Chemical control

Chemical control

- Defn.: management of insect pests using chemical pesticides
- Pesticides: chemicals which are used to kill pests

Definition of Pesticide*

"Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest (such as insects, rodents, fungi, weeds, and other forms of plant and animal life declared to be pests); and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant."

* US EPA, 1947

Classifying Pesticides

- Type of pest or organism controlled.
- Pesticide chemistry or chemical nature.
- Mode of action.
- Pesticide formulation.
- Mode of entry.

1.Type of Pest or Organism Controlled

Insecticide	Insects
Acaricide	Mites and ticks
Nematicide	Nematodes
Fungicide	Fungi
Rodenticide	Rats and rodents
Avicide	Birds
Herbicide	Weeds

2. Mode of Action

- **Physical poison:** Toxicant which brings about kill of one insect by exerting a physical effect e.g. diatomaceous earth.
- **Protoplasmic poison:** Toxicant responsible for precipitation of protein e.g. arsenicals
- **Nerve Poison** – chemicals which interferes with nervous system function e.g. malathion.
- **Respiratory poison**: chemicals which inactivate respiratory enzymes e.g. hydrogen cyanide.
- **Chitin inhibition:** chemicals which inhibit chitin synthesis e.g. diflubenzuron

3. Modes of Entry

- Contact - dermal –toxicant enter through the skin e.g. cypermethrin
- Stomach - oral – insecticide applied to leaves and other plant parts when ingested through the mouth kills the insect e.g. malathion
- Fumigant - inhalation through the nose or respiratory system e.g. Aluminium phosphide
- Systemic – chemicals when applied to plant or soil are absorbed by foliage or roots and translocated through vascular system and cause death of insect feeding on plant e.g. monocrotophos

Modes of Entry

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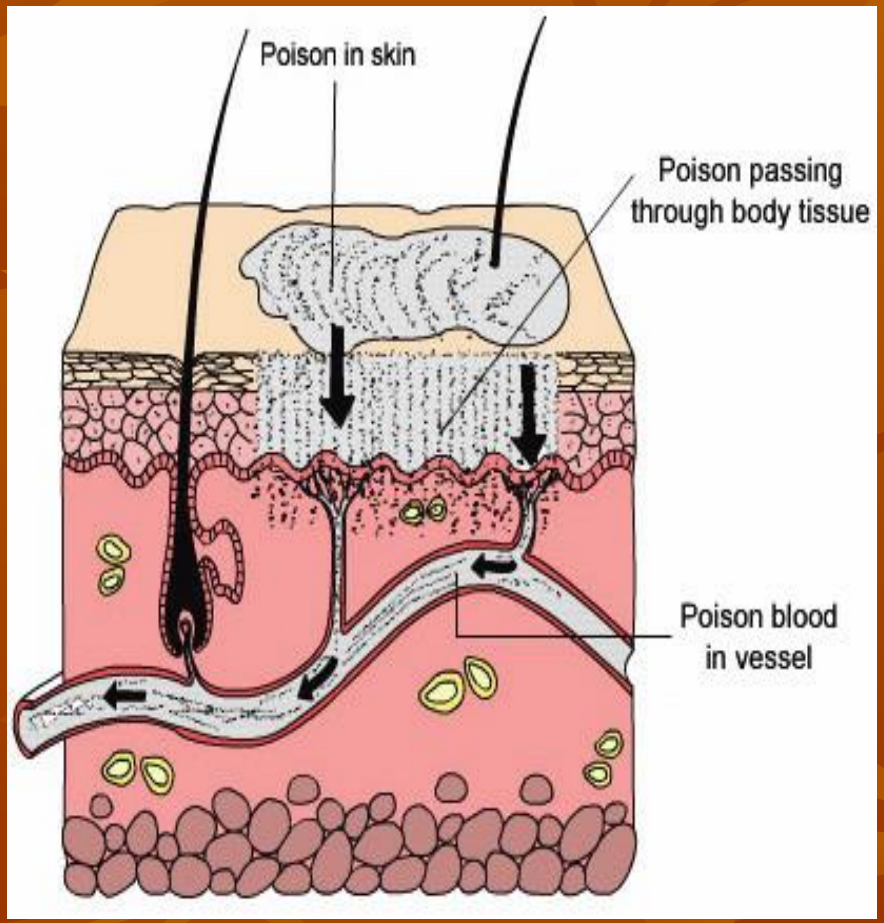

