# PESTICIDE: AN INTRODUCTORY APPROACH

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Human have been on earth for more than 1 million species while insects have existed for at least 250 million years .some 10,000 species of the more than 1 million species of insects are crop-eating and of these approximately 700 species worldwide insect damage to man's corps in the fields and in storages. it can guses the first approaches used by our primitive ancestors to reduse insect annoyance was hugging smoky fires or spreading mud and dust over bitting and tickling insects . today ,such approaches would be repellants and pesticides .

Now a days, The use of toxic pesticides to manage pest problems has become a common practice around the world . pesticides are used almost everywhere not only in agricultural fields, but in homes, parks, schools, forests, roads ,industries and almost all buildings. It is difficult to find somewhere where pesticides are not used from the can of bug spray under our kitchen sink to the air plane, crop dusting acres of farmland , our environment is filled with pesticides . in addition pesticides can be found in the air, food , water and everywhere . we know that use of pesticides is linked to a wide range of public health and environmental concerns ,beside this, the use of the most hazards pesticides is still on the rise which cause cancer , reproductive harm and other serious health problems inhuman beings.

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**What is a pest?**

Pests are living organisms that occur where they are not wanted of that cause damage to crops or humans or other animals. Examples include:

- Insects,
- Mice and other animals,
- Unwanted plants (weeds),
- Fungi,
- Microorganisms such as bacteria and viruses,

## INTRODUCTION TO PESTICIDES

Pesticides are toxic substances to deliberately added to our environment to kill living things .In the words of the environmental protection agency : *" Pesticides are not safe . they are produced specifically because they are toxic to something ."*U.S. EPA, Citizen's Guide to pesticides, 1987. pesticides are not only chemicals but they include a huge range of different types of compounds some are natural (like pyrethrums from chrysanthemums) and many are altered versions of natural chemicals.Thus a pesticides is defined as any substance used to control or protect from pests. Pesticides includes general use (bought "off the self"), restricted use (requires certification to purchase and use), and banned pesticides (i.e. DDT, Chlordane etc). The control may result from killing the insect or otherwise prengaging in behaviors deemed destructive.

Thus a pesticide is any substance or mixture of substances intended for:

- Preventing,
- Destroying,
- Repelling, or
- Mitigating any pest.

## VARIOUS USE OF PESTICIDES IN EVERYDAY LIFE

Many household products are pesticides. All of these common products are considered pesticides:

- Cockroach sprays and baits
- Insect repellents for personal use.
- Rat and other rodent poisons.
- Flea and tick sprays, powders, and pet collars.
- Kitchen, laundry, and bath disinfectants and sanitizers.
- Products that kill mold and mildew.
- Some lawn and garden products, such as weed killers.
- Some swimming pool chemicals. etc.



## TYPES OF PESTICIDES

Pesticides are often referred to according to the type of pest they control. Another way to think about pesticides is to consider those that are chemical pesticides or are derived from a common source or production method. Other categories include bio-pesticides, antimicrobials, and pest control devices. So on the different basis pesticides are different types :

1. **On Application Basis they are called**

- **Insecticides** when apply against the insects and arthropods
- **Fungicides** when apply against the fungi and blights, mildews, molds, and rusts
- **Rodenticides** when apply against the rodents. and mice
- **Miticides** also called acaricides when apply against the mites.
- **Herbicides** when apply against the unwanted herbs.
- **Nematocides** when apply against the nematodes (microscopic, worm-like organisms that feed on plant roots).
- **Molluscides** when apply against the molluc., snails and slugs.
- **Disinfectants and sanitizers** when apply against the inactivate disease-producing microorganisms on inanimate objects.
- **Ovicides** Kill eggs of insects and mites.
- **Pheromones** Biochemicals used to disrupt the mating behavior of insects.
- **Antifouling agents** Kill or repel organisms that attach to underwater surfaces, such as boat bottoms.
- **Fumigants** Produce gas or vapor intended to destroy pests in buildings or soil.

2. **On the mode of preparation**

- **Organic pesticides** when the active ingredient is some organic compounds and they are mainly prepared synthetically i.e. DDT, BHC, chlordane etc.
- **Inorganic pesticides** when the active ingredient is some inorganics i.e. ( Chromated Copper Arsenate )CCA, sodium fluorides etc. Inorganic insecticides are those that do not contain carbon. Usually they are white crystals in their natural state, resembling the salts. These chemicals do not evaporate and usually water-soluble.

- **Bio-pesticides** or **Natural pesticides** are derived from natural materials as animals, plants, bacteria, and certain minerals.

**CHEMICAL PESTICIDES :**
Synthetic chemical pesticides can be classified in the following classes :

**ORGANOCHLORINE PESTICIDES :**

The organochlorine are insecticides that contain carbon (thus organo ) hydrogen and chlorine thus they are also called as hydrocarbons, chlorinated organics, chlorinated insecticides, and chlorinated synthetics. Some of the organochlorine pesticides and their mode of action on a insect are as follows :

- **Di phenyl aliphatics :** the oldest group of the organochlorine is the diphenyl aliphatics which included DDT, DDD, BCH, dicofol, ethyl and methoxychlor etc.

  **Mode of action :** The mode of action for DDT is not clearly established but in some complex manner it destroy the potassium ions within the axons of the neuron in a way that prevents normal transmission of nerve impulses both in insects and apparently acts on the sodium channel to cause leakage of sodium ions. Eventually the affected neurons fire impulses spontaneous muscles to which-DDT jitters- followed by convulsions and death. DDT has a negative temperature correlation—the lower the temperature the more toxic it becomes to insects.

