

AGRO CHEMISTRY
18K3CHEL01

UNIT 1

Fungicides

Fungicides are **biocidal chemical compounds** or biological organisms used to kill **parasitic fungi** or their **spores**. A **fungistatic** inhibits their growth. Fungi can cause serious damage in **agriculture**, resulting in critical losses of **yield**, quality, and **profit**. Fungicides are used both in agriculture and to fight **fungal infections in animals**. Chemicals used to control **oomycetes**, which are not fungi, are also referred to as fungicides, as oomycetes use the same mechanisms as fungi to infect plants.

Fungicides can either be contact, translaminar or systemic. Contact fungicides are not taken up into the plant tissue and protect only the plant where the spray is deposited. Translaminar fungicides redistribute the fungicide from the upper, sprayed leaf surface to the lower, unsprayed surface. Systemic fungicides are taken up and redistributed through the xylem vessels. Few fungicides move to all parts of a plant. Some are locally systemic, and some move upwardly.

Most fungicides that can be bought retail are sold in a liquid form. A very common active ingredient is **sulfur**, present at 0.08% in weaker concentrates, and as high as 0.5% for more potent fungicides. Fungicides in powdered form are usually around 90% sulfur and are very toxic. Other active ingredients in fungicides include **neem oil**, **rosemary oil**, **jojoba oil**, the bacterium *Bacillus subtilis*, and the beneficial fungus *Ulocladium oudemansii*.

Fungicide **residues** have been found on food for human consumption, mostly from post-harvest treatments. Some fungicides are dangerous to human **health**, such as **vinclozolin**, which has now been removed from use. **Ziram** is also a fungicide that is toxic to humans with long-term exposure, and fatal if ingested. A number of fungicides are also used in human health care.

Bordeaux mixture

Bordeaux mixture (also called *Bordo Mix*) is a mixture of **copper(II) sulphate** (CuSO_4) and **slaked lime** ($\text{Ca}(\text{OH})_2$) used as a **fungicide**. It is used in vineyards, fruit-farms and gardens to prevent infestations of **downy mildew**, **powdery mildew** and other fungi. It is sprayed on plants as a preventive treatment; its mode of action is ineffective after a fungus has become established. It was invented in the **Bordeaux region** of France in the late 19th century. If it is

applied in large quantities annually for many years, the copper in the mixture eventually becomes a [pollutant](#).

Bordeaux mixture achieves its effect by means of the [copper ions](#) (Cu^{2+}) of the mixture. These ions affect [enzymes](#) in the fungal [spores](#) in such a way as to prevent [germination](#). This means Bordeaux mixture must be used preventively, before the fungal disease has struck.

Thorough coverage of the spray on the plants is necessary. The Bordeaux spray continues to adhere well to the plant during rain, though in the long term it is washed off by rain. Commonly in practice, it is applied just once a year, in the wintertime.

Bordeaux mixture can be prepared using differing proportions of the components. In preparing it, the CuSO_4 and the lime are dissolved separately in water and then mixed. [Calcium oxide](#) (burnt lime) and [calcium hydroxide](#) (slaked lime) give the same end result, since an excess of water is used in the preparation.

The conventional method of describing the mixture's composition is to give the weight of CuSO_4 , the weight of hydrated lime and the volume of water, in that order. The percentage of the weight of CuSO_4 to the weight of water employed determines the concentration of the mixture. Thus a 1% Bordeaux mixture, which is typical, would have the formula 1:1:100, with the first "1" representing 1 kg CuSO_4 (pentahydrated), the second representing 1 kg hydrated lime, and the 100 representing 100 litres (100 kg) water. As CuSO_4 contains 25% copper, the copper content of a 1% Bordeaux mixture would be 0.25%. The quantity of lime used can be lower than that of the CuSO_4 . One kg of CuSO_4 actually requires only 0.225 kg of chemically pure hydrated lime to precipitate all the copper. Good proprietary brands of hydrated lime are now freely available, but, as even these deteriorate on storage (by absorbing [carbon dioxide](#) from the air), a ratio of less than 2:1 is seldom used, which corresponds to a 1:0.5:100 mixture.

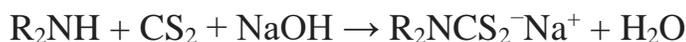
dithiocarbama

A **dithiocarbamate** is a [functional group](#) in [organic chemistry](#). It is the analog of a [carbamate](#) in which both oxygen atoms are replaced by sulfur atoms (when only 1 oxygen is replaced the result is [thiocarbamate](#)).

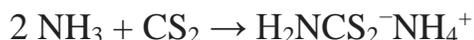
A common example is [sodium diethyldithiocarbamate](#). Dithiocarbamates and their derivatives are widely used in the [vulcanization](#) of rubber.

Formation

Many primary and secondary amines react with carbon disulfide and sodium hydroxide to form dithiocarbamate salts



Ammonia reacts with CS_2 similarly:



Dithiocarbamate salts are pale colored solids that are soluble in water and polar organic solvents.

