PESTICIDES

Definitions

According to EPA substances or mixtures of substances intended for preventing, destroying, repelling or mitigating any pest

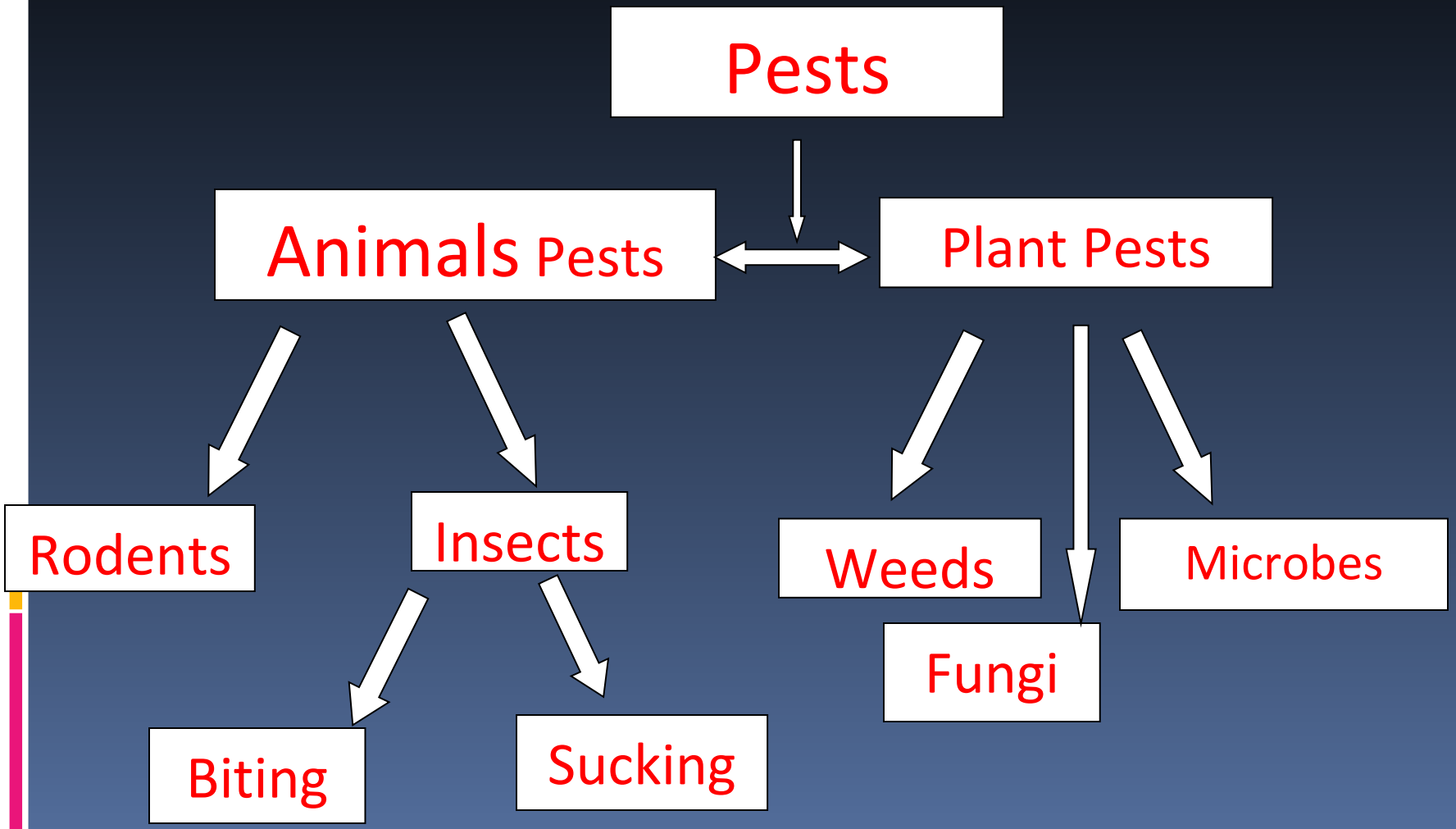
A substance that kills a pest (insect, weed, bacteria, nematode etc.)