- **Hexchlorocyclohexane (HCH) –** Also known as benzenehexachloride (BHC), the insecticidal properties of HCH were discovered in and British entomologists. In its technical grade, there are five isomers, alpha, beta, gamma, delta and epsilon. Surprisingly, only that has insecticidal properties. Consequently, the gamma isomer was isolated in manufacture and sold as the odorless insecticide Indian technical grade HCH has a strong musty odor and flavor, which can be imparted to treated crops and animal products. Because of its HCH is still used in many developing countries. In 2002, the U.S. EPA removed all food-related uses of linden.

  **Mode of action:** The effects of HCH superficially resemble those of DDT, but occur much more rapidly, and result in a much higher in insects. The gamma isomer is a neurotoxicant whose effects are normally seen within hours as increased activity, tremors, and con prostration. It



too, exhibits a negative temperature correlation, but not as pronounced as that of DDT.

**ORGANOPHOSPHATES**

Organophosphates (Ops) is the term that includes all insecticides containing phosphorus. Other names used, but no longer in vogue, phosphates, phosphorus insecticides, never gas relatives and phosphoric acid esters. All organophosphates are derived from one of acids, and as a class are also similar. Their insecticidal qualities wee first observed in Germany during World War II in the study toxic OP nerve gases sarin, soman and tobun. Initially, the discovery was made in search of substitutes of nicotine, which was hea insecticide but in short supply in Germany.

The Organophosphates have two distinctive features: they are generally more toxic to vertebrates than other classes of insecticides and most are ch or nonresistant. It is this latter characteristic that brought them into agricultural use as substivtes for the persistent organochlorine relatively high toxicity of the OP's, EPA, under provisions of the Food Quality Protection Act (1996), undertook an extensive reap class beginning in the late 1990's. Many OP's were voluntarily canceled and other lost user.the most widely used Organophosphates insecticide is chloropyrifos.

**CHLOROPYRIFOS:** Chloropyrifos is internationally include Pyrinex, Bordan, Dursban, Empire, Snare, Lorsban, Piridane, Scout, And Stipend. Chloropyrifos is active against insect pests. The toxicity of chloropyrifos chloropyrifos results from the action of the metabolites chloropyrifos oxon , which inactivates acetyl cholinesterase at neural junctions . over stimulation of the peripheral nervous system then results in death. chloropyrifos acts on insects primarily as a contect poison, and has some action as a stomach poison. The solvents used in formulations are usually hexane or xylene.

**IUPAC NAME OF CHLOROPYRIFOS :** *O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate

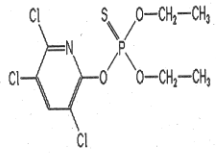
**CHEMICAL FORMULA:** $C_9H_{11}Cl_3NO_3PS$

**ACTIVITY:**

- acaricides (organothiophosphate acaricides).

- Insecticides (pyridine organothiophosphate insecticides).
- nematicides (organothiophosphate nematicides.

**STRUCTURE:**



**Mode of action:** The Organophosphates work by inhibiting certain important enzymes of the nervous system, namely cholinesterase (ChE). The en phosphorylated when it becomes attached to the phosphorous moiety of the insecticide, a binding that is irreversible. This inhibition accumulation of acetylcholine (Ach) at the beuron / neuron and neuron / muscle junctions or synapses, causing rapid voluntary muscles and finally paralysis.

**CARBAMATES**

The Carbamates insecticides are derivatives of carbamic acid. And like the OP's their that of inhibiting the vital enzyme cholinesterase (ChE).

The first successful Carbamates insecticide, carbary, was introduced in 1956. More of it has bees used worldwide that all Carbamates combined. Two distinct quality have made it the most popular Carbamates: its very low mammalian oral and dermal toxic exceptionally broad spectrum of insect control. Other long-standing carbamate insecticides are methomyl, carbofuran, oxamly, thiodicab, methiocarb, Propoxur, bendiocarb, carbosul aldoxycard, promecarb and fenoxycarb. Carbamates more recently introduced include indoxacarb, alaycarb and furathiocarb.

**Mode of action :** Carbamates inhibit cholinesterase (ChE) as Ops do and they behave in almost identical manner in biological system main differences. Some Carbamates are potent inhibitors of aliesterase (miscellaneous aliphatic esterases whose exact function are their selectivity is sometime more pronounced against the ChE of different species. Second, ChE inhibition by Carbamates is reverse inhobited by a Carbamate, it is said to



be carbamylated, as when an OP results in the enzyme being phosporylated. In insects, the effect Carbamates are primarily those of poisoning of the central nervous system, since the insect neuromuscular junction it not cholinergic. The only cholinergic synapse synapses known in insects are in the central nervous system.

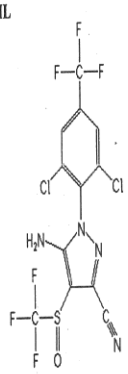
**PYRAZOLES:**

The example of tebufenpyrad and fenpyroximate. These were designed primarily as non systematic contact miticides , but do have limited effectiveness on psylla, aphids, whitefly, and thrips. Presently most widely used pyrazole insecticide is fipronil . Fipronil is active on a broad spectrum insecticide against chewing and sucking insects.

**IUPAC NAME OF FIPRONIL :** 5-amino-1-(2,6-dichloro-α,α,α-trifluoro-*p*-tolyl)-4-trifluoromethylsulfinylpyrazole-3-carbonitrile

**FORMULA** : $C_{12}H_4Cl_2F_6N_4OS$

**STRUCTURE OF FIPRONIL**



**ACTIVITY:** Acaricides (pyrazole acaricides)
insecticides (pyrazole insecticides

**Mode of action :** their Mode of action is thatb of inhibiting mitochondrial electron transport at NADH-CoQ reductase site, leading of adenosine triphosphate (ATP) formation, the crucial energy molecule. Fipronil show neurotoxicity .