Reactions

Dithiocarbamates are readily S-alkylated. Thus, methyl dimethyldithiocarbamate can be prepared by methylation of the dithiocarbamate



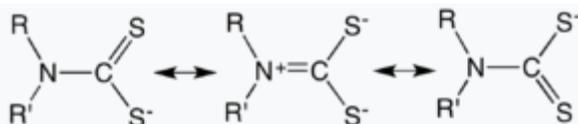
Oxidation of dithiocarbamates gives the thiuram disulfide:



Thiuram disulfides react with Grignard reagents to give esters of dithiocarbamic acid:^[4]



Structure and bonding Dithiocarbamates is described by invoking resonance structures that emphasize the pi-donor properties of the amine group. This bonding arrangement is indicated by a short C–N distance and the coplanarity of the NCS_2 core as well as the atoms attached to N.

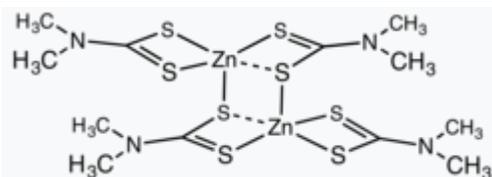


Main resonance structures of a dithiocarbamate anion.

Because of the pi-donation from nitrogen, dithiocarbamates are more basic than structurally related anions such as dithiocarboxylates and xanthates. Consequently, they tend to bind as bidentate ligands. Another consequence of the C–N multiple bonding is that rotation about that bond is subject to a high barrier.

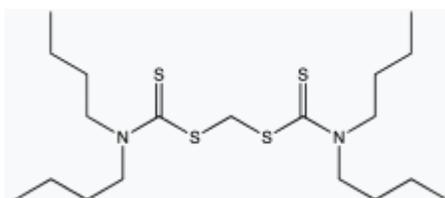
Applications

Zinc dithiocarbamates are used to modify the **cross linking** of certain **polyolefins** with sulfur, a process called **vulcanization**. They are used as ligands for chelating metals.



Structure of the dimethyldithiocarbamate of zinc.

Dithiocarbamates specifically ethylene bisdithiocarbamates (EBDCs), in the form of complexes with **manganese (maneb)**, **zinc (zineb)** or a combination of manganese and zinc (**mancozeb**), have been used extensively as fungicides in agriculture from the 1940s.



CLASSIFICATION OF HERBICIDES

1) Based on Method of application

i) Soil applied herbicides: Herbicide act through root and other underground parts of weeds.e.g.Fluchloralin

ii) Foliage applied herbicides: Herbicide primarily active on the plant foliage e.g.Glyphosate, Paraquat

2) Based on Mode of action

i) Selective herbicide: A herbicide is considered as selective when in a mixed growth of plant species, it kills some species without injuring the others.e.g. Atrazine

ii) Non-selective herbicide: It destroys majority of treated vegetation.e.g. Paraquat

3) Based on mobility

i) Contact herbicide: A contact herbicide kills those plant parts with which it comes in direct contact e.g. Paraquat

ii) Translocated herbicide/Systemic Herbicide: Herbicide which tends to move from treated part to untreated areas through xylem / phloem tissues depending on the nature of its molecule. e.g. Glyphosate

4) Based on Time of application

i) Pre - plant application: Application of herbicides before the crop is planted or sown. Soil application as well as foliar application is done here. For example, fluchloralin can be applied to soil and incorporated before sowing rainfed groundnut while glyphosate can be applied on the foliage of perennial weeds like *Cyperus rotundus* before planting of any crop.

ii) Pre – emergence

Application of herbicides before a crop or weed has emerged. In case of annual crops application is done after the sowing of the crop but before the emergence of weeds and this is referred as pre-emergence to the crop while in the case perennial crops it can be said as pre-emergence to weeds. For example soil application by spraying of atrazine on 3rd DAT to sugarcane can be termed as pre-emergence to cane crop while soil application by spraying the same immediately after a rain to control a new flush of weeds in a inter-cultivated orchard can be specified as pre-emergence to weed.e.g. Atrazine, Pendimethalin, Butachlor, Thiobencarb, Pretilachlor

iii) Post – emergence

Herbicide application after the emergence of crop or weed is referred as post-emergence application. When the weeds grow before the crop plants have emerged through the soil and are killed with a herbicide then it is called as early post-emergence. For example spraying 2, 4-D Na salt to control parasitic weed striga in sugarcane is called as post-emergence while spraying of paraquat to control emerged weeds after 10-15 days after planting potato can be called as early post-emergence.e.g. Glyphosate, Paraquat, 2,4-D Na Salt.

iv) Early post emergence: Another application of herbicide in the slow growing crops like potato, sugarcane, 2-3 week after sowing is classified as early post emergence.

5) Based on molecular structure:

Inorganic compounds

Organic compounds

Herbicide formulation:

Herbicides in their natural state may be solid, liquid, volatile, non-volatile, soluble or insoluble. Hence these have to be made in forms suitable and safe for their field use. An herbicide formulation is prepared by the manufacturer by blending the active ingredient with substances like solvents, inert carriers, surfactants, stickers, stabilizers etc.

Objectives in herbicide formulations are;

- Ease of handling
- High controlled activity on the target plants

Need for preparing herbicide formulation

- To have a product with physical properties suitable for use in a variety of types of application equipment and conditions.
- To prepare a product which is effective and economically feasible to use
- To prepare a product which is suitable for storage under local conditions?