1. Herbicide = plant killer
2. Insecticide = insect killer
3. Rodenticide = rodent killer

- And other cides e.g to kill bacteria and fungi

- Pesticides produce their effect by inhibiting or destroying the metabolic processes of animals
- All pesticides have their own
  - Mechanism of action
  - Potency
  - Speed of effect (onset of action)
  - Dose required to produce effect

Types of pests



Animal pests

- Rodents: are responsible for damaging and destroying medicinal and agricultural crops
- They spoil and contaminate the crude drugs in storage. The spoilage makes crude drugs unsuitable for use in pharmaceutical industry

- The spoilage and contamination is done by
  - By excretory products
  - Hairs
  - Rodents responsible for damage may be
    - Rabbits
    - Rats
    - Mice

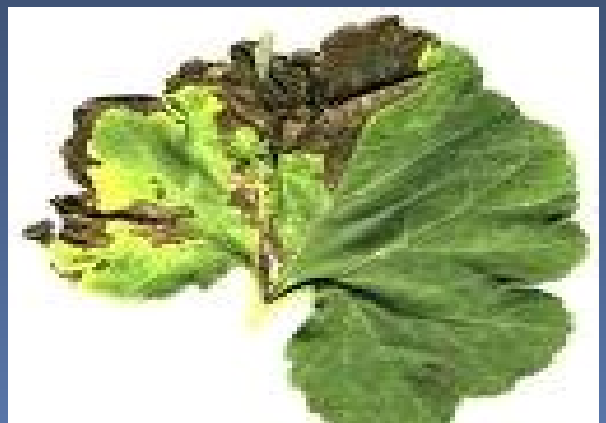
Insects

- More than 1M species of insects are present in this world
- Out of these , 10K species are responsible for crop eating
- Out of 10K, only 700 species can cause epidemic loss to medicinal plants and crops
- Insects are divided into 2 groups
  - Biting insects
  - Sucking insects

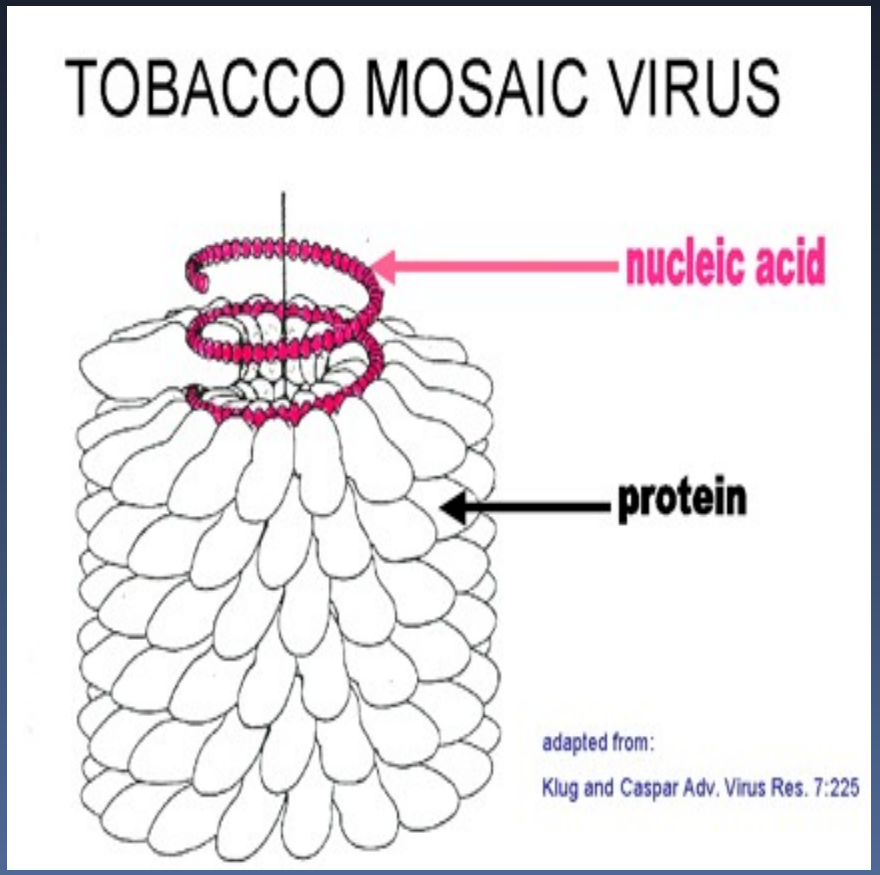
- Biting insects: grass hopper, corn ear worm
  - They bite seeds, stem, fruit and leaves etc.
- Sucking insects: suck instead of biting and examples include mosquito and butterflies