## BOTANICALS

Botanical insecticides are of great of many, for they are natural insecticides, toxicants derived from plants. Historically, the been in use longer than any other group with the possible exception of sulfur. Tobacco, pyrethrum , derris, hellebrore, quassia camp were some of the more important plant products in use before the organized search for insecticides began in the early 1940s.In recent years the term biorational has been put into play by the EPA. There are similarities and differences between the terms botanicals biorational. We include a section of the biorationals below and will address the overlaps in th at section. Botanical insecticide use in the U.S. peaked in 1966, and has declined steadily since. Pyrethrum is now the only classical botanical use. Some newer plant – derived insecticides that have come into use are referred to as florals or scented plant chemicals and include, limenene, cinnamaldehyde and eugenol. In addition there is azadirathtin from the neem tree which is used in greenhouse and on.

## PYRETHROIDS

Natural pyrethrum has seldom been used for insecticidal purposes because of its cost and instability in sunlight. In recent decades, pyrethrin-like materials have become available. They were orgginally referred to as a synthetic pyrethroids. Currently, the better nome pyrethroids. These are stable in sunlight generally effective against most agricultural insect pests used at the very low pound per acre.The pyrethroids have an interesting evolution, which is conveniently divided into four generations. The first generation contains only Allethrin, which appeared n 1949. Its synthesis was very complex, involving 22 chemical reactions to reach the final phonothrin. The second generation includes tetramethrin, followed by resmethrin in 1967 bioresmethrin, then Bioallethrin and finally phonothrin. The third generation includes fenvalerate, Tribut & Bellmark and Permethrin which appeared in 1972-73. These became the first agricultural parathyroid because of insecticidal activity and their photostability. They were virtually unaffected by ultraviolet in sunlight, lasting 4-7 days a residues on crop foliage.

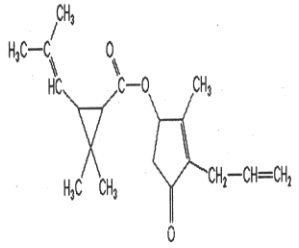


**IUPAC NAME OF ALLETHRIN:** (*RS*)-3-allyl-2-methyl-4-oxocyclopent-2-enyl (1*RS*,3*RS*;1*RS*,3*SR*)-2,2-dimethyl-3-(2-methylprop-1-enyl)cyclopropanecarboxylate

**FORMULA:** $C_{19}H_{26}O_3$

The name "palléthrine" is used in France. One subset of isomers of this substance has it own BSI common name; say bioallethrin.

**STRUCTURE:**



**ACTIVITY:** insecticides (pyrethroid ester insecticides)

**Mode of action –** The pyrethroids share similar modes of action resembling that of DDT and are considered axonic poisons. The keeping open the sodium channel in neuronal membranes. There are two type of pyrethroids. Type I, among other physiological negative temperature coefficient, resembling that of DDT. Type II in contrast have a positive temperature coefficient, showing increincrease in ambient temperature. Pyrethroids affect both the peripheral and central nervous system of the insect. They initially stimulating produce repetitive discharge and eventually casue paralysis. Such effects are caused by their action on the sodium channel, a tiny sodium ions are permitted to enter the axon to cause excitation. The stimulating effect of pyrethroids is much more pronounced than.

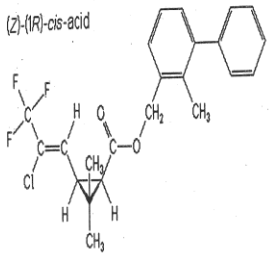
## BIFENTHRIN

**IUPAC OF BIFENTHRIN : :** 2-methylbiphenyl-3-ylmethyl (*Z*)-(1*RS*,3*RS*)-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate

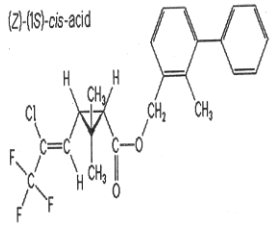
**FORMULA:** $C_{23}H_{22}ClF_3O_2$

**STRUCTURE**

(Z)-(1R)-cis-acid



(Z)-(1S)-cis-acid



**ACTIVITY:** acaricides (pyrethroid ester acaricides)
insecticides (pyrethroid ester insecticides

**Pyrethrum**

Pyrethrum is extracted from the flowers of a chrysanthemum grown in Kenya and Ecuador. It is one of the oldest and safest insecti ground , dried flowers were used in the early 19th century as the original louse powder to control body lice in the Napoleonic Wars. Insects with phenomenal speed causing immediate paralysis thus its popularity in fast knockdown house hold aerosols. However, un with one of the synergists, most of the para!yzed insects recover to once again become pests. Pyrethrum is a mixture of four compound I and II cinerins I and II.

**Mode of action-** Pyrethrum is an axonic poison, as are the synthetic pyrethroids and DDT. Axonic poisons are those that in some electrical impulse transmission along the axons, the extensions of the neuron cell body. Pyrethrum and some pyrethroids



insecticidal effect when the temperature is lowered a negative-temperature coefficient, as does DDT. They effect both the peripheral nervous system of the insect. Pyrethrum initially stimulates nerve cells to produce repetitive discharge, leading eventually to parlay caused by their action on the sodium channel, a tiny hole through which sodium ions are permitted to enter the axon to cause excitation are produced in insect nerve cord, which contains ganglia and systems as well as in giant nerve fiber axons.

**Rotenone** is extracted from the roots of derris plants in Asia and cube plants in South America. This broad-spectrum insecticide is highly toxic to fish and moderately toxic to mammals. It acts as both a contact and stomach poison to insects. It is slow acting and, in the presence of sun and air, its effectiveness is lost within a week after application. Wear a mask during application because rotenone can irritate the respiratory tract. Rotenone dusts and sprays have been used for years to control aphids, certain beetles and caterpillars. Rotenone is a broad spectrum insecticide that kills beneficial insects along with pests.