Types of formulation

I. Emulsifiable concentrates (EC): A concentrated herbicide formulation containing organic solvent and adjuvants to facilitate emulsification with water e.g., Butachlor

ii. Wettable powders (WP): A herbicide is absorbed by an inert carrier together with an added surface acting agent. The material is finely ground so that it may form a suspension when agitated with a required volume of water e.g., Atrazine

iii. Granules (G): The inert material (carrier) is given a granular shape and the herbicide (active ingredient) is mixed with sand, clay, vermiculite, finely ground plant parts (ground corn cobs) as carrier material e.g. Alachlor granules.

iv. Water soluble concentrates (WSC): e.g. paraquat

Methylenebis(dibutyldithiocarbamate) is an additive in some extreme pressure gear oils, serving as an antioxidant and protecting metal surfaces

2,4-D Compounds

2,4-Dichlorophenoxyacetic acid is an organic compound with the chemical formula $C_8H_6Cl_2O_3$ which is usually referred to by its ISO common name **2,4-D**. It is a systemic herbicide which selectively kills most broadleaf weeds by causing uncontrolled growth in them but most grasses such as cereals, lawn turf, and grassland are relatively unaffected.

2,4-D is one of the oldest and most widely available herbicides and defoliants in the world, having been commercially available since 1945, and is now produced by many chemical companies since the patent on it has long since expired. It can be found in numerous commercial lawn herbicide mixtures, and is widely used as a weedkiller on cereal crops, pastures, and orchards. Over 1,500 herbicide products contain 2,4-D as an active ingredient.

Manufacture

2,4-D is a member of the phenoxy family of herbicides.

2,4-D is manufactured from chloroacetic acid and 2,4-dichlorophenol, which is itself produced by chlorination of phenol. Alternatively, it is produced by the chlorination of phenoxyacetic acid. The production processes may create several contaminants including di-, tri-, and tetrachlorodibenzo-p-dioxin isomers and N-nitrosamines, as well as monochlorophenol.

Mode of action

2,4-D acts by mimicking the action of the plant growth hormone auxin, which results in uncontrolled growth and eventually death in susceptible plants. It is absorbed through the leaves and is translocated to the meristems of the plant. Uncontrolled, unsustainable growth ensues, causing stem curl-over, leaf withering, and eventual plant death. 2,4-D is typically applied as an amine salt, but more potent ester versions exist, as well.

Applications

2,4-D is primarily used as a selective herbicide which kills many terrestrial and aquatic broadleaf weeds, but not grasses. As it was discovered in the 1940s, a patent no longer governs the manufacture and sale of 2,4-D, and any company is free to produce it. Thus, it is sold in various formulations under a wide variety of brand names. 2,4-D can be found in commercial lawn herbicide mixtures, which

often contain other active ingredients including [mecoprop](#) and [dicamba](#). Over 1,500 herbicide products contain 2,4-D as an active ingredient.

A wide variety of different sectors uses products containing 2,4-D to kill weeds and unwanted vegetation. In agriculture, it was the first herbicide found to be capable of selectively killing weeds but not crops. It has been used since 1945 to control broad-leafed weeds in pastures, orchards, and cereal crops such as corn, oats, rice, and wheat. Cereals, in particular, have excellent tolerance to 2,4-D when it is applied before planting. 2,4-D is the cheapest way for farmers to control winter annual weeds by spraying in the fall, often at the lowest recommended rate. This is particularly effective before planting beans, peas, lentils, and chickpeas. The estimated use of 2,4-D in US agriculture is mapped by the US Geological Survey. In 2017, the latest date for which figures are available, this reached 40,000,000 pounds (18,000,000 kg) annually.

In domestic lawn and garden maintenance, 2,4-D is commonly used for weed control in lawns and other turf. It is used to kill unwanted weeds such as dandelions, plantain, clover, and chickweed. In forestry, it is used for stump treatment, trunk injection, and selective control of brush in conifer forests. Along roadways, railways, and power lines, it is used to control weeds and brush which might interfere with safe operation and damage equipment. Along waterways, it is used to control aquatic weeds that might interfere with boating, fishing, and swimming or clog irrigation and hydroelectric equipment. It is often used by government agencies to control the spread of invasive, noxious, and non-native weed species and prevent them from crowding out native species, and also to control many poisonous weeds such as poison ivy and poison oak.

A 2010 monitoring study conducted in the US and Canada found that "current exposures to 2,4-D are below applicable exposure guidance values."

2,4-D has been used in laboratories for plant research as a supplement in plant [cell culture](#) media such as [MS medium](#) since at least 1962. 2,4-D is used in plant cell cultures as a dedifferentiation (callus induction) hormone. It is classified as an auxin plant hormone derivative.

Picloram

Picloram is a systemic herbicide used for general woody plant control. It also controls a wide range of broad-leaved weeds, but most grasses are resistant. A [chlorinated](#) derivative of [picolinic acid](#), picloram is in the [pyridine](#) family of herbicides.

Picloram can be sprayed on foliage, injected into plants, applied to cut surfaces, or placed at the base of the plant where it will leach to the roots. Once absorbed by the foliage, stem, or roots, picloram is transported throughout the plant.

Herbicides containing Picloram are sold under a variety of brand names. [Dow Chemicals](#) and now [Dow AgroSciences](#) sell herbicides containing it under the brand name Tordon.

During the [Vietnam War](#), a mixture of picloram and other herbicides were combined to make [Agent White](#) (commercially available as Tordon 101) and enhanced [Agent Orange](#) which was previously conducted by the British military during the [Malayan Emergency](#). Large quantities of these herbicides were sprayed by U.S. forces in areas where they considered its long-term persistence desirable, such as inland forests.

