Pesticide Resistance Management
An Insect Perspective

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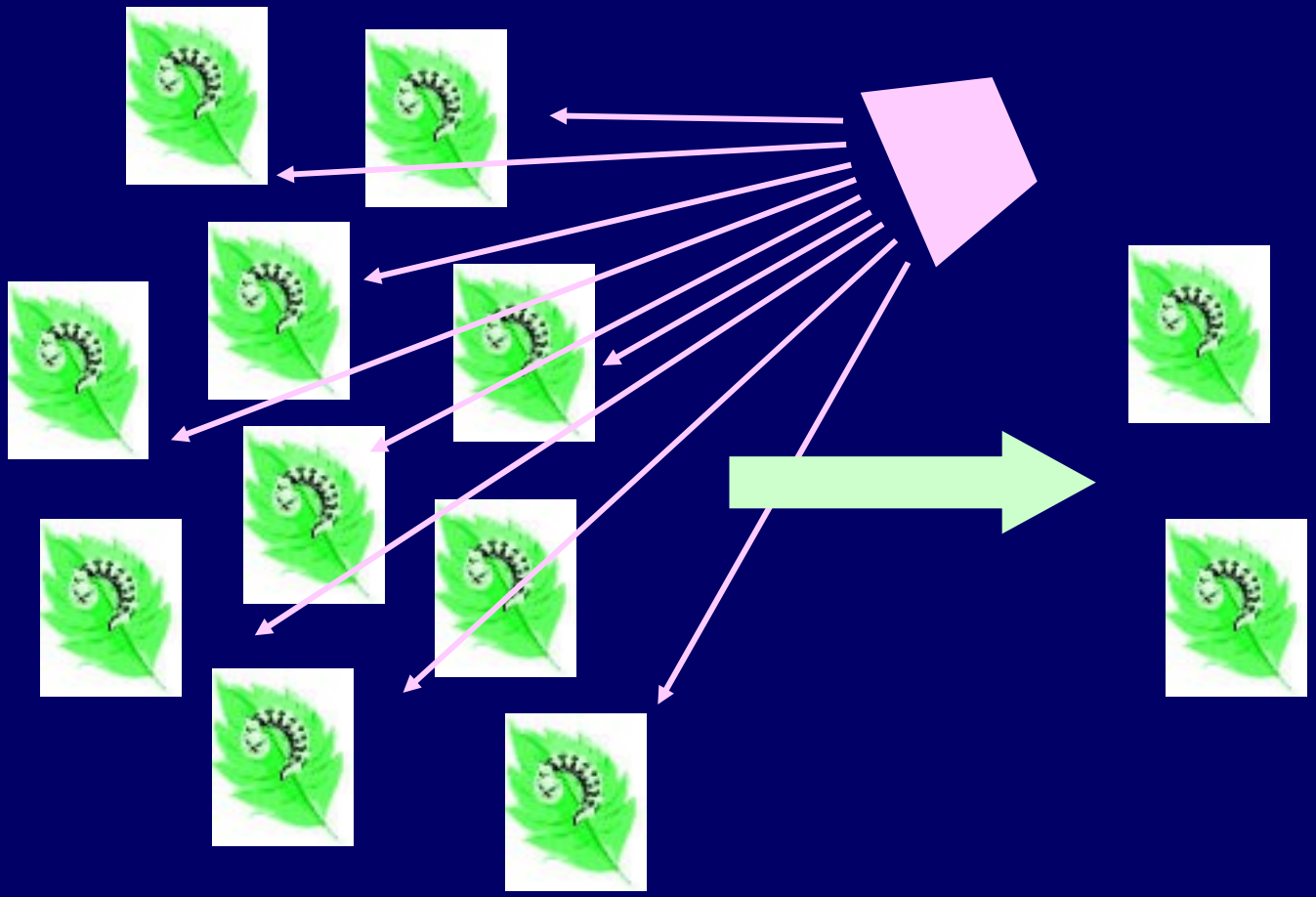