**FUMIGANTS**

The fumigants are small, volatile, organic molecules that become gases at temperatures above 40°F. They are usually heavier than contain one or more of the halogens. Most are highly pentrating reaching through large masses of material . Tey are insect eggs, nematodes and certain microorganisms in buildings, werehouse, grain elevcators, soils and greenhouses and in package dried fruits, beans, grain, and breakfast cereals. Although its use in mow in decline because of environmental concerns methl bromide is the most heavily used of the fumigants, 68 worldwide in 1996, almost half of which is used in the U.S. The dominant use is for preplanting soil treated accounted for 70% if that that global total. Quarantine uses account for 5-8%, while 8% is used to treat perishable products such as flow 12 % for nonperishable products, like nuts and timber. Approxmately 6% is used for structural application as in drywood termite infested building.

**INSECT REPELLENTS**

Historically, repellents have smoke, plants hung in dwellings or rubbed on the skin as the fresh plant or its brews oils pitc various earths applied to the dboy. Before a more edified approach to insect olfaction and behavior was developed, it was wrongly a substance was repugnant to humans it would likewise be repellent to annoying insects.In recent history, the repellents have been dimethlyl phthalate ,Indalone, Rutgers 612, dibutyl phthalate, various MGK repellent the military clothing repellent, dimethyl carbate and diethyl toluamide. Of has survived and is used worldwide for biting flies and mosquitoes. Most

of the others have lost their registrations are no longer. In 1999, EPA has registered a new insect repellent N-methylneodecanamide. Rather being used on humans to repel insects, it is household floors and other surface to repel cockroaches and ants.

## SPECIFIC ORGANIC PESTICIDES:

- **Microbial insecticides : B.t. (*Bacillus thuringiensis*)** is a naturally occuring bacterial disease of insects, effective against young caterpillars (B.t. substrain *kurstaki*.) B.t. substrain *San Diego tenebrionis* is effective against Colorado potato beetle grubs and B.t. substrain *israeliensis* is effective against fly and mosquito larvae. B.t. is considered safe to humans and wildlife. B.t. acts as a stomach poison by producing proteins ("toxic crystals") which react with the cells of the gut lining of susceptible insects. These B.t. proteins paralyze the digestive system, and the infected insect stops feeding within hours. Targeted insects die from starvation in 2-3 days. Insects must eat sprayed foliage for B.t. to be effective. B.t. has a relatively short shelf life (2-3 years at most) and is degraded relatively quickly by sunlight after spraying. It has been used with good success against the caterpillar pests of the cole crop family- imported cabbageworm, cabbage looper, cross-striped caterpillar, and the diamond back moth.

- **Insecticidal Soaps :** Soaps can be used to control a wide range of plant pests. Small, soft-bodied arthropods such as aphids, mealybugs, psyllids and spider mites are most susceptible to soaps. In most cases, control results from disruption of the cell membranes of the insect. Soaps and detergents may also remove the protective waxes that cover the insect, causing death through excess locs of water. Insecticidal soaps act strictly as contact insecticides, with no residual effect. To be effective, sprays must be applied directly to, and thoroughly cover, the insect. Insecticidal soaps are considered selective insecticides because of their minimal adverse effects on other organisms. Lady beetles, green lacewings, pollinating bees and most other beneficial insects are not susceptible to soap sprays. Predatory mites, however, which are often important in the control of spider mites, are vulnerable to insecticidal soaps.

**Drawbacks**: One of the most serious potential drawbacks to the use of soap-detergent sprays is their phytotoxicity. Certain plants are sensitive to these sprays and may be seriously injured. The risk of plant damage is greater with homemade preparations of household soaps or detergents. When in doubt, test soap-detergent sprays for phytotoxicity problems on a small area a day or two before an extensive area is treated. Limiting the number of soap applications can also be important, as leaf damage can accumulate with repeated exposure. Do not spray plants already severely damaged by



pests and do not spray when temperature is above 90 degrees farenheit or on warm, muggy days.

- **Horticultural Oil :** Various oils have been used for centuries to control insect and mite pests. Oils remain an important tool to manage certain pest problems (e.g., scales, aphids, mites) on a wide range of plants. Oils also can control some plant diseases, such as powdery mildew. Horticultural oils block the air holes (spiracles) through which insects breathe, causing death by asphyxiation. In some cases, oils also may act as poisons, interacting with the fatty acids of the insect and interfering with normal metabolism. Oils pose few risks to people or to most desirable species, including beneficial natural enemies of insect pests. Oils quickly dissipate through evaporation, leaving little residue.

The main limitation of spray oils is their potential to cause plant injury (phytotoxicity) in some sitreations. Essentially all commercially available horticultural oils are refined petroleum products. Impurities in the oil that are associated with plant injury, such as aromatic compounds and compounds containing sulfur, nitrogen or oxygen are removed. Do not spray plants already severely damaged by pests and do not spray when temperature is above 90 degrees farenheit or on warm, muggy days. Vegetable oils also can be used as insecticides, although the type of oil can greatly affect its activity. Cottonseed oil is generally considered the most insecticidal of the vegetable oils. Soybean oil, the most commonly available vegetable oil used in cooking, has also provided fair to good control.

