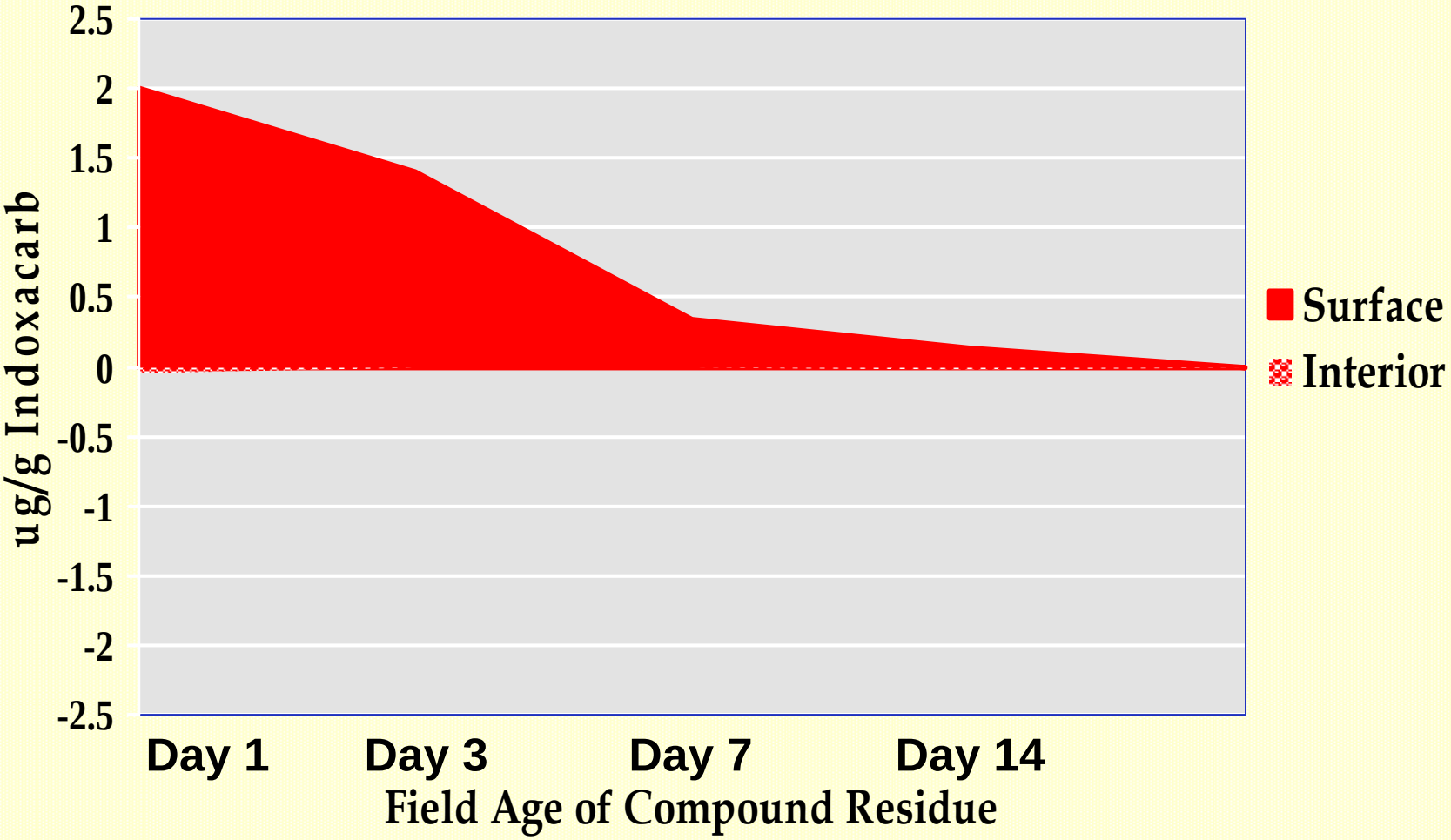
Application timing: shuck-off

Guthion Residue Profile on Cherry Fruit



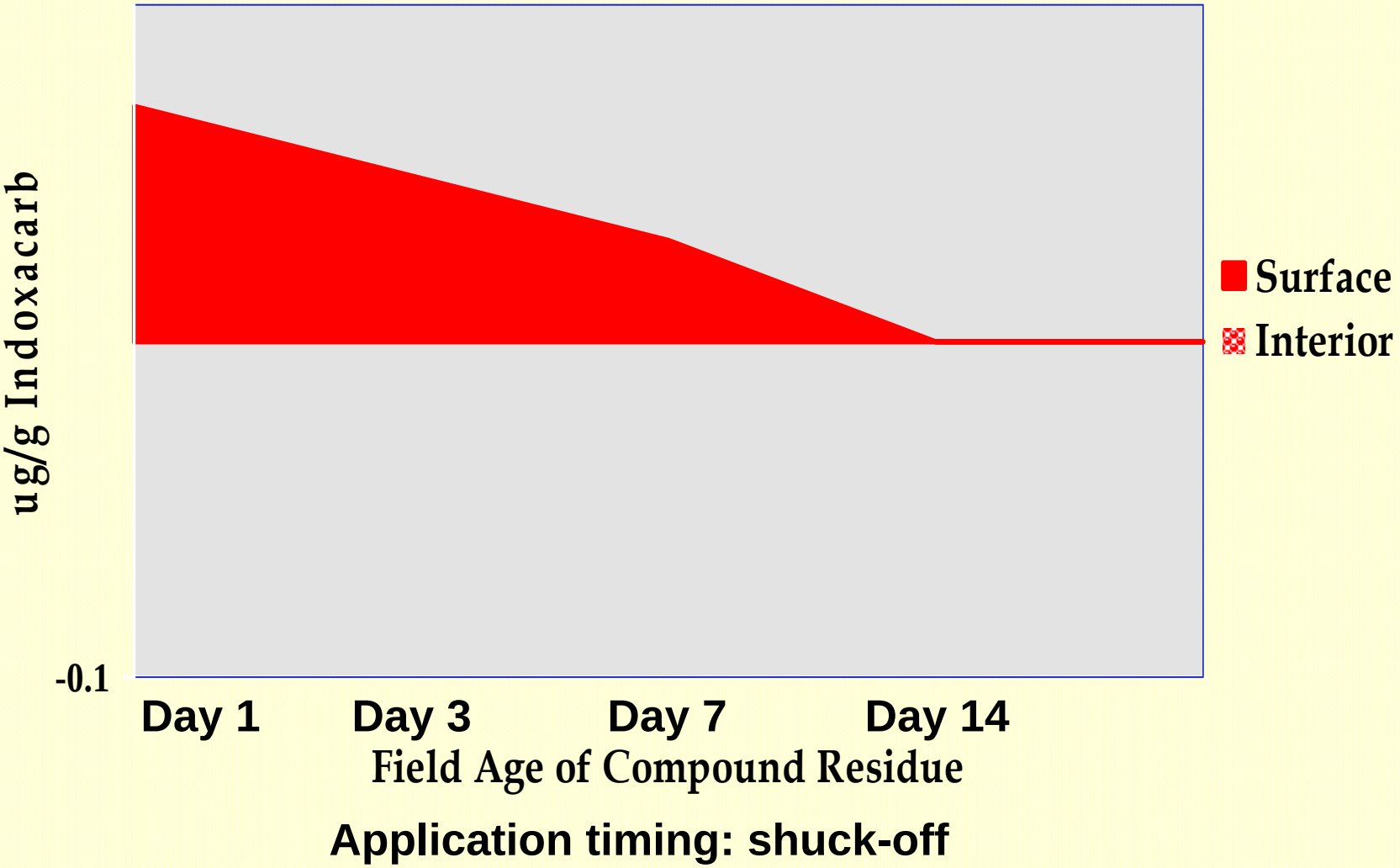