Safety

Picloram is of moderate toxicity to the eyes and only mildly toxic on the skin. There is no documented history of human intoxication by picloram so symptoms of acute exposure are difficult to characterize.

Picloram is the most persistent of its family of herbicides. It does not adhere to soil and so may leach to groundwater, and has in fact been detected there. It is degraded in soil and water mainly by microbes. Picloram has very little tendency to accumulate in aquatic life.

Gardeners who use dung as fertilizer should check to make certain that the animal source has not grazed on picloram-treated hay, as the dung still has broadleaf-killing potency.

In regards to occupational exposures, the [Occupational Safety and Health Administration](#) has established a [permissible exposure limit](#) of 15 mg/m³ total exposure and 5 mg/m³ for respiratory exposure, over an eight-hour workshift

Urea

Urea is one of the products of the life activity of animals. It is also used in agriculture as an excellent concentrated fertilizer. Practically, all plants tolerate the use of comparatively large dosages of this compound without any harm. But, even the simplest derivative of urea, biuret, has appreciable phytocidal effect and at dosages of 40-70 kg/hac. it inhibits the growth of many monocotyledonous and dicotyledonous plants. This in fact led to the systematic study of the pesticidal properties of urea derivatives, which revealed that most of the compounds of this

class are active herbicides with little insecticidal fungicidal activities. Consequently, the herbicidal properties of various derivatives of urea have been studied quite in details'. In a search for the effective herbicides and growth regulators, several thousand substituted ureas including the representatives of the aliphatic, alicyclic, aromatic and heterocyclic series have been synthesized and it has been found that the herbicidal activity resides in the urea structure $>N-CO-N<$ and not the nitrogen of the heterocyclic ring. Subsequently, these compounds were prepared in good yields by the reaction of alkyl/ar isocyanates with amines. The symmetrical tetra alkyl ureas do not have herbicidal effect. $RNCO + R'R''NH \rightarrow R'R''N.CO.NHR$ Derivatives of urea containing aliphatic and aromatic groups on the nitrogen have been studied in details. Among them are found active herbicides that have received wide use in agriculture and industry. The most active herbicides are N-aryl-N',N'-dialkylureas, that contain a phenyl group as the aromatic radical in which not over two hydrogens are substituted by functional groups and the total number of carbon atoms in the alkyl group is not over five (because otherwise the activity of the compounds diminishes). The general structure of aryldialkylurea can be show. Here "Ar" is phenyl, chlorophenyl or bromophenyl; R₁ is Ar N C N. (I) - CH₃ or -OCH₃ and R₂ is -CH₃, OCH₃ or H. Dichloral urea [1.3-bis (2,2,2-Trichloro-1-hydroxymethyl) urea], prepared by condensation of chloral with urea in the presence of hydrochloric acid with heating, was the first urea derivative herbicide, introduced in 1950 for the control of annual grasses for a number of crops. Due to the presence of irritating action on the mucous membranes and thereby decreasing its herbicidal activity, it has however now been superceded and is little used. Among the derivatives of aryldimethylurea. 3-phenyl-1,1-dimethyl urea (fenuron) is the first urea herbicide used for the control of woody plants by basal applications and for pre-emergence use in a variety of vegetable crops. The compound is prepared either by the condensation of phenylisocyanate with dimethylamine or by the reaction of dimethylcarbamiyl chloride with anilines. The former method is most universal and produces fenuron with a high degree of purity and in good yields; the herbicide is marketed in the form of wettable powders (80%) or granulated (25%) formulations. This herbicide has high persistence in conditions of the environment and a prolonged residual action in the soil. For this reason, it is used most frequently as non-selective herbicide and only in small doses as selective herbicide on certain crops.

Alachlor

Alachlor is an [herbicide](#) from the chloroacetanilide family. It is an odorless, white solid. The greatest use of alachlor is for control of [annual grasses](#) and broadleaf weeds in crops. Use of alachlor is illegal in the European Union and no products containing alachlor are currently registered in the United States.

Its mode of action is elongase [inhibition](#), and inhibition of [geranylgeranyl pyrophosphate](#) (GGPP) cyclisation [enzymes](#), part of the [gibberellin](#) pathway. It is marketed under the [trade names](#) Alanex, Bronco, Cannon, Crop Star, Intrro, Lariat, Lasso, Micro-Tech and Partner.

Uses

The largest use of alachlor is as a herbicide for control of annual grasses and broadleaf weeds in crops, primarily on corn, sorghum, and soybeans.

Application

Alachlor mixes well with other herbicides. It is marketed in mixed formulations with [atrazine](#), [glyphosate](#), [trifluralin](#) and [imazaquin](#). It is a selective, [systemic herbicide](#), absorbed by germinating shoots and by roots. Its mode of action is elongase inhibition, and inhibition of [geranylgeranyl pyrophosphate](#) (GGPP) cyclisation [enzymes](#), part of the [gibberellin](#) pathway. Stated more simply, it works by interfering with a plant's ability to produce protein and by interfering with root growth.

It is most commonly available as microgranules containing 15% active ingredients (AI), or emulsifiable concentrate containing 480 g/ litre of AI. Homologation in Europe requires a maximum dose of 2,400 g per hectare of AI, or 5 litres/hectare of emulsifiable concentrate or 17 kg/ha of microgranules. The products are applied as either pre-drilling, soil incorporated or pre-emergence.