## BIORATIONAL INSECTICIDES

The U.S. EPA identifies biorational pesticides as inherently different from conventional pesticides, fundamentally different mode os action and consequently, lower risk of adverse effects from their. Biorational has come to mean any substance of natural origin that has a detrimental or lethal effect on specific target pest(s) e.g. , insects, weeds, and vertebrate pests, possess a unique mode of action , are the environment. Similar term, biopesticides, which will be defined below.Biorational insecticides are grouped as either(1) biochemical or (2) microbial. In the 1990s the US-EPA began to emphasize a class of products known as biopesticied places biopesticides into three categories:

- Microbial pesticides (bacteria, fungi, virus or protozoa)
- Biochemials –natural substances that control pests by non-toxic mechanisms. An example is insect pheromones.
- Plant-Incorporated protectants (PIPs)- (primarily transgenic plants, e.g. , Bt corn).

EPA discloses that at the end of 2001 there were nearly 200 biopesticide active ingredients registered nearly 800 products. Charateristics that distinguish biorational and biopesticides form conventional ones include: very toxicity to non-target species, pest targets are specific, generally low use rates rapid decomposition environment, usually work well in IPM programs and reduce reliance on conventional pesticide.

## INSECT GROUTH REGULATORS

Insect growth regulators(IGRs) are chemical compounds growth and development in insect. The IGRs disrupt insect growth and development in three ways: hormones, as precocenes, and a s chitin synthesis inhibitors. Juvenile hormones(JH) include ecdyso hormone, JH mimic, JH analog (JHA), and are known by their broder synonyms, juvenodis and disrupt immature development and emergence as adults. Precocenes interfere with the normal function that produce juvenile hormones. And, chitin synthesis inhibitors, affect the ability of insets to produce new exoskeletons when molting.The IGRs are effective when applied in very minute quantities and generally have few or no effects and wildlife. They are however, nonspecific since they affect not target species, other arth well.

Instead of killing directly, IGRs interfere in the normal mechanisums of development and cause the before reaching the adult stage. One JH is the classical juvabione, found in the wood of balsam fir. I discovered quite by accident when paper towels made from this source were used to line insect –reari and the insects' development was suppressed.Some of these plant-derived substances actually serve to inhibit the development of insects feeding protecting the host plant. These are referred to broadly as antijuvenile hormances, more accurately, antiallatotopins or precocenses. Although the mode of action of the precocenes is still unclear, it is they depress the level of juvenile hormone below that normally found in immature insects. For practical purpose. IGRs are used on crops to suppress damageing insect number. They would be the purpose of preventing pupal development or adult emergence, thus keeping the insects in the resulting eventually in their deaths. Commercial successful pheromones have shown activity on caterpillars, and hemipteranc, although effects have been observed on practically all insect. Several IGRs are now registetered by the EPA. The most common are: methoprene, a regulator for use against second through fourth larvl stage floodwater mosquitoes and a s Precor control of dog and cat flies; Hydroprene for use against all cockroaches and pests; and kinoprene, which is effective against aphids, whiteflies, mealybugs.



## APPLICATION AND HEALTH EFFECTS OF PESTICIDES COMMONLY USED IN INDIA

| S.No. | Pesticide Name | What it is used for | Health impacts |
|---|---|---|---|
| 1. | DDT | Effective against wide variety of insects, including domestic insects and mosquitoes | Chronic liver damage cirrhosis and chronic hepatitis, endocrine and reproductive disorders, immuno suppression, cytogenic effects, breast cancer, Non hodkins lymphoma, polyneuritis. |
| 2. | Endosulfan | It is used as a broad spectrum non systemic, contact and stomach insecticide, and acaricide against insect pests on various crops | Effects kidneys, developing foetus, and liver Immuno-suppression, decrease in the quality of semen, increase in testicular and prostate cancer, increase in defects in male sex organs, and increased incidence of breast cancer. It is also mutatagenic |
| 3. | Aldrin | Effective against wireworms and to control termites | Lung cancer, liver diseases |
| 4. | Dieldrin | Used against ectoparasites such as blowflies, ticks, lice and widely employed in cattle and sheep dips. Also used to protect fabrics from moths, beetles and against carrot and cabbage root flies/ Also used as seed dressing against wheat and bulbfly | Liver diseases, Parkinson's & Alzheimer's diseases |
| 5. | Heptachlor | It controls soil inhibiting pests. | Reproductive disorders, blood dyscariasis |
| 6. | Chlordane | It is a contact, stomach and respiratory poison suitable for the control of soil pests, white grubs and termites. | Reproductive disorders, blood dyscariasis, brain cancer, Non Hodkins lymphoma |
| 7. | Lindane | It is used against sucking and biting pest and as smoke for | Chronic liver damage-cirrhosis and chronic hepatitis, endocrine |

| | | | |
|---|---|---|---|
| | | control of pests in grain sore-. It is used as dust to control various soil pests.such as flea beetles and mushroom flies. It is effective as soil dressing against the attack of soil insects | and reproductive disorders, allergic dermatitis; breast cancer, Non hodkins lymphoma, polyneuritis. |
| 8. | Fenitrothion | It is a broad spectrum contact insecticide effective for the control of chewing and sucking pests- locusts aphids, caterpillars and leaf hoppers. It is also used against domestic insects and mosquitoes | Human epidemiological evidence indicates fenitrothion causes eye effects such as retinal degeneration and myopia. Chronic exposure to Fenitrothion can cause frontal lobe impairment. Organo-phosphates are suspected of causing neurologic deficits. |
| 9. | Fenthion | It is a persistent contact insecticide valuable against fruitflies, leaf hoppers, cereal bugs, and weaverbirds in the tropics | Fenthion may be mutagenic: causing genetic aberrations. It may be a carcinogen |
| 10. | Parathion | A contact insecticide and acaricide with some fumigant action. Very effective against soil insects with high mammalian toxicity | Parathion is a possible carcinogen |
| 11. | Profenofos | Used for control of important cotton and vegetable pests. Used against chewing and sucking insects and mites, cotton bollworms, aphids, cabbage looper and thrips | Cholinesterase inhibition and the associated neurological and neuromuscular effects |
| 12. | Phorate | A systemic and contact insecticide employed for the control of aphids, carrot fly, fruit fly and wireworm in potatoes | Cholinesterase inhibition and the associated neurological and neuromuscular effects |
| 13. | Malathion | Widely used insecticide and acaricide used for the control of aphids thrips, red spider mites, leafhoppers and thrips | Malathion and its oxygen analog malaoxon are both quite carcinogenic and have been linked with increased incidence of leukemia in mammals. Chronic |