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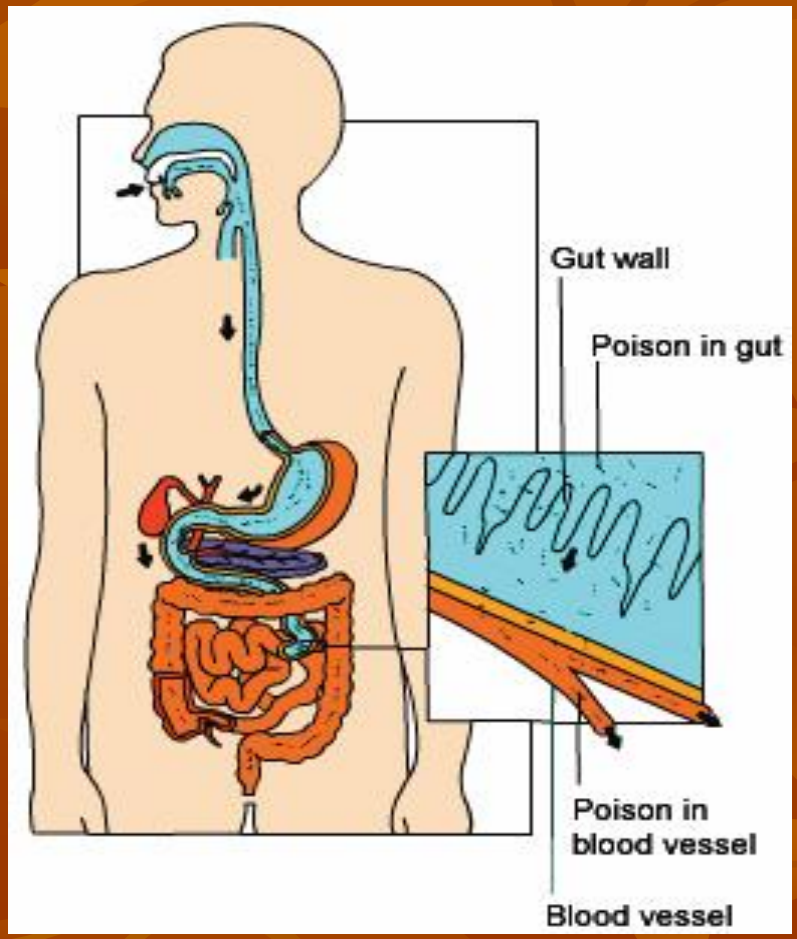