Plant pests

- Microorganisms
  - Bacteria, Fungi and Viruses
- Weeds
- Microorganisms
  - Bacteria: *Xanthomonas* causing leave spots
  - Fungi: spores when come in contact cause rhinitis and if inhaled cause asthma and hay fever



Virus: Tobacco Mosaic virus



Weeds

- Undesirable plants in desirable or cultivated plants
- Such plants consume minerals, water and fertilizer given to cultivated plants hence inhibit their growth
- Weeds may also be toxic for example spores of Agrostemma githago contain cyanophore glycoside

  and which upon

  hydrolysis release HCN

Pesticides

- Grouped into 4 groups
  - Rodenticides- against rodents (rabbit, rat, mice)
  - Insecticides- against insects
  - Herbicides-against weed and herbs
  - Fungicides-against fungus

Mechanism of action

- Pesticides kill the pests in many ways. Each pesticide has its own mechanism of action, onset of action, potency and dose required.
- Usually they perform their function by one of the following ways
  - When ingested kill the pest also called stomach poison
  - When come in contact kill the pest also called contact poisons
  - When inhaled also called fumigants

Choice of chemicals

- The choice of chemical used to kill the pest depends
  - Types of pest
    - Rodents, herbs or insects
  - Habitat of the pest
    - Indoor or outdoor
    - If rodents are present indoor, chemical used should be such that it should not cause damage to human

Methods of controlling pests

- Some of the methods are given as follows:
  - Mechanical methods
  - Biological methods
  - Environmental methods
  - Agricultural methods
  - Chemical methods

Mechanical methods

- Hand picking
  - Method of choice when pests are slowly crawling and are not able to fly e.g caterpillars
- Trapping
  - Is used for flying pests which cant be picked by hand or burned.
- Burning
  - Is used for flying pests which cant be picked by hand and can cause damage. Pests are burned and waste is removed frequently.

Biological methods

- This method is applicable for removal of animal pests. It depend on the following considerations:
  - Animals and insects which feed upon smaller forms
    - Hawk, owl, eagle and cats etc.
  - Insects having small life span parasitize bigger
    - Some flies lay eggs on larvae of the crop which cause damage. They attack slowly moving larvae. After few days when eggs are hatched , small larvae appear and consume the body tissues of the crop larvae. Hence death of pest occurs

Environmental methods

- The surrounding of the pest is changed in such a way it becomes unfavorable for its growth
- It can be achieved by removing food stuff needed for the growth of the pest or draining swamps e.g mosquito control

Agricultural methods

- Involves cultivation of such crops which are resistant to pests
- It may be achieved using biotechnology and genetic engineering
- Another method for removal is crop rotation

Chemical methods

- In this method, certain chemicals are used for controlling pests. E.g.
- Rodenticides
- Insecticides
- Herbicides
- fungicides

Why are pesticides used in agriculture and the environment?