Butachlor is a [herbicide](#) of the [acetanilide](#) class. It is used as a selective pre-emergent herbicide. It is extensively used in India in the form of granules in rice as post emergence herbicide.

APPLICATIONS

- [Butachlor is an herbicide of the acetanilide class. It is used as a selective pre-emergent herbicide.](#)

- An analytical method using a macroporous diatomaceous earth column and florisil cartridge for cleanup procedure was developed for determination of butachlor and pencycuron in vegetables and rice.
- Butachlor is the most commonly used herbicide on paddy fields in Taiwan and throughout Southeast Asia.
- Butachlor-degrading bacteria were isolated using enrichment culture technique.
- The solid-phase microextraction technique using a 100 µm film poly(dimethylsiloxane) has been examined with the aim to determine butachlor in aqueous samples.
- Butachlor can be Used pre-emergence for the control of annual grasses and certain broad-leaved weeds in rice, both seeded and transplanted. It shows selectivity in barley, cotton, peanuts, sugar beet, wheat and several brassica crops.
- Butachlor and pyrazosulfuron-ethyl are two new highly active herbicides that have been extensively used to control a wide range of weeds in a variety of vegetables and other crops.
- Degradation of the herbicide butachlor was investigated using laboratory-synthesized zerovalent iron . The synthesized zerovalent iron was determined to be nanoscale powder by scanning electron microscopic analysis.
- China's butachlor capacity is 6000 t/a today and output is around 4 000 tons a year.
- The market price of 50% butachlor emulsion oil was RMB28 000 per ton in the brisk application season, being 19% higher than that in the same period of last year.
- Butachlor domestic production capacity of 6,000 tons / year, the actual output of about 4,000 tons / year, domestic consumption of 3,000 tons / year, exports of 1,000 tons / year in recent years the market showed a saddle-type development. 2007,2008 national rice procurement price is too low for two years, the enthusiasm of farmers to plant rice decreased significantly cut paddy field area, and to plant corn, soybeans and other dry land crops, the use of butachlor has dropped significantly

UNIT II
PESTICIDES AND
INSECTICIDES

Pesticides

Pesticides are substances that are meant to control **pests**, including weeds. The term pesticide includes all of the following: **herbicide**, **insecticides** (which may include **insect growth regulators**, **termiticides**, etc.) **nematicide**, **molluscicide**, **piscicide**, **avicide**, **rodenticide**, **bactericide**, **insect repellent**, **animal repellent**, **antimicrobial**, and **fungicide**. The most common of these are herbicides which account for approximately 80% of all pesticide use. Most pesticides are intended to serve as plant protection products (also known as crop protection products), which in general, protect plants from **weeds**, **fungi**, or **insects**.

In general, a pesticide is a chemical (such as **carbamate**) or **biological agent** (such as a **virus**, **bacterium**, or **fungus**) that deters, incapacitates, kills, or otherwise discourages pests. Target pests can include insects, plant **pathogens**, weeds, **molluscs**, **birds**, **mammals**, **fish**, **nematodes** (roundworms), and **microbes** that destroy property, cause nuisance, or spread disease, or are disease **vectors**. Along with these benefits, pesticides also have drawbacks, such as **potential toxicity** to humans and other species.

Pesticides are defined as substances or mixtures of substances intended for controlling, preventing, destroying, repelling, or attracting any biological **organism** deemed to be a pest. **Insecticides**, **herbicides**, **defoliants**, **desiccants**, **fungicides**, **nematicides**, **avicides**, and rodenticides are some of the many kinds of pesticides.

CLASSIFICATION OF PESTICIDES

Pesticides may be classified in a number of ways; these classifications can provide useful information about the pesticide chemistry, how they work, what they target, etc. Following are brief descriptions of some commonly used classification systems.

BY CHEMICAL NATURE

One traditional classification of pesticides places them in one of two groups: **organic** and **inorganic**. **Organic pesticides** are based on chemicals having carbon as the basis of their molecular structure. The chemicals in organic pesticides are more complex than those of **inorganic pesticides**, and usually do not dissolve easily in water. Inorganic pesticides are simpler compounds. They have a crystalline, salt-like appearance, are environmentally stable, and usually dissolve readily in water. The earliest chemical pesticides were inorganic, and included substance such as sulfur and lime.

The vast majority of modern pesticides contain an organic chemical. There have been hundreds of pesticides developed based on organic chemicals, often with oxygen, phosphorus, or sulfur in their molecules, in addition to their basic carbon structure.

Organic pesticides can be subdivided into two additional groups: the **natural organics**, and the **synthetic organics**. The natural organic pesticides (sometimes just called "organics") are derived from naturally occurring sources such as plants. Rotenone and pyrethrum are examples of natural organic pesticides.

Synthetic organic pesticides (usually just called "synthetics") are produced artificially by chemical synthesis. This group comprises most "modern" pesticides (i.e., discovered or used as insecticides post-World War II), and includes DDT, permethrin, malathion, 2, 4-D, glyphosphate, and many, many others.

Fate of pesticides in soil and plant.