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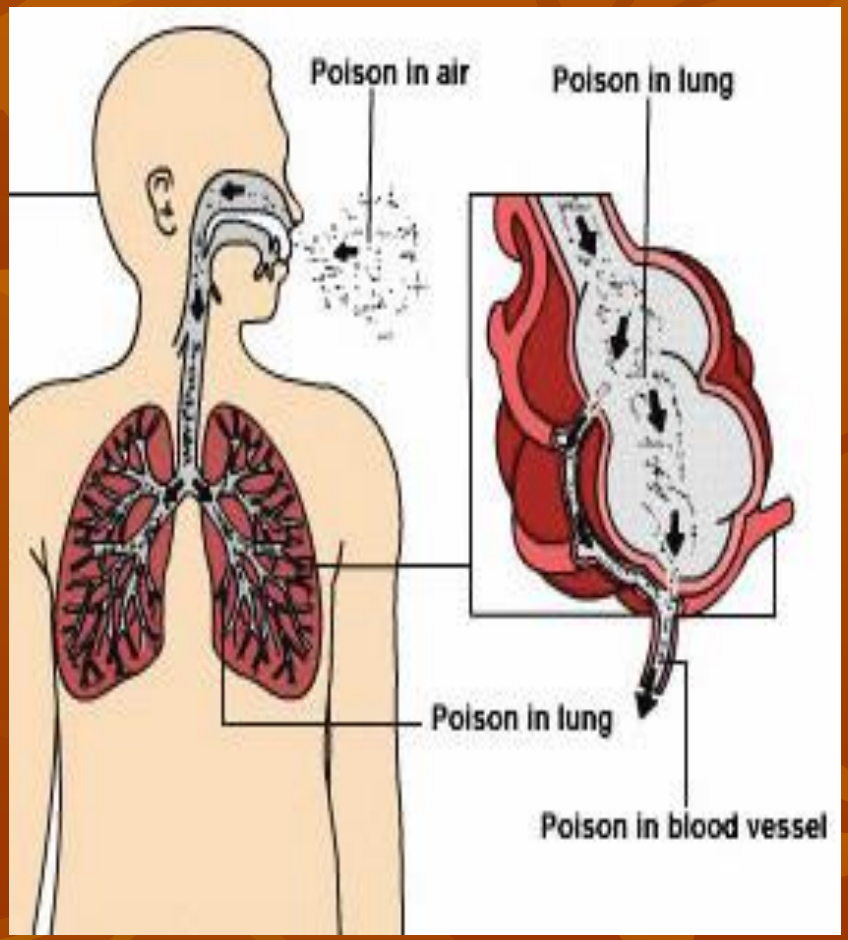
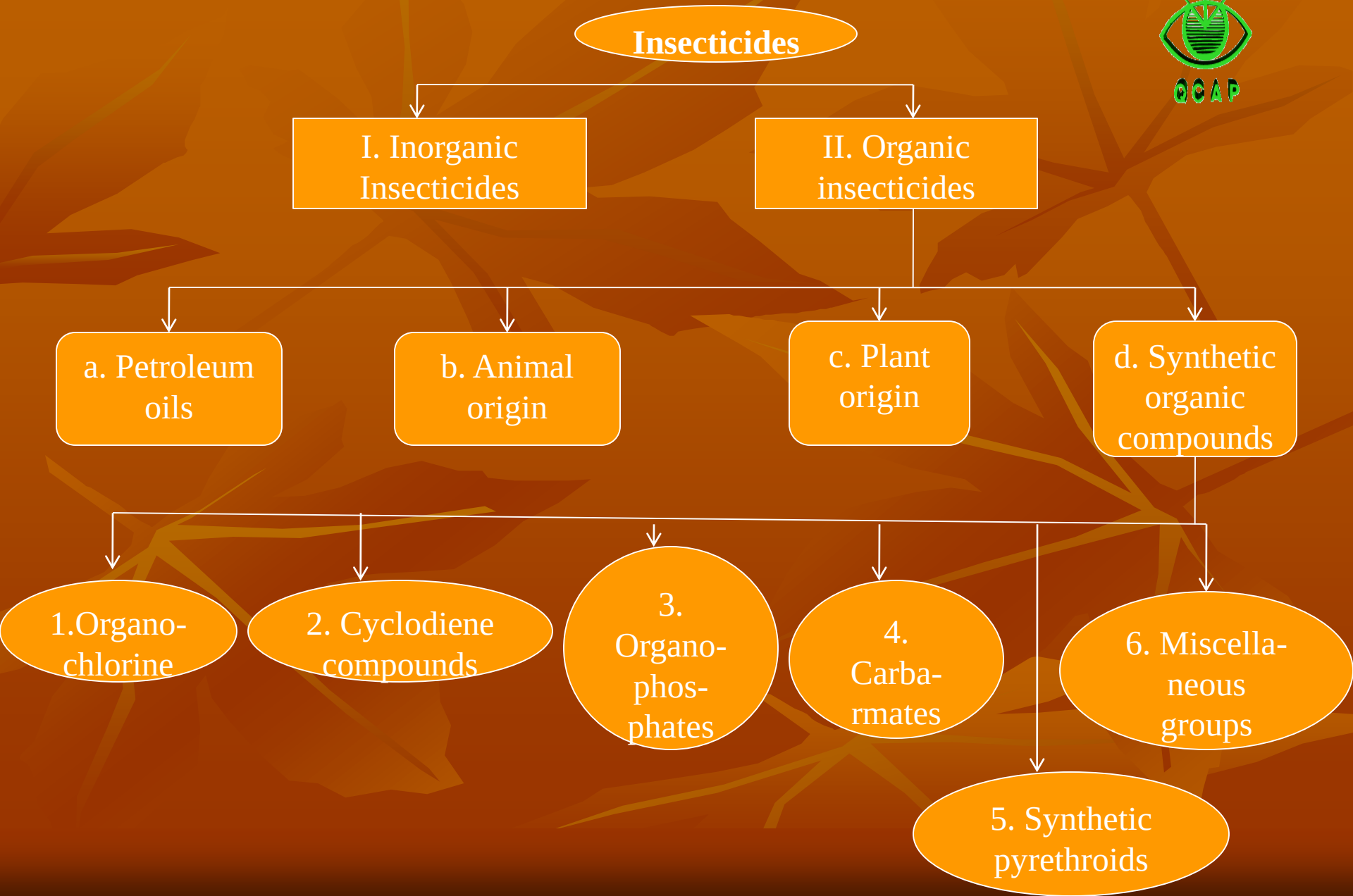