1. Agriculture:

a. Use of "crop protecting" agents improves yield and quality of agricultural products

b. Prevents the spread of diseases to crops and livestock (Pierce's Disease)

c. The use of pesticides is regulated by the E.P.A. (Environmental Protection Agency, State law and Country regulation

Containers or equipment used for chemical control

- Spray solutions
- Spray suspensions
- Baits
- Stomach Poisons
- Fumigants
- Contact poisons

Concerns With Pesticide Use

1. Environmental concerns

   a. They kill beneficial insects and plants (non selective).

   b. Pollution – runoff of herbicides and insecticides into irrigation water and then into rivers - damages wildlife habitat, kills fish.

   c. Cause cancer – organophosphates

   d. Disrupt the natural ecosystem and natural biodiversity

   e. Creates chemical resistance – insects and weeds.

2. Society & Environment:

a. Aesthetics - used regularly in city parks and other recreational areas to control insect damage and weeds

b. Protect humans from insect-borne diseases, mosquitoes transmit many diseases, Malaria.

c. Protect our food supply. In developing countries up to 1/3 of all harvested grain is destroyed by rodents and insects.

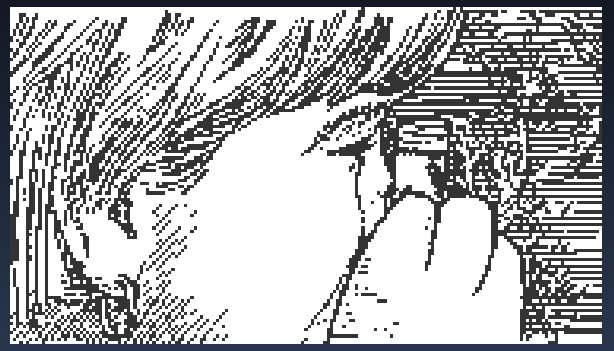
Integrated Pest Management (IPM)

Pest management that utilizes several strategies to control insects and other pests rather than strictly relying on chemical control.

It has 4 components…

Integrated Pest Management (IPM) Components

1. **Pest identification** – important for proper pest control



- **Confuse beneficial insects with harmful (not all bugs are bad!)**
- **Pest that's on the plant may not be the one causing damage.**
- **Damage may not even be caused by an insect or herbicide- nutritional deficiency due to weather**