When a pesticide is released into the environment many things happen to it. Sometimes what happens is beneficial. For example, the leaching of some herbicides into the root zone can give you better weed control. Sometimes, releasing pesticides into the environment can be harmful, as not all of the applied chemical reaches the target site. For example, runoff can move a herbicide away from target weeds. The chemical is wasted, weed control is reduced, and there is more chance of damaging other plants and polluting soil and water. Or some of the pesticide may drift downwind and outside of the intended application site. Many processes affect what happens to pesticides in the environment. These processes include adsorption, transfer, breakdown and degradation. Transfer includes processes that move the pesticide away from the target site. These include volatilization, spray drift, runoff, leaching, absorption and crop removal. Each of these processes is explained in the following sections. Transfer Processes Adsorption is the binding of pesticides to soil particles. The amount a pesticide is adsorbed to the soil varies with the type of pesticide, soil, moisture, soil pH, and soil texture. Pesticides are strongly adsorbed to soils that are high in clay or organic matter. They are not as strongly adsorbed to sandy soils. Most soil-bound pesticides are less likely to give off vapours or leach through the soil. They are also less easily taken up by plants. For this reason you may require the higher rate listed on the pesticide label for soils high in clay or organic matter. Volatilization is the

process of solids or liquids converting into a gas, which can move away from the initial application site. This movement is called vapour drift. Vapour drift from some herbicides can damage nearby crops. Pesticides volatilize most readily from sandy and wet soils. Hot, dry, or windy weather and small spray drops increase volatilization. Where recommended, incorporating the pesticide into the soil can help reduce volatilization. Spray Drift is the airborne movement of spray droplets away from a treatment site during application. Spray drift is affected by: spray droplet size - the smaller the droplets, the more likely they will drift wind speed - the stronger the wind, the more pesticide spray will drift distance between nozzle and target plant or ground - the greater the distance, the more the wind can affect the spray Drift can damage nearby sensitive crops or can contaminate crops ready to harvest. Drift may also be a hazard to people, domestic animals, or pollinating insects. Drift can contaminate water in ponds, streams, and ditches and harm fish or other aquatic plants and animals. Excessive drift also reduces the pesticide applied to the target and can reduce the effectiveness of a treatment. Runoff is the movement of pesticides in water over a sloping surface. The pesticides are either mixed in the water or bound to eroding soil. Runoff can also occur when water is added to a field faster than it can be absorbed into the soil. Pesticides may move with runoff as compounds dissolved in the water or attached to soil particles. The amount of pesticide runoff depends on the slope, the texture of the soil, the soil moisture content, the amount and timing of a rain-event (irrigation or rainfall), the type of pesticide used Runoff from areas treated with pesticides can pollute streams, ponds, lakes, and wells. Pesticide residues in surface water can harm plants and animals and contaminate groundwater. Water contamination can affect livestock and crops downstream. Pesticide runoff can be reduced by: using minimum tillage techniques to reduce soil erosion grading surface to reduce slopes diking to contain runoff leaving border vegetation and plant cover to contain runoff Pesticide losses from runoff are greatest when it rains heavily right after you spray. Reduce the chances of runoff by watching the weather forecast. If heavy rain is expected, delay spraying to avoid runoff. Irrigate according to label instructions. Leaching is the movement of pesticides in water through the soil. Leaching occurs downward, upward, or sideways. The factors influencing whether pesticides will be leached into groundwater include characteristics of the soil and pesticide, and their interaction with water from a rain-event such as irrigation or rainfall. These factors are summarized in the table below. Leaching can be increased when the

pesticide is water soluble the soil is sandy a rain-event occurs shortly after spraying the pesticide is not strongly adsorbed to the soil Groundwater may be contaminated if pesticides leach from treated fields, mixing sites, washing sites, or waste disposal areas.

Impact of pesticides on Environment

The **impact of pesticides** consists of the effects of pesticides on non-target [species](#). Pesticides are chemical preparations used to kill fungal or animal pests. Over 98% of sprayed [insecticides](#) and 95% of [herbicides](#) reach a destination other than their target species, because they are sprayed or spread across entire agricultural fields. [Runoff](#) can carry pesticides into aquatic environments while wind can carry them to other fields, grazing areas, human settlements and undeveloped areas, potentially affecting other species. Other problems emerge from poor production, transport and storage practices. Over time, repeated application increases [pest resistance](#), while its effects on other species can facilitate the pest's resurgence.

Each pesticide or pesticide class comes with a specific set of environmental concerns. Such undesirable effects have led many pesticides to be banned, while regulations have limited and/or reduced the use of others. The global spread of pesticide use, including the use of older/obsolete pesticides that have been banned in some jurisdictions, has increased overall

The arrival of humans in an area, to live or to conduct agriculture, necessarily has environmental impacts. These range from simple crowding out of wild plants in favor of more desirable cultivars to larger scale impacts such as reducing [biodiversity](#) by reducing food availability of native species, which can propagate across food chains. The use of [agricultural chemicals](#) such as [fertilizer](#) and pesticides magnify those impacts. While advances in [agrochemistry](#) have reduced those impacts, for example by the replacement of long-lived chemicals with those that reliably degrade, even in the best case they remain substantial. These effects are magnified by the use of older chemistries and poor management practices

Water

pesticides were found to pollute every stream and over 90% of wells sampled in a study by the [US Geological Survey](#). Pesticide residues have also been found in rain

and groundwater. Studies by the UK government showed that pesticide concentrations exceeded those allowable for drinking water in some samples of river water and groundwater.

Pesticide impacts on aquatic systems are often studied using a [hydrology transport model](#) to study movement and fate of chemicals in rivers and streams. As early as the 1970s quantitative analysis of pesticide runoff was conducted in order to predict amounts of pesticide that would reach surface waters.