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| | | | health effects include: suspected mutagen and teratogen, delayed neurotoxin, allergic reactions, behavioral effects, ulcers, eye damage, abnormal brain waves and immuno-suppression |
| 14. | Monocrotofos | A powerful contact and systemic insecticide and acaricide with a broad spectrum of activity used to control pests on crops like cotton, rice, soyabean, maize, coffee, citrus and potatoes | Monocrotophos has also been shown to cause delayed neuropathy |
| 15. | Dimethoate. | A systemic and contact insecticide and acaricide, effective against red spider mites and thrips on most agricultural and horticultural crops | Dimethoate might have carcinogenicity, birth defects, reproductive toxicity and mutagenic effects |
| 16. | Chlorpyrifos | A broad spectrum insecticide used against mosquitoes, fly larvae, cabbage root fly, aphids, codling and wintermoths on fruit trees. It is also used in homes, restaurants against cockroaches and other domestic pests. It is also used for the control of termites | Chlorpyrifos has chronic neurobehavioral effects like persistent headaches, blurred vision, unusual fatigue or muscle weakness, and problems with mental function including memory, concentration, depression, and irritability. |
| 17. | Diazinon | A contact insecticide effective against a number of soil, fruit, vegetable and rice pests e.g. cabbage root, carrot and mushroom flies, aphids, spidermites, thrips and scale insects domestic pests and livestock pests | Non Hodkins lymphoma |
| 18. | Quinalphos | A broad spectrum contact and systemic insecticides applied as a spray to control pests in cereals, brassicas and other vegetables | Anti-choline esterase |
| 19. | Triazophos | Used against flies and insect pests of cerealos, maize, oilseed rape, | Anti choline esterase |

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| | | brassicas, carrots, weevils in peas and cut worms in potatoes and other crops | |
| 20. | Ethion | Used for the control of aphids and mites | Impaired memory and concentration, disorientation, severe depression, irritability, confusion, headache, speech difficulties, delayed reaction times, nightmares, sleepwalking, and drowsiness or insomnia. An influenza-like condition with headache, nausea, weakness, loss of appetite, and malaise |
| 21. | Acephate | It is a systemic insecticide effective against chewing and sucking pests. | It is a possible human carcinogen and evidence of mutagenic effects and reproductive toxicity. |
| 22. | Fenvalerate | It act contact and stomach poison. It controls the pests on crops of cotton, vegetables and fruits. | Reduction in weight. |
| 23. | Permethrin | It is a stomach and contact insecticide effective against broad range of pests of cotton, fruit and vegetable crops. | Health risks found include genetic damage - cancer potential - neurotoxic dangers to unborn children - and harm to marine life. |
| 24. | Cypermethrin | It is a stomach and contact insecticide effective against broad range of pests of cotton, fruit and vegetable crops. | Cypermethrin is a possible human carcinogen. |
| 25. | Deltamethrin | It is a potent insecticide effective as a contact and stomach poison against broad range of pests of cotton, fruit and vegetable crops and store products. | Potential endocrine disrupter |
| 26. | Carbaryl | It is a contact insecticide and fruit thinner with a broad spectrum of activity effective against many pests of fruits, vegetables and cotton. It is also used to control earthworms and leather jackets in | Carbaryl may cause mutations (genetic changes) in living cells. It is a possible teratogen & may damage the kidneys and nervous systems. Within the stomach produces N-nitrocarbaryl, a well |



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| | | turf. | known carcinogen, Non-hodkins Lymphoma, brain cancer. |
| 27. | Carbofuran | It is a broad spectrum systemic insecticide, acaricide and nematicide used against insects, mites and incorporated in soil for control of soil insects and nematodes. | Carbofuran causes cholinesterase inhibition in both humans and animals, affecting nervous system function. |
| 28. | Aldicab | It is a systemic insecticide, acaricide and nematicide which is formulated as granules for soil incorporation. It is effective for control of aphids, nematodes,flea beetles, leaf miners, thrips and white flies on a wide range of crops. | Aldicarb is a cholinesterase inhibitor and so can result in a variety of symptoms including weakness, blurred vision, headache, nausea, tearing, sweating, and tremors. |
| 29. | Methomyl | It is used as a soil and seed systemic insecticide applied as a foliar spray to control aphids. | Inhibition of cholinesterase, resulting in flu-like symptoms, such as weakness, lack of appetite, and muscle aches. |
| 30. | 2, 4-D | It is a selective systemic post emergence herbicide used for the control of many annual broadleaf weeds in cereals, sugarcane and plantation crops. | Twofold excess of all cancers in Swedish railway workers, Non Hodkins Lymphoma |
| 31. | Butachlor | It controls annual grasses and some broad leaved weeds in transplant and direct seeded rice. It is applied as pre-emergence in EC formulations and as early post emergence in the form of granules. | Weight loss, weight changes in internal organs, reduced brain size together with lesions. |
| 32. | Paraquat | It is used as a plant dessicant effective against grasses. | Parkinson's & Alzheimer's diseases. |
| 33. | Simazine &Atrazine | It is a persistent soil acting herbicide which in high concentrations acts as total weed killer and in lower concentrations | Cancer of testes |