Application timing: shuck-off

Avaunt Residue Profile on Cherry Leaves

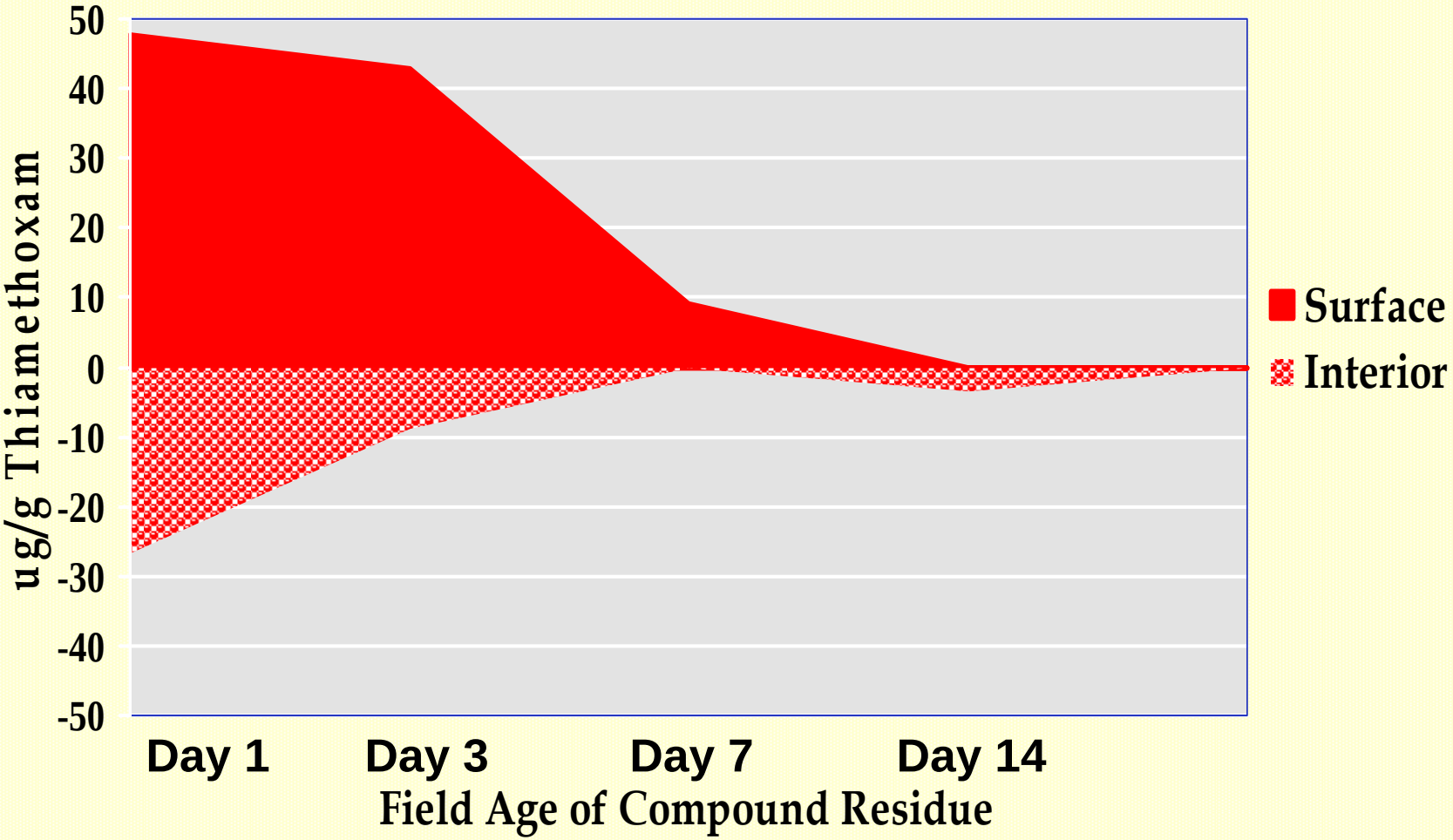


Application timing: shuck-off

