Insecticides and Vector Control

1. Chemical Insecticides
2. Environmental measures
3. Biological control
4. Genetic control
5. Use of Insect Growth Regulators
6. Personal protection

1. Insecticides

Insecticides can be classified according to their mode of entry to the body.

1. Stomach poisons - important in agriculture
2. Fumigants – breathed in. Public health importance. eg. fumigating aircrafts etc.,
3. Contact poisons – more important for the vectors of medical importance.
4. Desiccants- hygroscopic substance used as a drying agent

Almost all the contact poisons are nerve poisons. Some affect the hormone systems.

a. Organochlorines – DDT group. Eg. DDT, methoxychlor
Mode of action – It acts on the CNS on the membrane of nerve cells and affects chemically the ion transmission across the membranes. However if an insect develops resistance to one member of the DDT group, it acquires resistance to almost all members of that group.

b. Organochlorines - HCH/Dieldrin, BFC, Aldrin.
Mode of action is similar to members of the DDT group. Resistance to DDT group does not confers resistance to cyclodiene group, but resistance to one member of the group usually confers resistance to other members.

c. Organophosphates – Malathion, Parathion, Abate, DDVP.
Mode of action – Destroys acetyl choline esterase at nerve synapse. ACE is then not broken down and continuous alarms are set off. Insects become very active, and finally collapse and die. Action much faster than DDT etc.,

d. Carbamates – Carbaryl Enzyme inhibitors, like organophosphate. Acts on different sites to those of organophosphates. When resistance develops to one carbamate, they are usually resistant to all other carbamates. At times a cross-resistance develops to organophosphates.

e. Pyrethroids – Pyrethron, a natural plant product, has components called pyrethrins, which have insecticidal properties. Synthetic preparations of these are pyrethroids eg. Permethrin, Cyhalothrin.

Mode of action – attacks enzyme systems in a more general manner rather than a specific one. Death is due to inactivation of the enzyme

systems in the cytochrome oxidase system and therefore action is at a cellular level. Action is very quick. Resistance to one pyrethroid confers resistance against others, and at times cross resistance develops to DDT as well.

Application Methods

Application has to be in human dwellings and constructions associated with them, because a lot of vectors rest in these places.

1. Solutions - eg. DDT in kerosene. No markings left behind. Expensive.

2. Emulsions– Combination of a solution of insecticide mixed with emulsifying agent. Diluted with H_2 0 to make a suspension of droplets.

3. Wettable powder or water dispensable powder. These are very fine grindings of insecticide particles with an inert filling agent. Highest concentration of insecticide is about 75%.

Solutions, Emulsions are usually for non-absorbable surface (painted walls, tinned roofs).

Wettable powders – Mud walls etc., when water is absorbed the powder remains on top.

Particulate effect – Once insecticide is deposited on the wall, currents of air moving, remove particles from the wall and bring into contact with insect and kills it.

Machines used for spraying.

1. Ordinary stirrup pump.
2. Knapsack machine.

Other Formulations

1. Dusts – 10% DDT
   By hand, special guns, air planes.
2. Aerosols – Solution droplets less than 50:m
   a. By ordinary flit guns.
   b. Fogging machines.
3. Smoke generators – Insecticide and slow burning chemicals.
4. Pyrethron coils.
5. Ultra Low Volume dispersal (ULV) – Application of ½ gal or less of insecticide over large area.
6. Incorporation of Insecticides to paints. eg. 20% DDT in urea formaldehyde resin.
7. Impregnation of cords or strips – Particularly for house flies – 25% Diazinon.
8. Pellet or granules – Insecticide and clay which disintegrate in water- havy dense vegetation, mosquito breeding places etc., eg. Abate.
9. High spreading oil larvicides.
10. Baits – Primarily against flies.

11. Vapour dispensers – volatile insecticide absorbed into pieces of plastic. eg. Dichlorvos.

2. Environmental control

Means modifying the environment to make it unfavourable for the vector. Very often this involves removing potential breeding places of the vector, and again this too is widely used in the control of mosquitoes.

It involves methods such as cleaning vegetation, good house-keeping, drainage of swamps etc. In the case of most medically important insects it involves water management in one way or another. It is one of the earliest methods of vector control to be practiced – malaria control in the ancient times was by cleaning marshes.

Environmental control is a naturalistic method – interfering to upset balance in nature, but is not effective enough to be used alone. Further it requires an initial knowledge of the habits of the vectors. Making the environment unsuitable for one species might make it suitable for another.

In Sri Lanka one of the environmental control methods practiced against malaria in limited areas is the periodic flushing of rivers in the wet zone.

Use of polystyrene beads over the surfaces of stagnant polluted water collections is an environmental modification practiced in some countries to control *Culex* breeding.

3. Biological Control

Means using one animal or plant to control another. The biological control of arthropod vectors is based on the use of *parasites*, *predators* or *pathogens* of these vectors to control them.

This method is used most commonly against mosquitoes and their larval stages. Some protozoa (eg. *Nosema* spp) and some nematode worms, parasitise mosquitoes naturally. They either shorten the life-span of the mosquito or prevent reproduction in some way.

Predators of vectors are often used. Even in Sri Lanka certain species of fish are introduced to localized restricted water collections where mosquitoes breed. A Genus of mosquito. Eg: *Toxorrhynchites* – Large mosquito which does not bite man, but its larvae feed on larvae of *Aedes* mosquitoes. One eats about 250 *Aedes.* Has potential to be used in *Aedes* control.

Larvivorous fish such as *Gambusia affinis*, *Poecilia reticulata* (Guppy), *Aplocheilus dayi* (Nalahandaya) are also used as predators for mosquito larval control.

Bacillus thuringiensis and *B. sphaericus* are pathogenic organisms to insects. *B. sphaericus* is highly pathogenic to *Culex* mosquitoes but non-pathogenic to man. It produces toxins which kills larvae.

There are several disadvantages of biological control methods. By trying to manipulate nature itself, it upsets nature. One has to be careful when introducing completely foreign plant or animals into an area – its effects on other life and toxicity to man etc., Also there should be a plentiful supply of the biological control agent.

4. Genetic control

Basis is, either sterile insects or insects carrying genes which are not favourable to the insect (insecticide susceptible genes) are released into the environment with the hope that they will mate with the naturally occurring insect so that the following generations of this mating would either be sterile and cannot reproduce or if they do reproduce, the will have characters which are incompatible with normal life.

So these systems are based on the principle of using the mate-seeking behaviour of male insects, to introduce genetic abnormalities chosen by man, into eggs laid by wild females. This is done by releasing lab-reared insects into the wild.

The most commonly chosen form of genetic abnormalities are those causing sterility. The idea is to either eradicate the vector or to replace the harmful insect population by harmless one.

Sterile male technique – Male insects of the species to be controlled, are reared in laboratories on a large scale and sterilized with (chemicals or by irradiation). Released to environment in large numbers, to complete with wild males to mate with wild females. No offspring. Males are chosen as they do not bite man.

Genetic control methods depend on several factors.

1. Large-scale rearing of insects is difficult.
2. Sterilizing procedure should not affect the normal survival, dispersal, mating behaviour etc., of insects.
3. Effective mostly on a single female mating. Some insects mate several times during life cycle – less effective.

An advantage is that they do not change or pollute the environment.

One success story in the US is the control of a New World fly causing myiasis namely, screw- worm infestation in cattle.