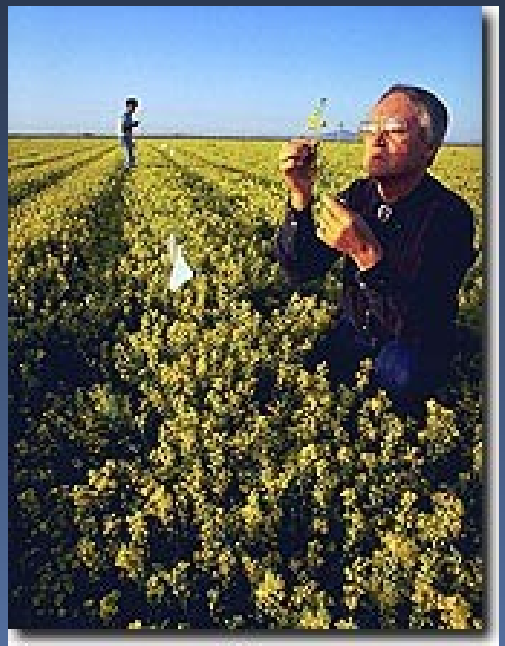


Photo courtesy of USDA-ARS

Integrated Pest Management (IPM) Components

2. Surveying for pests – systematically check for pests and pest damage

- Pheromone traps
- Sweeping the field
- Random leaf, fruit and stem samples

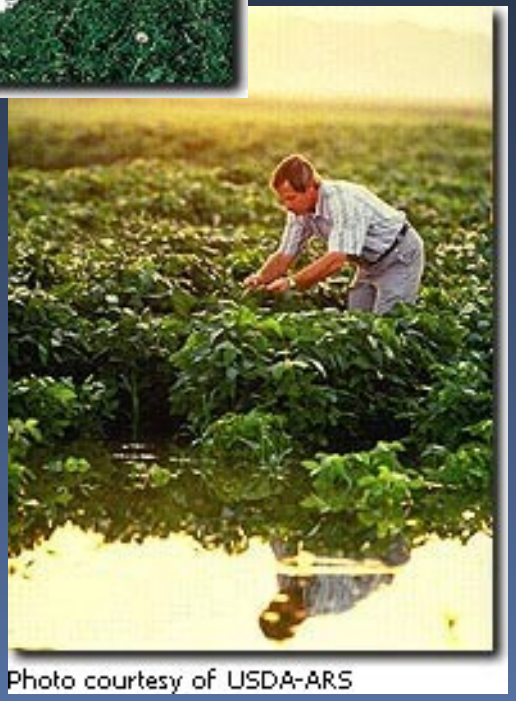


Photo courtesy of USDA-ARS

Integrated Pest Management (IPM) Components

3. Encourage Beneficial Insect/Animal Populations

- Use milder chemicals or selective sprays that don't kill beneficial animals.
- Examples – "Barn Owl Nesting Boxes" – rodent control
- Predatory wasp populations – fly control in poultry and dairy operations
- Natural insect enemies – lady bugs

Integrated Pest Management (IPM) Components

4. Control Action Guidelines –

Application of pesticides only after a certain number of pests have been found and there is a threat of economic loss.

Future Challenges?

- IPM – "requires people to work smarter" dealing with biology & ecology and utilizing…
  - Environmentally Friendly pesticides
  - Mycotoxins – aflatoxins, naturally occurring toxins in peanuts, mushrooms
- Organic Farming – now will be regulated by the federal government, fringe element no more.
- Biotechnology – fear of the unknown, no risk is acceptable according to anti-biotech groups.

Future of Chemicals & Pesticides

Alternatives will be Key Issue…not a new concept!

- Beneficial insects
- Mechanical control
- Chemical controls
- Hedgerows – create a place for native species- self perpetuating
- Cover crops that produce nitrogen…lower fertilizer use
- Cover crops that encourage beneficial insects…
- Proper irrigation for various crops…reduce runoff

Pesticide Routes of Entry

- Dermal (skin) most common
- Oral
- Respiratory
- Ocular

Rodenticides

Rodents: vectors of disease

- Zinc phosphide - PH_3 (cell toxicity, necrosis, GI, liver, kidneys)
- Fluoroacetic acid and derivatives (Fluoroacetyl-CoA --> fluorocitrate: Krebs cycle collapse)

  α-naphthyl thiourea (ANTU)

  must be metabolically activated --> resistance
- Anticoagulants (coumadin, warfarin) - antagonist of vit. K in synthesis of clotting factors; requires multiple doses; resistance