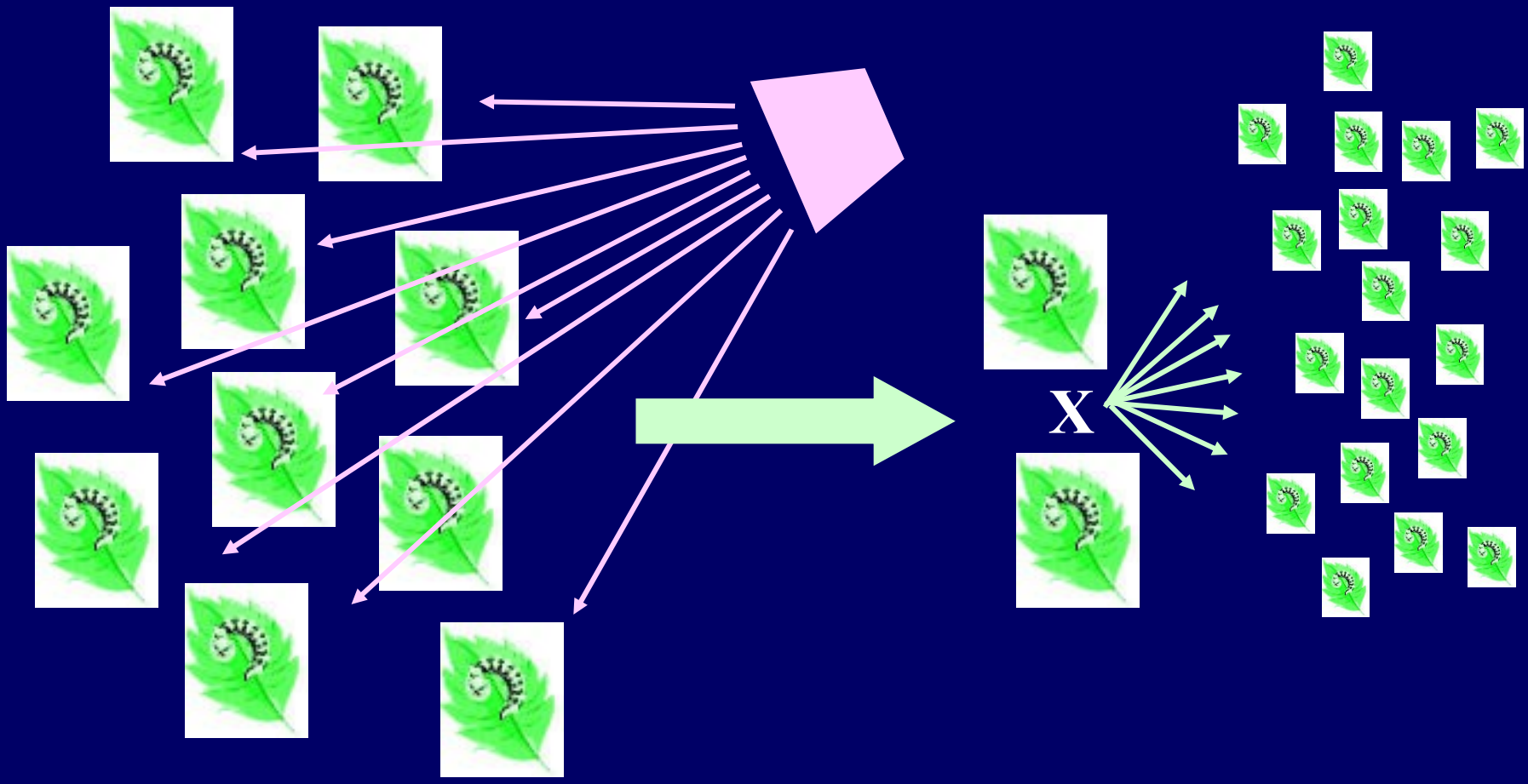
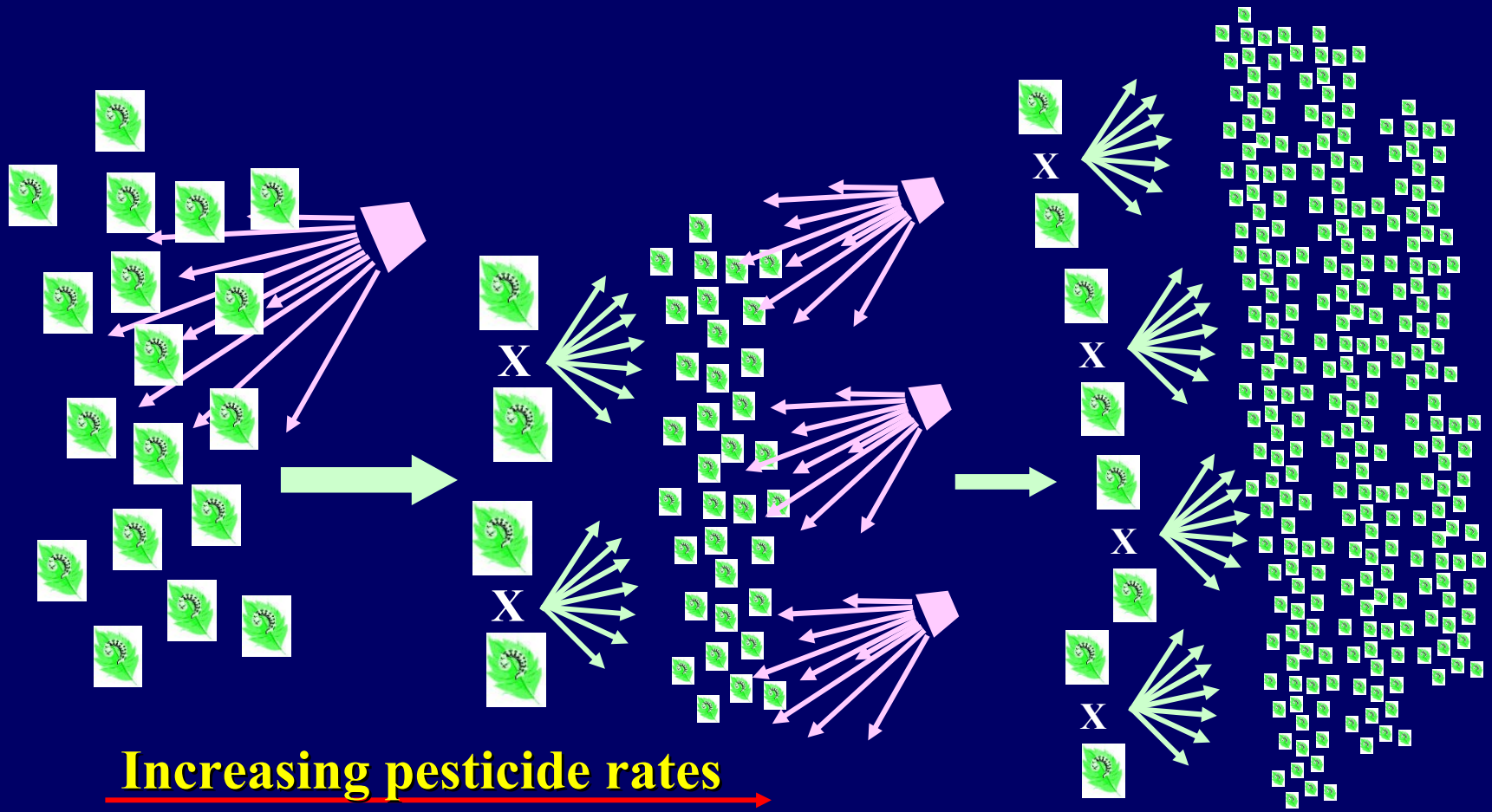
Insecticide resistance is due to a genetic trait a pest inherits that allows it to survive an application that most other individuals in the population cannot survive.