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| | | is used for selective control of germinating weeds in a variety of crops - maize, sugarcane, pineapple, sorghum. It is also used for long term control of annual grass and broad-leaved weeds in crops like citrus, coffee, tea and cocoa. | |
| 34. | Glyphosate | It is a potent non-selective post emergence herbicide which kills mono and dicotyledonous annual and perennial weeds | No adverse effects. |
| 35. | Isoproturon | It is used to control annual grass weeds in wheat rye and barley. | Isoproturon appears to be a tumour promoter rather than a complete carcinogen. |
| 36. | Trifluralin | It is used for the control of annual grasses and broad leaved weeds in a wide range of crops cotton, groundnuts, soyabeans, brassica, beans an cereals. | Prolonged or repeated skin contact with trifluralin may cause allergic dermatitis . Other effects include decreased red blood cell counts and increases in methemoglobin, total serum lipids, triglycerides, and cholesterol. It has been shown to cause liver and kidney damage in other studies of chronic oral exposure in animals . |
| 37. | Mancozeb | It is a protective fungicide, effective against a wide range of foliage disease. | Ethylenethiourea (ETU) in the course of mancozeb metabolism and production has the potential to cause goiter, a condition in which the thyroid gland is enlarged, this metabolite has produced birth defects and cancer in experimental animals |
| 38. | Captan | It is a foliage fungicide with protective action . It is mainly used for seed treatment and soil fungicide. | Captan is a possible carcinogen and mutagen |
| 39. | Captafol | It is a protective, wide spectrum foliage and soil fungicide. | Captafol has oncogenic potential (potential to cause cancer) |



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| 40. | Carbendazim | It is a systemic fungicide which controls wide range of pathogens of cereals , fruits, grapes ornamentals and vegetables. It is very effective against leaf and ear disease of wheat. | It disrupts the production of sperm and damages testicular development in adult rats. Carbendazim is also a teratogen damaging development of mammals in the womb. |

*PESTICIDES AND HUMAN HEALTH*

**Toxicity** is the capacity of a substance of inflict injury on a living system. Two types of toxicity are acute toxicity and chronic toxicity. Exposure is defined as "contact" with a substance. Exposures can also be either acute or chronic. The effects from exposure to a pesticide vary based on the pesticide's toxicity, type of exposure and route of entry (ROE). All of these issues will be discussed in this section.

**Acute vs. Chronic**

Acute toxicity relates to effects which result within 24 hours of exposure to a pesticide. Pesticide labels contain warming statements based on acute toxicity. Chronic toxicity is associated with the delayed effects which result from exposure to a pesticide. Exposures can also be referred to as acute and chronic. Acute exposure refers to a single contact with a pesticide. Chronic exposure refers to repeated contact with a pesticide. Categories of toxicity and related dose information is presented in the table below.

| Category of Toxicity | | Label Signal Word | LD50 Oral mg/kg | LD50 Dermal mg/kg | LC50 Inhalation (mg/l) | Approx. lethal oral dose |
|---|---|---|---|---|---|---|
| I. | Highly toxic | DANGER-POISON! | 0-50 | 0-200 | 0-0.2 | A few drops to one teaspoon |
| II. | Moderately toxic | WARNING! | 50-500 | 200-2000 | 0.2-2 | one teaspoon to one ounce |
| III. | Slightly toxic | CAUTION! | 500-5000 | 2000-20,000 | 2.0-20 | One ounce to one pint/lb |
| IV. | Relatively non- toxic | CAUTION! | >5000 | >20,000 | >20 | Over one pint/lb |

**How do pesticides harm people?**

- Pesticides can enter the body through the lungs, digestive system, or skin. Depending on the pesticide, health effects can be immediate or they can occur after years of low-level exposure.
- Symptoms of acute poisoning can include headaches, blurred vision, nausea and vomiting, changes in heart rate, muscle weakness, respiratory paralysis, mental confusion, convulsions, coma, and death.
- Chronic low-level pesticide exposure can lead to cancer, nervous system disorders, liver and kidney damage, respiratory problems, and reproductive problems. Often pesticide-caused health problems do not become evident until years later, when it may be difficult to link to a specific chemical.
- Pesticides can affect reproduction by harming the foetus, causing miscarriage, stillbirth or birth defects, or by altering genetic material so that a mutation is carried on to the next generation.

**What is the difference between acute toxicity and chronic toxicity?**

Acute toxicity occurs when the poisonous effects of the pesticide are felt right away. Whereas chronic toxicity occurs when the poisonous effects of the pesticides on the health are delayed. That is, they take a long time to develop and these long-term effects may not occur until after months or years of exposure to the pesticide.

**What is the meaning of 'local effects' of acute pesticide poisoning?**

Local acute effects are those that affect only the parts of the body the pesticides comes in direct contact with. Local acute effects can be irritant effects such as dryness, burning, redness, and itching of the eyes, nose, throat and skin; watering of the eyes, and cough. Or they can be skin problems, such as redness, itching, burning, rashes, blisters and discolouration. A common symptom of pesticide poisoning is when fingernails and toenails turn black or blue. In bad cases, the nails will even fall off.

**Don't we need pesticides to eliminate insect-borne diseases, like malaria?**

Some pesticides, especially DDT have been useful in controlling mosquitoes carrying malaria. But overuse of insecticides in farming has caused mosquitoes to develop resistance, leading to a resurgence of malaria in many parts of the world. In Sri Lanka



during the 1960's public health programmes using pesticides helped bring about a drop in malaria cases from 3 million to 25. By the early 1970s, however, DDT-resistant mosquitoes started to push infection levels to new levels. Ironically, pesticides may now be a more serious health concern than malaria in some countries. Malaria did not cause a single death in 1978 in Sri Lanka, yet at least a thousand people died from pesticide poisoning. For long-term control, non-chemical methods may well be more effective than the quick fix' use of pesticides. Sri Lanka's self-help Sarvodaya movement has had considerable success mobilising villagers to identify breeding sites of malaria?bearing mosquitoes and then drain, fill, or apply oil films to the breeding sites.