4. BASED ON CHEMICAL NATURE OR CHEMISTRY



INSECTICIDES

- Organochlorines
- Organophosphates
- Carbamates
- Pyrethroids

BASED ON CHEMICAL STRUCTURE

I. Inorganic insecticides include Arsenic, flourine, sulphur, lime sulphur, zinc phosphide (Rodenticide)

II. Organic insecticides (constituted mainly by C, H, O and N mainly)

a. Hydrocarbon oil or Petroleum oil e.g. Coal tar oil, kerosine etc.

b. Animal origin insecticides- e.g. Nereistoxin extracted from marine annelids-commercially available as cartap, padan

c. Plant origin insecticides e.g. Nicotine from tobacco plants, Azadirachtin from Neem, Rotenoids from roots of *Derris* and *Lonchocarpus*

BASED ON CHEMICAL STRUCTURE

d. Synthetic organic compounds: are synthetically produced in the laboratory

1. Chlorinated hydrocarbon or organochlorines e.g. DDT, HCH, endosulfan, lindane, dicofol
2. Cyclodienes e.g. chlordane, heptachlor
3. Organophosphates e.g. dichlorvos, monocrotophos, acephate, dimethoate, malathion, chlorpyriphos
4. Carbamates e.g. carbaryl, carbofuran
5. Synthetic pyrethroids e.g. cypermethrin, fenvalerate,

BASED ON CHEMICAL STRUCTURE

6. Miscellaneous compounds

a. Neonicotinoids (Analogues of nicotine) e.g. Imidacloprid
b. Spinosyns (Isolated from actinomycetes) e.g. Spinosad
c. Avermectins (Isolated from bacteria) e.g. Abemactin, Avermectin, Vertimec
d. Fumigants e.g. Aluminium phosphide, Hydrogen cyanide

5. BASED ON PESTICIDE FORMULATION

- An insecticide formulation is a form in which an insecticide is manufactured.
- Insecticides are not usually applied in pure form (active ingredient) since they are highly toxic and quantity available for application is low and hence they are diluted with inert materials like talc (or) with water combining with other materials such as solvents, wetting agents, stickers etc.

TYPES OF FORMULATION

- For dry application directly from container

1. DUSTS

   In insecticides formulated as dusts the active ingredient is mixed with an inert substance such as talcum powder, or with some other finely-divided material.

   Particle size will be less than 100 and it should pass through 200 mesh sieve.

TYPES OF FORMULATION

- Dusts are best applied either when the crop is wet, or when dew is on the plants so that the dust will easily stick to the plant.
- Dusts are used to protect stored produce and seed treatment.

Advantages:

- Dusts are cheaper and are bought ready for use without the need for further dilutions. They are comparatively less phytotoxic than some other formulations.

TYPES OF FORMULATION

Disadvantages

- Dusts are least effective and cause wind drift leading to poor deposit on surface; they are highly toxic to beneficial insects.
- The other disadvantage is that they are messy to handle.

TYPES OF FORMULATION

2. Granules (G): Granular formulations are dust formulations with larger particles of inert material. The amount of a.i. ranges from 2-10 percent.

- The size of granules varies from 0.01 to 3 mm in diameter. The granule size affects placement, distribution and release rate of the insecticide.
- Granules are highly suitable against soil-inhabiting pests and for distribution of systemic chemicals which translocate through the roots.

TYPES OF FORMULATION

Advantages:

- They are easy to apply by hand (in gloves), thus avoiding the need for expensive machinery.
- Because of their size, granular formulations do not drift and can be kept on site.
- Use of controlled-release granules prolongs exposure.
- Granular formulations are less harmful to natural enemies of pests and bees.

TYPES OF FORMULATION

For spraying after mixing with water

3. Wettable Powder (WP): It consists of active ingredient mixed with inert dust and a surfactant that mixes readily with water and forms a short - term suspension.

- WPs are much more concentrated than dusts, containing 15 to 95 per cent active ingredient.
- Frequent agitation is required to keep the insecticides in suspension.