The survivor then passes the genes for resistance on to the next generation.



The more the insecticide is used, the more quickly susceptible individuals are eliminated and the faster the proportion of resistant individuals increases in the population.



Resistance Mechanisms

Insecticide avoidance behaviors -

- **Insects may change their behavior in order to avoid the pesticide.**

★**Biochemical mechanisms -**

- **Resistant insects posses enzymes that break down the pesticide or the pesticide may not affect them in the same way.**

Factors Influencing Selection

Biochemical mechanisms

- Target site resistance - decreases sensitivity of target site (e.g. nerves); insecticide no longer binds to its target.
- Detoxification - occurs when enzymes (e.g. esterases, oxidases, or glutathione S-transferases (GST)) prevent the insecticide from reaching its site of action.
- Cuticular penetration - reduced movement of pesticide through the insect's cuticle.

Factors Influencing Selection

Biochemical mechanisms

- Cross-resistance - **Pest is resistant to 2 or more pesticides, and the same genes mediate the resistance.**

★**Once a pest exhibits resistance to one pesticide, resistance to other pesticides with the same mode of action may follow more quickly.**

Target Site Resistance Mechanisms

- **The target of organophosphates (e.g. azinphosmethyl, diazinon, chlorpyrifos) and carbamates (e.g., carbaryl and methomyl) is acetylcholinesterase (ache) in nerve synapses.**

At least five point mutations in the (ache) insecticide-binding site have been identified that singly or together cause varying degrees of reduced sensitivity to OPs and carbamates.

Target Site Resistance Mechanisms

- The target of organochlorines (e.g. DDT) and synthetic pyrethroids are the sodium channels of the nerve sheath.

  Their common resistance mechanism is referred to as "knockdown resistance" (kdr) or target-site insensitivity.

Target Site Resistance Mechanisms

- **The genes that convey kdr are recessive.**

Recessive genes can persist at low levels in a population without being detected even if no selection pressure is present.

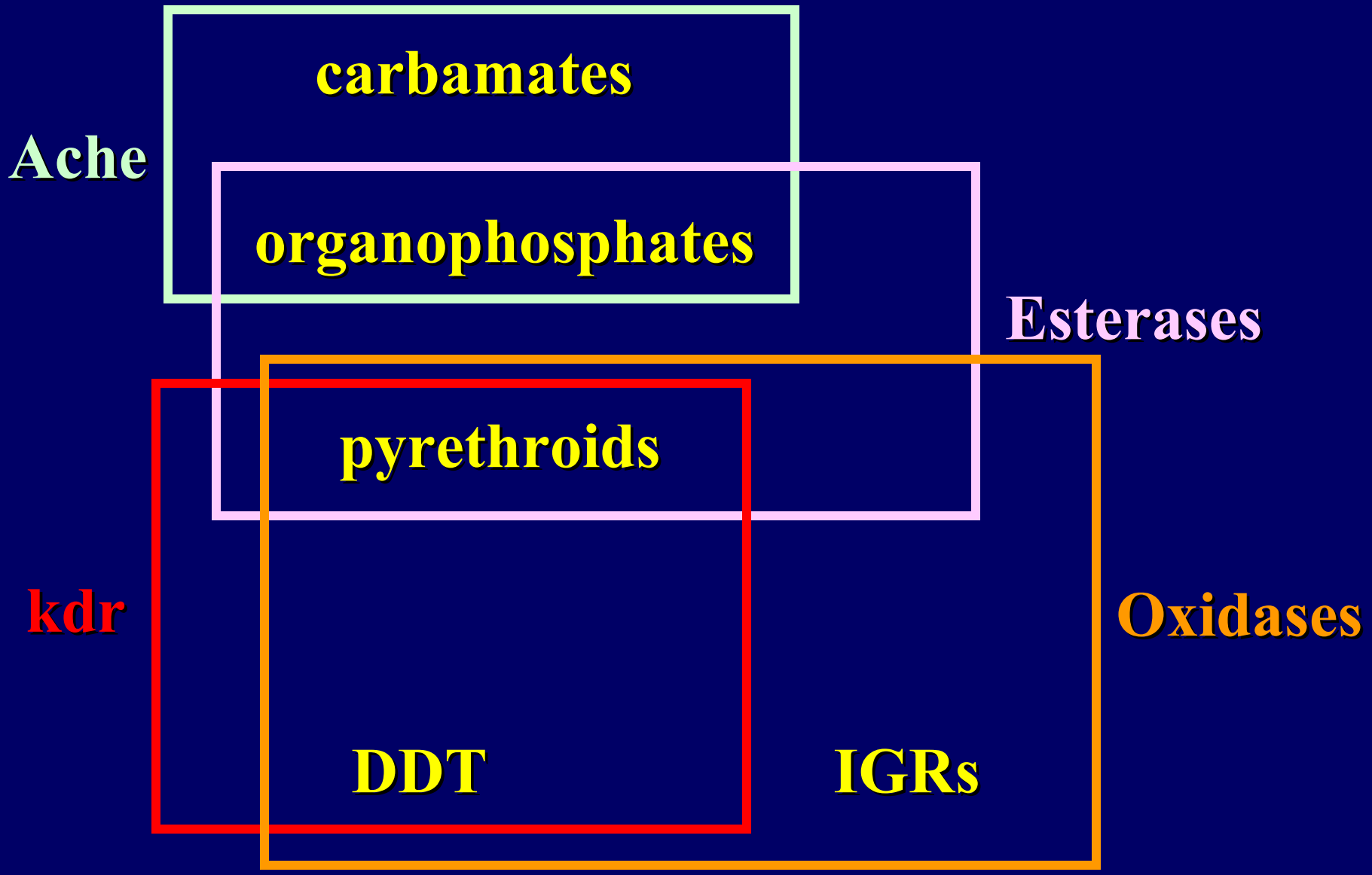
In 1980, at least 229 insect pests were documented to be resistant to DDT.