Avaunt Residue Profile on Cherry Fruit

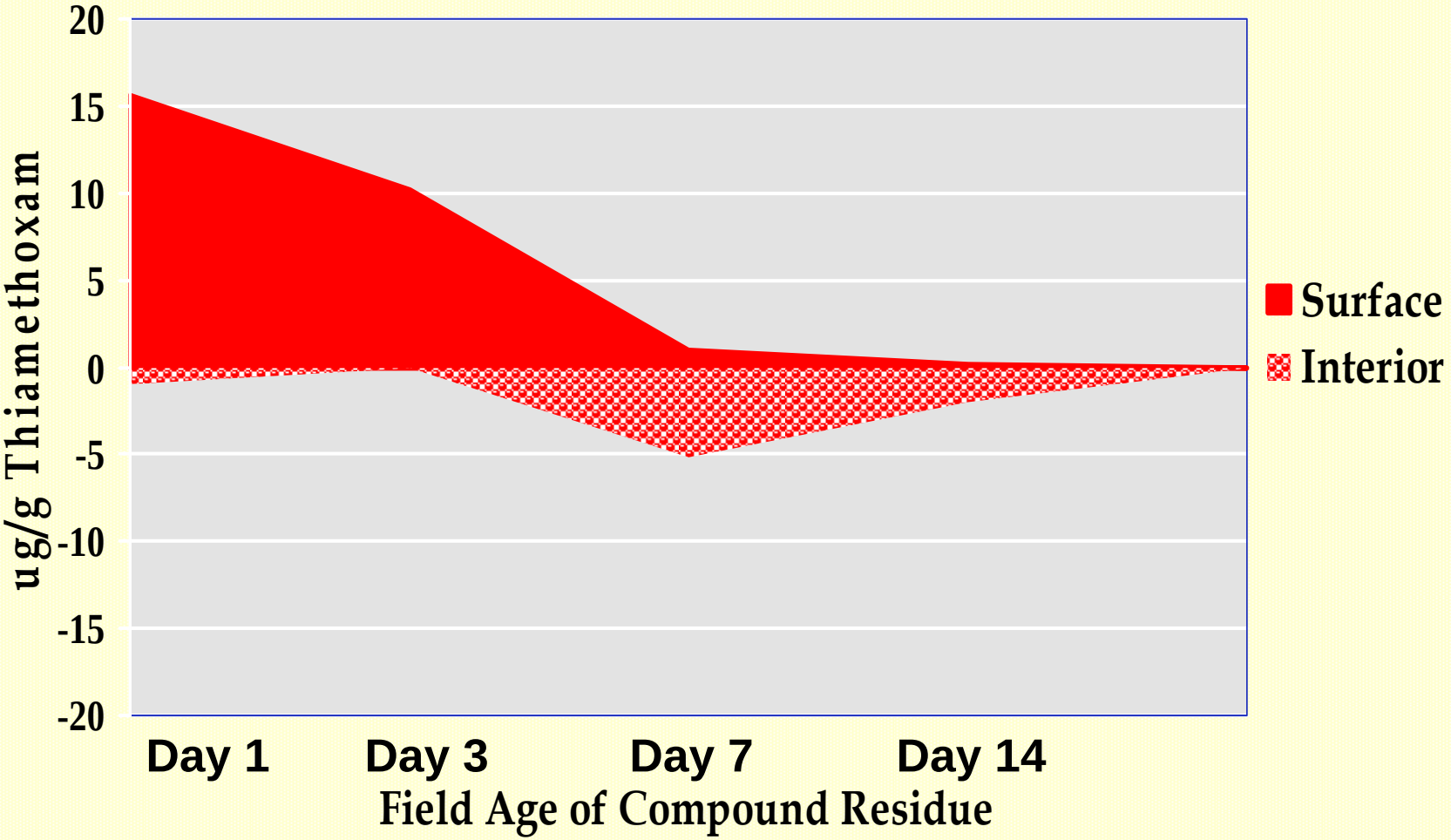


Actara Residue Profile on Cherry Leaves



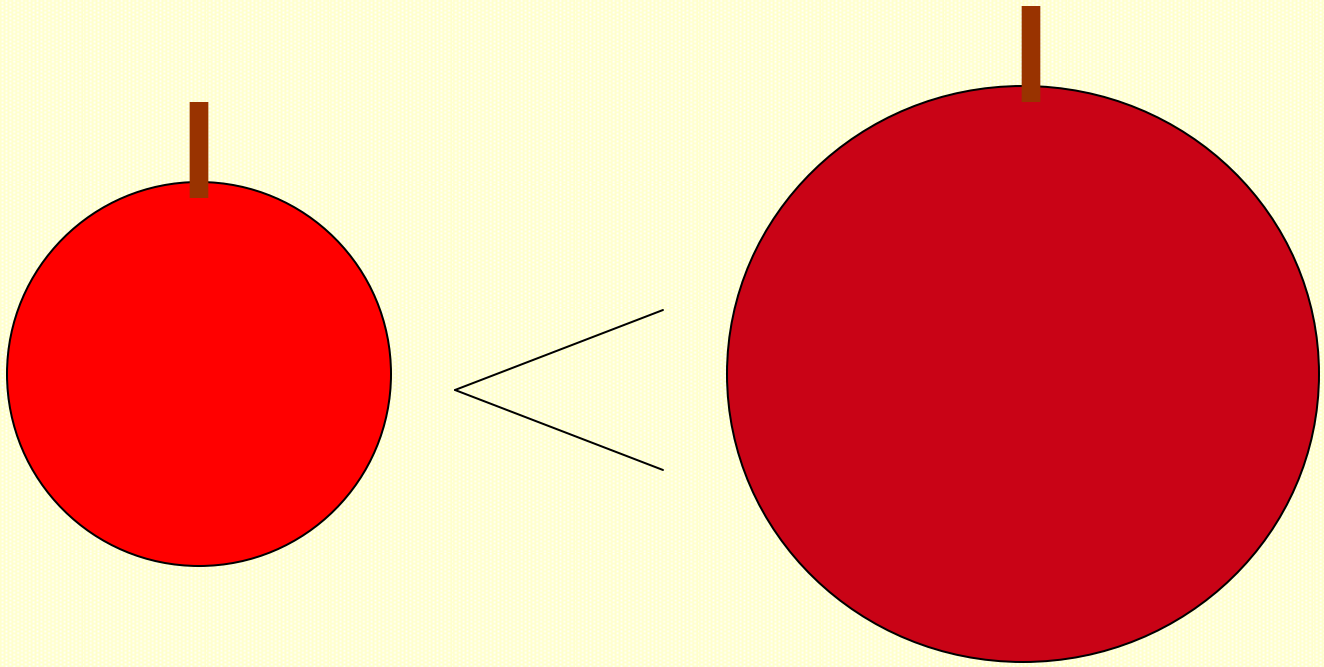
Application timing: shuck-off

Actara Residue Profile on Cherry Fruit



Application timing: shuck-off

Growth Dilution



Cherry Fruit Growth Rate

Cherry Fruit Growth Rate (starting at Shuck-off)

Day	Diameter	Surface Area
1	10.9 mm	3.7 cm^2
7	14.5 mm	6.6 cm^2
14	16.7 mm	8.8 cm^2