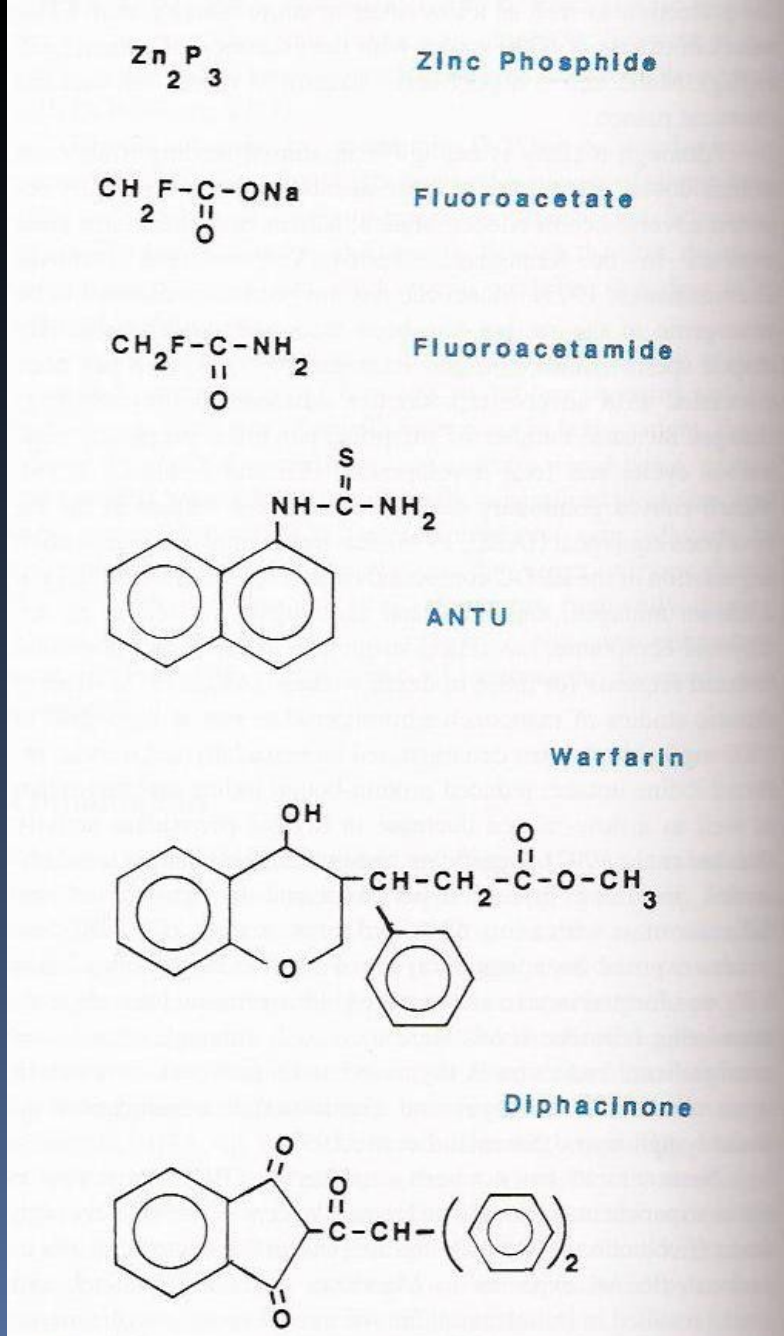
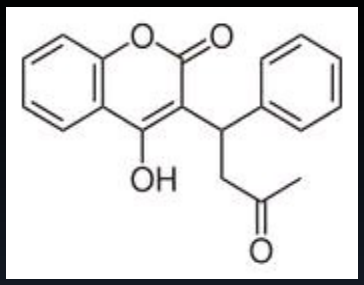


Figure 22-27. Representative structures of inorganic and organic rodenticides from various chemical classifications.

Important properties of rodenticides

- Should be so toxic/potent to kill the rodents
- Should be acceptable to rodents so that lethal dose can be taken by rodents