Detoxification Mechanisms

The enzymes responsible for detoxification are transcribed by members of large multigene families of esterases, oxidases, and GST.

The most common resistance mechanisms in insects are modified levels or activities of esterase detoxification enzymes that metabolize a wide range of insecticides.

Cross resistance for selected insecticide classes



Factors Influencing Selection

Biological/ecological factors -

- Life span of insect/ number of generations
- Reproductive capacity -
- Mobility -
- Availability of refugia -
- Polyphagy vs. monophagy (host range) -

Factors Influencing Selection

Operational factors -

Those factors related to the application of pesticides including:

- **Choice of pesticide**
- **Timing**
- **Dose**
- **Persistence**

Resistance Monitoring

Monitoring detects tolerance to pesticides in pest populations before resistance becomes widespread.

Resistance Monitoring

Topical bioassays - expose insects to a discriminating dose of an insecticide.

- **Dipping - dip into pesticide**
- **Caging - confine to sprayed fruit or leaf**
- **Petri-dish bioassays - on a treated dish (or vial or plastic baggie) surface**
- **Pheromone card bioassays - adults captured on pheromone traps**

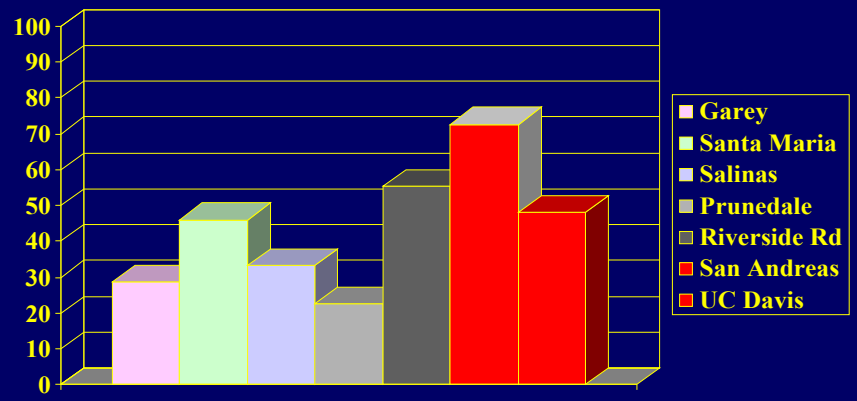
Range of doses required to determine discriminating dose = research

Resistance Monitoring

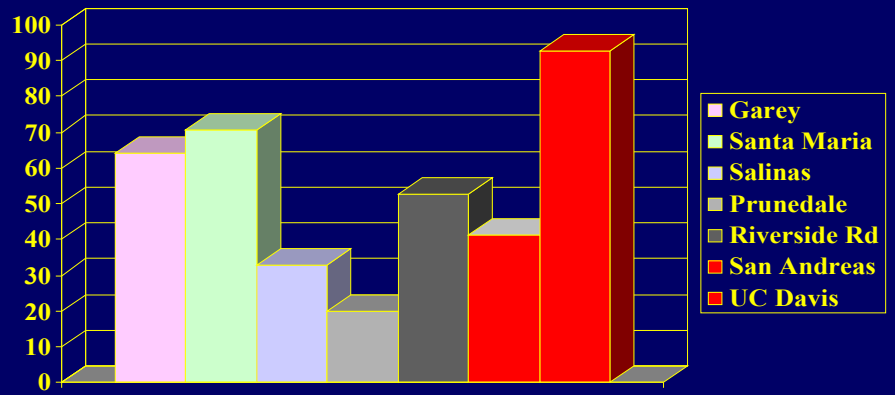
ELISA tests - developed for insects that use known enzymes to resist the pesticide.