There are four major routes through which pesticides reach the water: it may drift outside of the intended area when it is sprayed, it may percolate, or [leach](#) through the soil, it may be carried to the water as runoff, or it may be spilled, for example accidentally or through neglect. They may also be carried to water by [eroding soil](#). Factors that affect a pesticide's ability to contaminate water include its water [solubility](#), the distance from an application site to a body of water, weather, [soil type](#), presence of a growing crop, and the method used to apply the chemical.

Soil

The extensive use of pesticides in agricultural production can degrade and damage the community of [microorganisms living in the soil](#), particularly when these chemicals are overused or misused as chemical compounds build up in the soil. The full impact of pesticides on soil microorganisms is still not entirely understood; many studies have found deleterious effects of pesticides on soil microorganisms and biochemical processes, while others have found that the residue of some pesticides can be degraded and assimilated by microorganisms. The effect of pesticides on soil microorganisms is impacted by the persistence, concentration, and toxicity of the applied pesticide, in addition to various environmental factors. This complex interaction of factors makes it difficult to draw definitive conclusions about the interaction of pesticides with the [soil ecosystem](#). In general, long-term pesticide application can disturb the biochemical processes of nutrient cycling.

Many of the chemicals used in pesticides are persistent [soil contaminants](#), whose impact may endure for decades and adversely affect [soil conservation](#).

The use of pesticides [decreases the general biodiversity](#) in the soil. Not using the chemicals results in higher [soil quality](#), with the additional effect that more organic matter in the soil allows for higher water retention. This helps increase yields for farms in [drought](#) years, when organic farms have had yields 20-40% higher than their conventional counterparts. A smaller content of organic matter in the soil

increases the amount of pesticide that will leave the area of application, because organic matter binds to and helps break down pesticides.

Degradation and sorption are both factors which influence the persistence of pesticides in soil. Depending on the chemical nature of the pesticide, such processes control directly the transportation from soil to water, and in turn to air and our food. Breaking down organic substances, degradation, involves interactions among microorganisms in the soil. Sorption affects bioaccumulation of pesticides which are dependent on organic matter in the soil. Weak organic acids have been shown to be weakly sorbed by soil, because of pH and mostly acidic structure. Sorbed chemicals have been shown to be less accessible to microorganisms. Aging mechanisms are poorly understood but as residence times in soil increase, pesticide residues become more resistant to degradation and extraction as they lose biological activity.

Effect on plants

[Nitrogen fixation](#), which is required for the growth of [higher plants](#), is hindered by pesticides in soil. The insecticides [DDT](#), [methyl parathion](#), and especially [pentachlorophenol](#) have been shown to interfere with [legume-rhizobium](#) chemical signaling. Reduction of this symbiotic chemical signaling results in reduced nitrogen fixation and thus reduced crop yields. [Root nodule](#) formation in these plants saves the world economy \$10 billion in synthetic nitrogen [fertilizer](#) every year.

[Pesticides can kill bees](#) and are strongly implicated in [pollinator decline](#), the loss of species that pollinate plants, including through the mechanism of [Colony Collapse Disorder](#), in which worker bees from a [beehive](#) or [western honey bee](#) colony abruptly disappear. Application of pesticides to crops that are in bloom can kill [honeybees](#), which act as pollinators. The [USDA](#) and [USFWS](#) estimate that US farmers lose at least \$200 million a year from reduced crop pollination because pesticides applied to fields eliminate about a fifth of honeybee colonies in the US and harm an additional 15%.

On the other side, pesticides have some direct harmful effect on plant including poor root hair development, shoot yellowing and reduced plant growth

Effect on animals

Many kinds of animals are harmed by pesticides, leading many countries to regulate pesticide usage through [Biodiversity Action Plans](#).

Animals including humans may be poisoned by pesticide residues that remain on food, for example when wild animals enter sprayed fields or nearby areas shortly after spraying.

Pesticides can eliminate some animals' essential food sources, causing the animals to relocate, change their diet or starve. Residues can travel up the [food chain](#); for example, birds can be harmed when they eat insects and worms that have consumed pesticides. Earthworms digest organic matter and increase nutrient content in the top layer of soil. They protect human health by ingesting decomposing litter and serving as bioindicators of soil activity. Pesticides have had harmful effects on growth and reproduction on earthworms. Some pesticides can [bioaccumulate](#), or build up to toxic levels in the bodies of organisms that consume them over time, a phenomenon that impacts species high on the food chain especially hard.

Aquatic life

Fish and other aquatic biota may be harmed by pesticide-contaminated water. Pesticide [surface runoff](#) into rivers and streams can be highly [lethal to aquatic life](#), sometimes killing all the fish in a particular stream.

Application of herbicides to bodies of water can cause [fish kills](#) when the dead plants decay and consume the [water's oxygen](#), suffocating the fish. Herbicides such as [copper sulfate](#) that are applied to water to kill plants are toxic to fish and other water animals at [concentrations](#) similar to those used to kill the plants. Repeated exposure to sublethal doses of some pesticides can cause physiological and behavioral changes that reduce fish populations, such as abandonment of nests and broods, [decreased immunity](#) to disease and decreased predator avoidance.

Application of herbicides to bodies of water can kill plants on which fish depend for their habitat.

Pesticides can accumulate in bodies of water to levels that kill off [zooplankton](#), the main source of food for young fish. Pesticides can also kill off insects on which some fish feed, causing the fish to travel farther in search of food and exposing them to greater risk from predators.