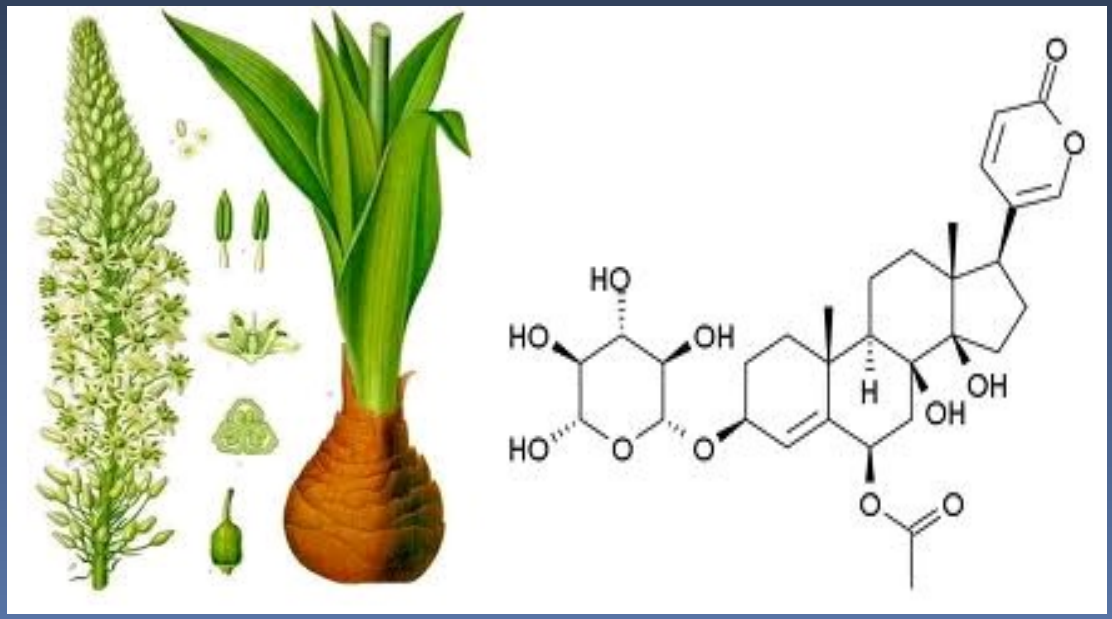
Warfarin



- Chemically it is 3-acetyl benzyl 4-hydroxy coumarine
- Very important anticoagulant drug used in mammalian
- Death occurs due to hemorrhage
- Toxicity appears with dose of 1 mg/kg
- Used for 4-5 days
- Also used to prevent cereals from rats

Scilliroside-stomach poison

- Obtained from Red squill (*Liliaceae*)
- Also present in white squill
- Part used is fleshy scale of bulb
- Contains cardio-active glycoside-Scilliroside



- It is irritant to hands, so should be used with gloves
- It does not produce toxic effects on other animals e.g cats
- Death in rodents occur due to hemorrhage, convulsions and respiratory failure

insecticides

- Stomach poisons
  - These are toxic substances which when enter in GIT lead to death. Death occurs due to respiratory failure
  - Available in the form of dry powders, solution spray and suspension spray
  - Effective for biting insects
  - Methods
    - Substance is sprinkled over the plants. The resinous material gets attached to various plant parts. When biting insects eat the plant, toxic material is also taken in. After ingestion, respiratory failure leads to death

Commonly used stomach poisons

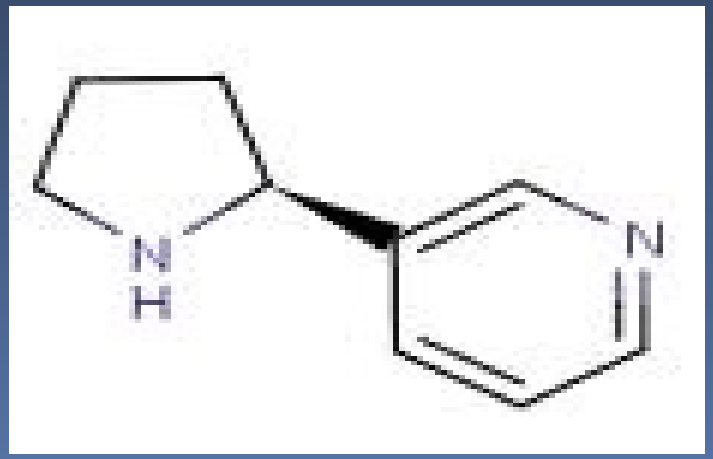
- For growing plants
  - Lead arsenate
- For tomatoes, potatoes and cotton
  - Calcium arsenate
- Some phosphorous compounds are also used
  - e.g octamethyl pyrophosphoimide, phosphorous is absorbed from root and make the plant resistant to pest attack
- Sodium fluoride
- Sodium fluoroacetate

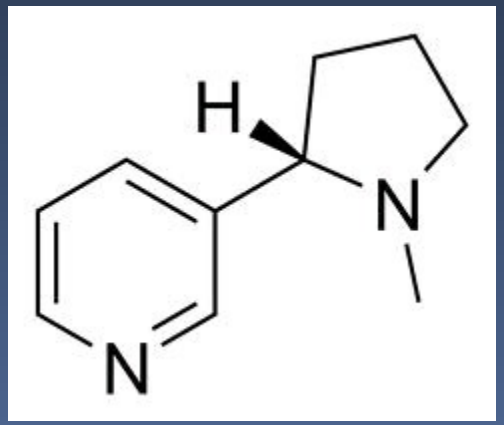
Contact poisons

- These poisons penetrate through the skin or cuticle and cause death of the pest
- These are commonly used for sucking insects
- Contact poisons are of two types
  - Natural contact poisons
    - Tobacco plant
    - Pyrethrum
    - Darris eliptica