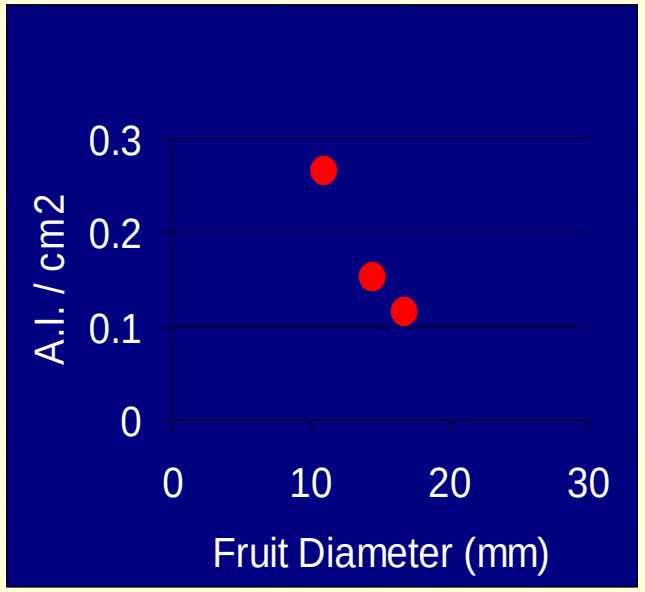
Rule of Thumb: For every doubling of diameter, there is a 4X increase in the surface area

How Does Growth Dilution Affect Pesticide Distribution?

Example: If a 10.9mm diameter cherry is covered with 1 g of chemical we can say that there is 1 g chemical on 3.7 cm^2 surface area or .27 g/cm^2.

In 7 days, the fruit has grown to 14.5mm. That 1g of chemical now is spread out over 6.6 cm^2. This translates to 0.15 g/cm^2. A **45% reduction** in chemical per unit of surface area from Day 1.

In 14 days, the fruit has grown to 16.7mm, surface area of 8.8 cm^2, the chemical present is 0.11 g/cm^2. A **60% reduction** in chemical per unit of surface area from Day 1.



Even ignoring environmental degradation, there will be a significant loss of ai/surface area via growth dilution.

Physical and Chemical Properties

Compound	Residual (on plant)	Systemic Activity **	Rainfastness (M, H,S)*
Organophosphates	Medium	1	M
Carbamates	Short	1	M
Pyrethroids	Short	1	M
IGRs	Medium-Long	2	M
Spinosyns	Short	2	H
Neonicotinoids	Medium	3	S
Oxidiazines	Medium	1	H
Anthranilic Diamides	Long	2	H

* H – highly rainfast, M – moderate, S – systemic in plant; ** 1 - weak, 2 - moderate, 3 - Strong

What is Effective Pest Management Performance?

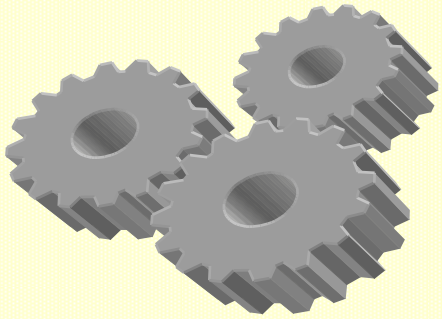
"Any pest control tool (or combination of tools) employed in an IPM program must ultimately provide sufficient fruit protection to meet minimum grade standards for the targeted market."


The Only Good
Bug is a
Dead Bug !!!

20th Century IPM

Industrial Age

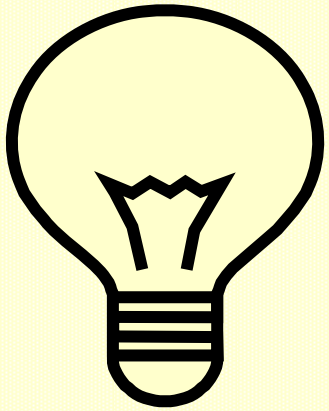
"Time for another poison"



21st Century IPM

Information Age

"What management action, and strategic combination of tools, do my sources of information lead me to take?"



Implications for MI Fruit Pest Management

- New insecticide chemistries are inherently different than conventional compounds.
- They should be judged according to their performance characteristics.
- The performance characteristics will influence optimal use patterns (timing, rate, interval, spray gallonage).
- Greatest challenge will be evaluating in-field performance during the growing season.
  - will require well trained scouts and pest consultants
  - will require intimate knowledge of the critical performance characteristics.