Proportion of Lygus Bugs Killed

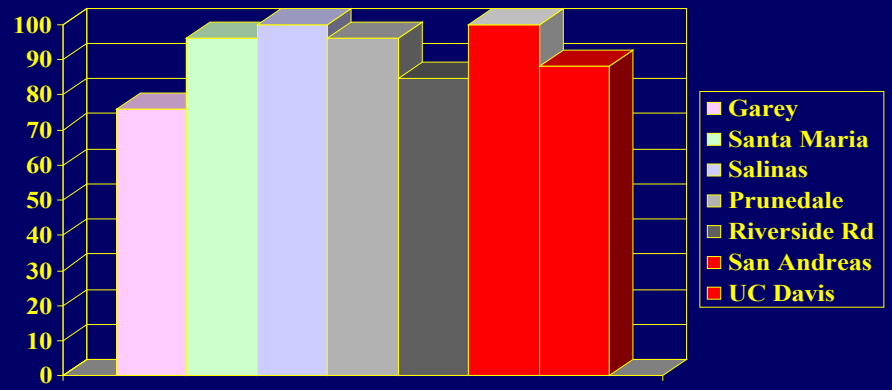
Malathion
200 *ug* in Bioassay Bag



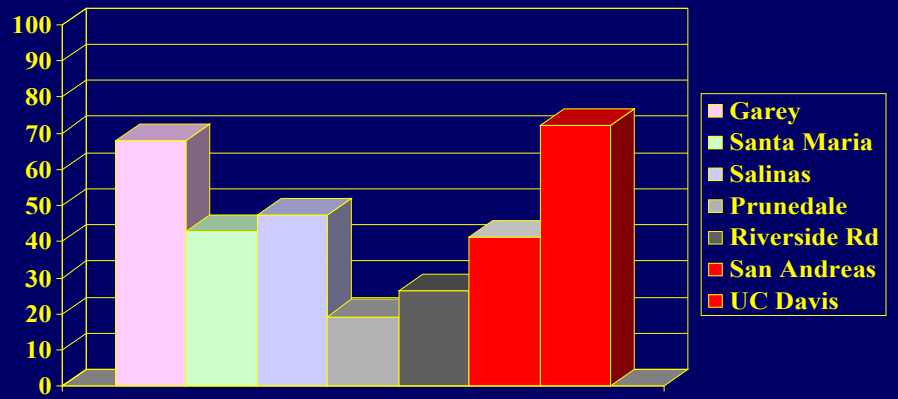
Bifenthrin (Brigade)
100 *ug* in Bioassay Bag



Methomyl (Lannate)
1.5 *ug* in Bioassay Bag



Fenpropathrin (Danitol)
100 *ug* in Bioassay Bag



★Resistance Management Strategies

- Change frequency of application, use only when necessary based on monitoring and economic thresholds
- Local rather than areawide treatments
- Take into consideration life stages of a pest, treat the more susceptible stage
- Maintain untreated refuges
- Use less persistent pesticides

★Resistance Management Strategies

- Use rotations of insecticides with different modes of action
- Use recommended high rates
- Use selective pesticides
- Pesticide mixtures in suitable areas
- Promote use of natural enemies with pesticide tolerance

The goal of resistance management is to conserve genetic susceptibility of a population.

★ Pesticide Resistance Is Not The Only Factor Influencing Efficacy

(It may not even be the most important factor)

- **Inadequate coverage**
- **Incorrect pesticide rate or calibration**
- **Improper treatment timing**
- **Incompatibility with other pesticides or adjuvants**
- **pH**
- **Temperature**
- **Immigration after treatment applied**

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