Tobacco plant

- Nicotina tobaccum
- Family: Solonaceae
- Part used: dried leaves
- Annual herb
- Habitat: America and cultivated in many countries
- Active constituents
  - Nicotine
  - Nor nicotine





- Drying process is done by curing. By curing a new compound is formed called tobacco camphor, which is responsible for odor of tobacco
- Some of nicotine is also converted to tobacco camphor by enzymatic action

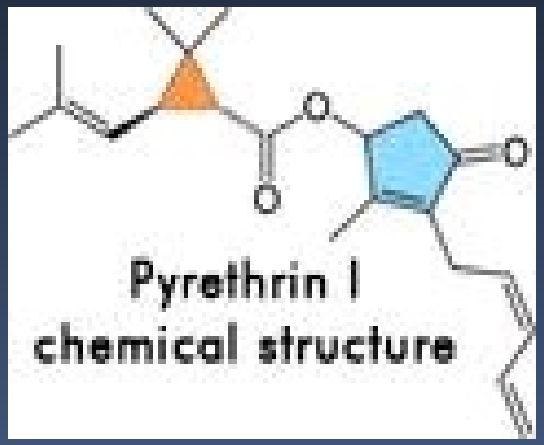
Nicotine

- Colorless
- Turns brown when exposed to sunlight
- Bitter
- Pyridine like flavor

- Soluble in non-polar solvents like chloroform, alcohol, ether and CCl_4
- Miscible with water
- Very toxic
- It is present in plat as: 18% stem, 64% leaves, 13% root and 5% flower
- Seeds don't contain nicotine
- It cause death by convulsions
- Effective against soft pests

pyrethrum

- Family: Compositae
- Parts used: Dry flower
- Active constituents
  - Pyrithrine
  - Linoleic acid
  - Volatile oil
  - Palmitic acid

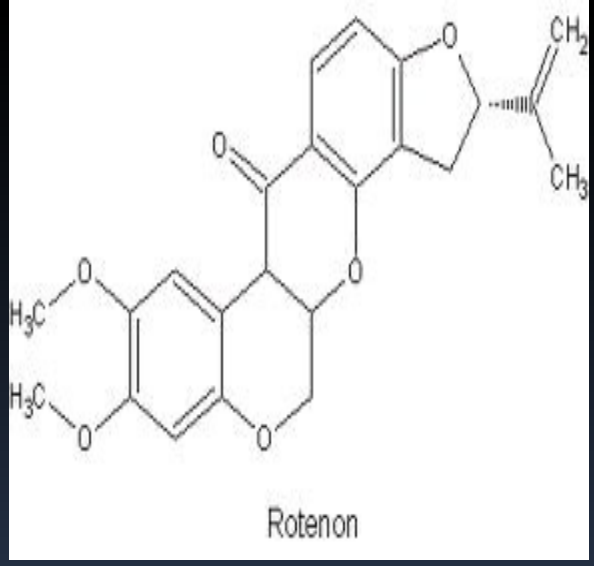


- Perennial herb
- Drying is done by sunlight
- Habitat: Cultivated in Yugoslavia, Brazil, Africa etc.

- Flowers are collected from 4-5 years plant. Closed flowers contain more toxic principles
- These are mainly stomach poisons. But when flying insect's skin come in contact with them. They penetrate through skin and cause death due to convulsions and respiratory failure
- Used along with DDT, ethylene glycol mixture to form aerosol which is sprayed on fly and mosquito
- Used to preserve cotton during storage

Derris elliptica

- Family: Leguminosae
- Parts used: dried root
- Active constituents
  - Rotenon
- Cultivation
- Philipines, Malaysia, Indonesia and Burma
- Rotenon
  - Soluble in non-polar solvents
  - Insoluble in water
  - Used for both biting and sucking insects
  - It leaves no harmful residues



Rotenon