TYPES OF FORMULATION

Advantages:

i. They are easily manufactured and cheap.

ii. They usually cause less phytotoxicity than Emulsifiable Concentrates (Ecs).

Disadvantages:

i. Powder can puff up into the operator's face.

ii. As with dust formulations, they are highly susceptible to drift.

TYPES OF FORMULATION

4. EMULSIFIABLE CONCENTRATES (EC):It consist of a toxicant, a solvent and a emulsifier with a stabilizing agent. When EC is mixed in water gives emulsion - droplets of oil containing the insecticide dispersed in water.

- Emulsifier makes the water insoluble toxicant to water soluble and its yield a stable milky solution when diluted with water.

TYPES OF FORMULATION

- The proportion of active ingredient in an emulsion is higher than that found in dusts, but lower than that in wettable powders.
- An emulsifiable concentrate is more expensive than dusts and wettable powders due to the solvents needed.

TYPES OF FORMULATION

For application as gas or vapour

1. **Fumigants :** Fumigants are pesticides in the form of poisonous gases that kill when absorbed or inhaled. Most of the fumigants are liquid and are mixtures of two or more gases.
2. **Smoke generators :** They are used in the form of coil like strips containing pyrethrum, oxidant and wood dust for the control mosquitoes. When ignited, these coils release vapour.

TYPES OF FORMULATION

3. **Aerosols :** Aerosol contains a small amount of pesticide that is driven through a fine opening by a chemically inactive gas under pressure when the nozzle is triggered (or) by burning toxicant or vapourizing it with that.

   The toxicant is suspended as minute particle (0.1 - 50 w/w) in air as a mist. It consists of toxicant (2%), solvent (10%), knockdown agent (2%) and propellent gas (86%).

TYPES OF FORMULATION

Other formulations

- **1. Poison bait** : These mixtures of an insecticide with food attractive to the target pests.
- **2. Seed dressers :** This consist of an active ingredient in carrier material with an adhesive for better coating of the chemical on the seeds.
- **3. Tablets :** It consist of a toxicant, a carrier to prevent the flamability.

TYPES OF FORMULATION

4. **Insecticide paints and polishes** : Toxicant is produced in the form of paint/polish and can be applied as such by using a brush.
5. **Encapsuled fumigants :** The fumigant is impregnated in some inert material and sealed in plastic containers. Cut open the plastic container before use.

NAMES OF INSECTICIDES

An insecticide may have three different names:

- **Trade or Proprietary Name:** A trade name is a name of an insecticide under which it is sold or marketed. Trade names are the most commonly used names and several trade names may be assigned to one chemical.
- **Chemical Name:** This is a name which denotes the chemical structure of the insecticide
- **Common Name:** This is a common name that is approved by a national or an international organization

Ideal qualities of an insecticide

- An ideal insecticide should possess the following qualities:

1. Kill the target insect effectively and quickly
2. Be less toxic to Nes
3. Be less toxic to honey bees, soil micro-organisms
4. Be less toxic to fishes and mammals
5. Less hazardous and less toxic during handling or accidental consumption by human beings
6. Quickly degradable in environment and should be less persistent (residues should very little)
7. Should not cause resurgence of the target insect (i.e. increase in population of target insect)

Ideal qualities of an insecticide contd.

8. Should not cause outbreak of secondary pest on a minor pest by killing the Nes.
9. Should have a complex mode of action against which resistance development will take more time e.g. Azadirachtin from neem tree has complex action
10. Should have a longer storage life or shelf life
11. It is advantageous to select an insecticide which can kill a relatively broad spectrum of target pests
12. It should be cost effective (high benefit/cost ration) and safe to use (high benefit/risk ratio)

However there is no ideal insecticide at the moment that meets all the above qualities .

Various generations of insecticides

Generation	Year	Compounds
1st Generation insecticide	1939-1942	BHC and DDT
2nd Generation insecticide	1944-1947	Organophosphates & Carbamates
3rd Generation insecticide	1967	Hormonal insecticides, JH mimic insect growth regulators
4th Generation insecticide	1970s	Synthetic pyrethroids

Insecticides problems

- Human poisonings and health risks
- Environmental hazards
- Loss of biodiversity
- Wildlife deaths
- Interference with natural pest control
- Resistance among pests
- Unwanted imports
- Obsolete and unusable stocks
- Residues in food
- Water pollution
- High input costs

Insesticide…Why?

