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Insect resistance to insecticides

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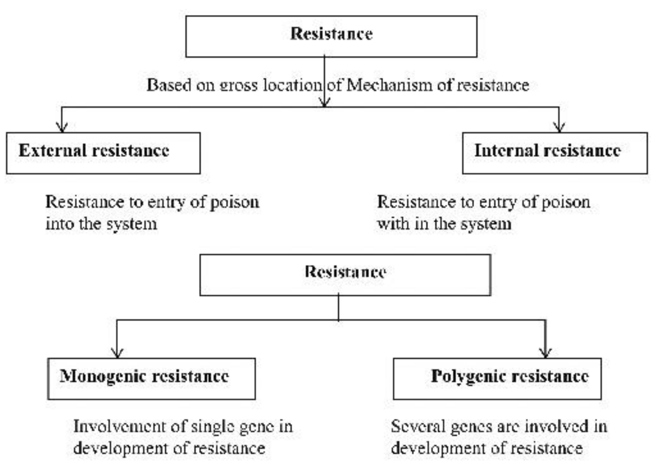
Insects possess a strategic weapon which places them at a definite advantage in the chemical warfare waged between pest and man. Under insecticidal pressure, certain insect strains are able to develop resistance within a few generations. Hoskins and Gordon (1956) defined the resistance as "the added ability to withstand an insecticide acquired by breeding of those individuals which survive exposures to that particular insecticide sufficient to wipe out the whole colony. Most quoted definition of resistance is that of the World Health Organization (W.H.O.) which is described as "Resistance to Insecticides is the development of an ability in a strain of insects to tolerate doses of toxicant which would prove lethal to the majority of individuals in a normal population of the same species". Resistance may be of low level or high level. Low level resistance is termed as Vigor tolerance which implies overall enhanced ability to withstand conditions of stress including exposure to insecticides. Two types of resistance are observed:

Genotypic resistance / Genetic resistance: Resistance due to change in genetic constitution.

Phenotypic resistance / vigour resistance: resistance brought about by factors such as temperature, food, humidity etc.

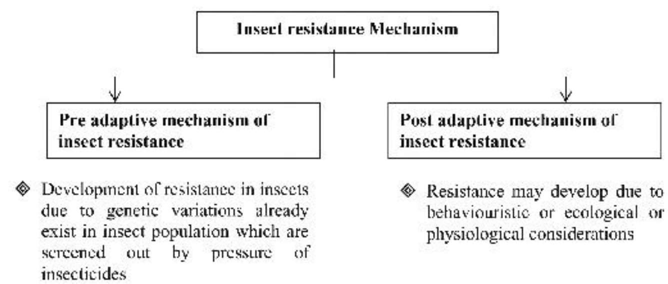


Mechanism of resistance: Insecticide resistance can be defined as change in sensitivity of population which is reflected in repeated features of a product to achieve the expected level of control, when used according to the label recommendations for that pest species (IRAC, 1993).

– If insect population is treated with insecticide, individuals that are killed are said to be "susceptible".

– Those not killed may include individuals with genetic properties that protect them against the insecticide are said to be "resistant".

About 504 insect species have been confirmed to be resistant to at least one chemical class of insecticide of these 283 are agricultural pests, 198 are medical and veterinary and 23 are beneficial insect species.



Preadaptive mechanisms of resistance:

– Role of mixed function oxidases – insect resistance

– Resistance to insecticides due to reduced sensitivity of nervous system.

– Role of hydrolases and glutathione – S - transferase in insect resistance.

– Role of detoxification esterases in insect resistance.

– Enzyme induction and gene amplification in insect resistance to insecticides.

– Resistance to insecticides due to reduced sensitivity of Acetyl choline.

– Role of kdr – factor in insect resistance

Post adaptive mechanism of resistance:

Physiological considerations:

Followings are the important physiological considerations for the development of resistance in insects.

Lipid content: The insect strains contain higher lipid content are comparatively resistant than normal ones. The lipoids pick up the insecticides particularly organochlorines and deposited them in different tissues. Brown (1971)

Table 1 : Insecticide resistance in the pests of public health program

Name of pest	Insecticide	Place	Year first reported
Culex fatigans	DDT	U.P., Bombay	1952
Anopheles stephensi	DDT	Tamil Nadu	1956
A. culcifacies	DDT	Gujarat	1957
A. annularis	DDT	U.P., M.P., Bihar	1962
A. flaviatils	DDT	Maharashtra, Mysore	1964
Aedes aegypti	DDT	Calcutta	1963
Aedes vittalus	DDT	Baroda	1964
Aedes albopictus	DDT	Lucknow	1965

reported that the lipoid content was higher in the resistant flies particularly in their ganglia and tarsi. Increased lipoid was also reported in the adults of DDT resistant strains of *Anopheles atroparvus*.

Detoxification of insecticides to non-toxic metabolites:

The DDT resistant insect strains have the ability to detoxify DDT to the nontoxic metabolite DDE by a process of dehydrochlorination catalyzed by the enzyme DDTase in the presence of glutathione. In cyclodiene derivateive houseflies oxidize aldrin to dieldrin and heptachlor to heptachlor epoxide. Certain strains of house files absorb less aldrin than some normal strains. The resistant strains of house flies to cyclodiene are cross resistant to gamma BHC and *vice versa*. Oxidation of malathion to malaoxon is reported to an equal rate in both susceptible and resistant house flies but malaoxan is degraded more rapidly by the action of phosphatase in resistant fly. In *culex tarsalis* the resistant larvae convert malathion to non toxic metabolites by carboxy esterase at much higher rate than susceptible larvae. The increased carboxyesterase activity is also reported in malathion resistant leaf hoper, *Nephotettix cinticeps*. Dimethoate is converted into nontoxic derivatives by amylase in resistant strains of bollworm. Carbaryl resistant houseflies have greater activity than normal in hydrolyzing carbaryl to 1-naphthol. A strain of *Culex fatigans* made resistant to propoxur is highly cross resistant to closely related carbamates. Diazinon imparts resistance by enhanced detoxification through phosphatases and mixed function oxidase.

Behavioural considerations : Behavioural resistance may be defined as the ability of insect, through protective habits or behaviour to avoid lethal contact with a toxicant. Kerr *et al*. (1957) reported that the late emerging houseflies have increased level of DDTase.

Occurrence of resistance: The occurrence of pesticide resistance in India was first noticed in insects of public health importance. The first report of DDT resistance in mosquitoes came in 1952 in *Culex fatigans*, a transmitter of filaria from U.P. and Bombay (Pal *et al.,* 1952). Since then this mosquito has been resistant to both DDT and BHC in various parts of the country.

Strategies to combat insecticide resistance:

– Judicious use of insecticides : Indiscriminate use of insecticides should be avoided. The essentiality may be measured on the monitoring of the pest population. If the pest population reaches the economic threshold level only then the application of selective insecticides at proper dose level should be made.

– Alteration of insecticide

– Use of Synergist

– Avoid use of same chemical repeatedly. Chemicals of different groups are to be used alternatively.

– Avoid mixing if chemicals.

Adopt the practice of using of good sprayers with recommended doses of insecticides.

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