LIST OF PESTICIDES EVALUATED/UNDER EVALUATION PROGRESS IN BUILDING PESTS AND MYCOLOGY LABORATORY UPTO MARCH 2003

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| 1. Chlorpyrifos 20E.C. | M/s Dow-Elanco Ltd, Mumbai |
| 2. Endosulfan 35E.C. | M/s Excel Industries Ltd, Mumbai |
| 3. Hostathion 40E.C. | M/s Hoechst India Ltd, New Delhi |
| 4. Triazophos 40E.C. | M/s Hoechst India Ltd, New Delhi |
| 5. Silafloofen 80E.C. | M/s Hoechst India Ltd, New Delhi |
| 6. Dursban 50T.C. | M/s DE-Nocil India Ltd, New Delhi |
| 7. Deltamethrin2.5.E.C. | M/s Hoechst India Ltd, New Delhi |
| 8. Fenavalerate 2.5 E.C. | M/s Rallis-Searle India Ltd, Bangalore |
| 9. Fosmite 50 E.C. | M/s Pesticide India Ltd. Udaipur |
| 10. Lambdacyhalothrin 2.5 E.C | M/s Synzenta Pvt ., Chennai |
| 11. Bifenthrin 2.5 E.C. | M/s F.M.C.-Rallis Ltd, Bangalore |
| 12. Vinash 2% | M/s United Phosphrous Ltd,Mumbai |
| 13. Cypermethrin 2.5E.C. | M/s United Phosphrous Ltd,Mumbai |
| 14. Fipronil 2.5 E.C. | M/s Aventis Crop Science Ltd, Mumbai |
| 15. Imidacloprid 200SL | M/s Bayer India Ltd, New Delhi |
| 16. Imidacloprid 350 SC | M/s Bayer India Ltd, New Delhi |

## RESOURCES FOR INSECTICIDES:

- USDA Home Page-(http:/www.usda.gov/)
- U.S. EPA Office of Prevention, Pesticides and Toxic Substance – (http://www. epa.gov/pesticides)
- U.S. Geological Survey- Pesticides in the Hydrologic System (http://www. usgs.gov/)
- U.S. Occupational Safety & Health Administration (http://www. osha.gov/)
- California Department of Pesticide Regulations (DPR) (http://www. dcpr.ca.gov/)
- California Environmental protection Agency (CalEPA) (http://www. Calepa.ca.gov/)
- Center for Environmental and Regulatory Information Systems (Purdue University) (http://www. ceris.purdue.edu/)
- Cooperative State Research, Education and Extension Service (CSREES), (http://www. Reeus
- EXTOXNET: Extension Toxicology Network (http://ace.orst.edu/info/extoxnet)
- Interregional Research Project #4-mionr crop pest management ((http://ir4.ruthers.edu/)
- Minnesota Pesticide Impact Assessment Program (http://www3. extension. Umn.edu/projects/)
- National Pesticide telecommunications Network (NPTN), (Oregon State University) (http://www. cce.orst.edu/info/nptn/)
- Pesticide Impact Assessment in New Yark (Cornell University), (http://cce.cornell.edu/programms/ag/pesticide-assessment.html)
- Wisconsin Integrated Pest and Crop Management (http://ipcm.wisc.edu/)
- Crop Life America (http://www. Croplifeamerica.org/)
- CAST: Council for Agricultural Science and Technology (http://www. netins.net/showcase/c)
- Greenpeace (http://www. Greenpeace.org/)
- Insecticide Resistance Action Committee (http://www. plantprotection.org/irac/)
- International Service for the Acquistion of Agri-biotech applications (http://www. Isaaa.org/)
- Pestide.Net- Pesticide News, Information and Resources (http://www. pesticide.net/?)



## SELECTED REFERENCE


1. Aspelin AL, Grube AH (1998) Pesticide Industry Sales and Usage: 1996 and 1997 market Estimates. Office of Prevention, Pesticide Substances, U.S. Environmental Protection Agency. 733-R-98-0001. Washington, DC 20460.37 pp.

2. Carpenter MJ, Ware GW (2004) Defending pesticides in Litigation, 14th Ed. West Thomson. St. Paul, MN 55123, 763 pp.

3. Charles D. 2001, Lords of the harvest: Biotech, big money, and the future of food. Perseus Publishing Cambridge, MA, 348 pp.

4. Crop protection Handbook (2004) Meister Media Worldwide, Willoughby. Ohio, Vol. 90, 900 pp.

5. Mayer MS, McLaughlin JR (1990) Insect pheromones and sex attractants. CRC Press, Boca Raton, FL. 235 pp.

6. Salgado VL (1997) The modes of action of spinosad and other insect control products. Down to Earth 52(2):35-43. Dow AgroScien

7. Thomson WT(2001) Agricultural Chemicals, Book I, Insecticides. Thomson Publications, Fresno, California. 249 pp.

8. Thomson WT (1999-2000 Revision). Agricultural Chemicals, Book III, Miscellaneous Agricultural Chemicals. Thomson Publication California. 189 pp.

9. Tomlin C(ed) (2000) the Pesticide Manual, 12th Ed. British Crop Protection Council. Blackwell Scientific Publications, Cambridge 1250 pp.

10. Ware GW, Whitacre DM (2004) The Pesticide Book, 6th Ed. 496pp. Meister Media Woldwide, Willoughby, Ohio. (ISBN 189282).