Food crops compete with 30,000 species of weeds, 3,000 species of nematodes and 10,000 species of insects. 20-40% of potential food production is still lost per year to pests.

- Protect our food supply
- Increase yield
- Supply of high-quality food
- Efficient & effective land use
- Improve agricultural productivity
- Contribute to food security and alleviate poverty
- Reliable food supply

CHEMICAL CONTROL

- **Insecticide residues**

  The toxicant that remains in the environment (like soil, water, plant harvested produce, etc.) after the application of insecticides. The duration of retention is referred to **persistence.**

- **Waiting period**

  It is the minimum period allowed between time of application of pesticide and harvest of commodities in order to allow the toxicant residue level to come below maximum residue limits.

CHEMICAL CONTROL

- **Role of insecticides in IPM**

1. Insecticides should be applied only based on the need, i.e. if pest reaches ETL.
2. It should be judiciously combined with other components of IPM and insecticides should be used as last resort.
3. When insect population approaches ETL, insecticides are the only means of preventing economic damage.

CHEMICAL CONTROL

4. Insecticides are available in easy and ready to use packages.
5. Easy to apply and large area can be covered.
6. A range of insecticides are available depending on crop, insect and nature of damage.
7. Insecticides which are cost effective (High benefit/Cost ratio and safe (High benefit/Risk ratio) should be used in IPM.

Environmental Hazard

- Environmental hazard of pesticides is generally evaluated as a function of persistence often compared to effectiveness.

  High – Environmental persistence far greater than period of effectiveness (> 5 months and often < a year).

  Intermediate – Persists beyond effectiveness (3-5 month half-life).

  Low – Persists about the period of effectiveness (up to about 3 months) and then degrades completely over several months.

  Very low – Persists for short periods (<45 days) and degrades completely.

Toxicity to Humans
(or Non target Organisms)

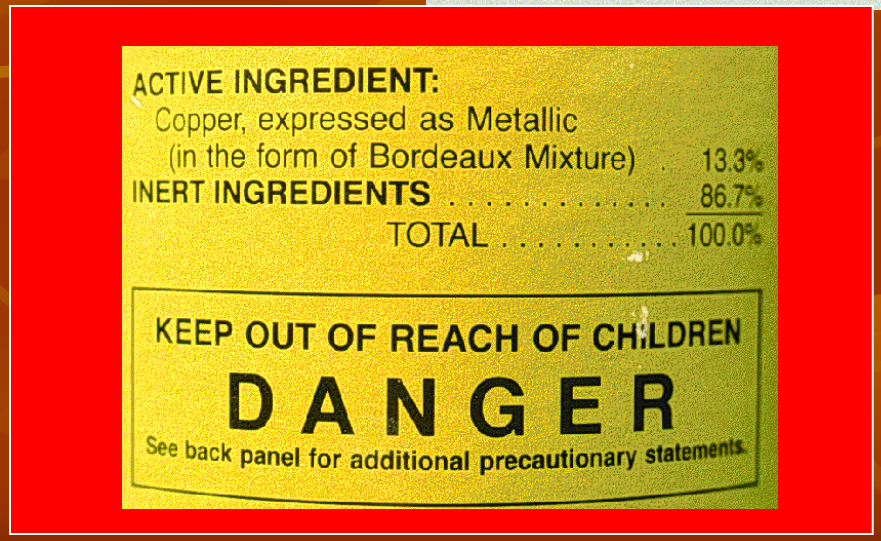
- Most insecticides have the capacity to affect non-target organisms
- Same as previously discussed
  - Highly toxic – LD_{50} 0 – 50 mg/kg
  - Moderately toxic - LD_{50} 50 – 500 mg/kg
  - Low toxicity - LD_{50} 500 – 5,000 mg/kg
  - Nontoxic - LD_{50} >5,000 mg/kg

US EPA Toxicity Classification

- Class I: “Danger”
  - Fatal if ingested; corneal opacity; corrosive to skin
- Class II: “Warning”
  - May be fatal if ingested; reversible corneal opacity; severe skin irritation
- Class III: “Caution”
  - Harmful if ingested; no corneal opacity; moderate skin irritation
- Class IV: “Caution”
  - May be harmful if ingested; no eye irritation; mild/no skin irritation

Precautionary Statements: Signal Words

- Danger (or Poison)
- Warning
- Caution

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