The faster a given pesticide breaks down in the environment, the less threat it poses to aquatic life. Insecticides are typically more toxic to aquatic life than herbicides and fungicides.

Amphibians

In the past several decades, [amphibian populations have declined](#) across the world, for unexplained reasons which are thought to be varied but of which pesticides may be a part.

Pesticide mixtures appear to have a cumulative toxic effect on [frogs](#). [Tadpoles](#) from ponds containing multiple pesticides take longer to [metamorphose](#) and are smaller when they do, decreasing their ability to catch prey and avoid predators. Exposing tadpoles to the [organochloride endosulfan](#) at levels likely to be found in habitats near fields sprayed with the chemical kills the tadpoles and causes behavioral and growth abnormalities.

The herbicide [atrazine](#) can turn male frogs into [hermaphrodites](#), decreasing their ability to reproduce. Both reproductive and nonreproductive effects in [aquatic reptiles](#) and amphibians have been reported. [Crocodiles](#), many [turtle](#) species and some [lizards](#) lack sex-distinct chromosomes until after fertilization during [organogenesis](#), depending on temperature. Embryonic exposure in turtles to various [PCBs](#) causes a sex reversal. Across the United States and Canada disorders such as decreased hatching success, feminization, skin lesions, and other developmental abnormalities have been reported.

Humans

Pesticides can enter the body through inhalation of [aerosols](#), dust and [vapor](#) that contain pesticides; through oral exposure by consuming food/water; and through skin exposure by direct contact. Pesticides secrete into soils and groundwater which can end up in drinking water, and pesticide spray can drift and pollute the air.

The [effects of pesticides on human health](#) depend on the toxicity of the chemical and the length and magnitude of exposure. Farm workers and their families experience the greatest exposure to agricultural pesticides through direct contact. Every human contains pesticides in their fat cells.

Children are more susceptible and sensitive to pesticides, because they are still developing and have a weaker [immune system](#) than adults. Children may be more exposed due to their closer proximity to the ground and tendency to put unfamiliar objects in their mouth. Hand to mouth contact depends on the child's age, much like [lead](#) exposure. Children under the age of six months are more apt to experience exposure from breast milk and inhalation of small particles. Pesticides tracked into the home from family members increase the risk of exposure. Toxic

residue in food may contribute to a child's exposure. The chemicals can bioaccumulate in the body over time.

Exposure effects can range from mild skin irritation to [birth defects](#), tumors, genetic changes, blood and nerve disorders, [endocrine disruption](#), coma or death. Developmental effects have been associated with pesticides. Recent increases in childhood cancers in throughout North America, such as [leukemia](#), may be a result of [somatic cell](#) mutations. Insecticides targeted to disrupt insects can have harmful effects on mammalian nervous systems. Both chronic and acute alterations have been observed in exposures. DDT and its breakdown product DDE disturb estrogenic activity and possibly lead to [breast cancer](#). Fetal DDT exposure reduces male [penis](#) size in animals and can produce undescended [testicles](#). Pesticide can affect fetuses in early stages of development, in utero and even if a parent was exposed before conception. Reproductive disruption has the potential to occur by chemical reactivity and through structural changes.

Handling of pesticides

Chemicals used to manage insects, rodents, weeds, molds and germs all have the potential to cause harm to workers. Pesticides come in different forms, including sprays, liquids, powders, granulates, baits and foggers. The Canadian Centre for Occupational Health and Safety in Hamilton, Ontario, offers the following advice to help mitigate the risks associated with using pesticides:

Working safely

- Choose the least hazardous product for the task being performed.
- Keep the label intact and make sure it is readable.
- Only use product as intended, and never use additional pesticide for an increased effect.
- Wear appropriate personal protective equipment, such as gloves, long pants, boots, a faceshield, a hat and goggles.
- Thoroughly clean all spills and isolate the spill area.
- Do not burn pesticides or pour them down a drain.
- Wash skin and change clothes after using a pesticide.
- Discard contaminated leather boots, shoes and belts.
- Clearly label treated surfaces where residue may remain.
- Keep people away from the applied area until the pesticide has dried.

Mixing

- Ventilate areas where chemicals are mixed.
- Mix at the recommended rate and only use the amount directed by the label.
- Avoid creating dusts or splashes.
- Keep containers below eye level.
- Never transfer pesticides into cups or bowls that may be confused with food containers.

Storage

- Lock pesticide storage areas.
- Post warning signs on entrances and walls.
- Maintain an inventory of the quantity, type and age of products.
- Place products on non-absorbent shelves and upright and off the floor.
- Keep pesticides away from highly permeable soil and areas that may flood.
- Store pesticides in a temperature-controlled environment.
- Check containers for leaks or defects and tightly seal and store in original containers.
- Separate pesticides from flammable and combustible materials.
- Keep spill-cleaning equipment and a first aid kit outside or near storage areas.
- Keep pesticides away from food, utensils or water.

First aid precautions

If a person suffers acute pesticide poisoning do the following **immediately**:

- a. Find out if possible the way the poison entered the body. This may either be through the mouth, nose, skin or eyes.
 - If the pesticide has been inhaled, move the person to fresh air.
 - If the pesticide is in the person's eyes, quickly wash the eyes for 15 minutes with clean, gently running water. If there is no running water, bathe eyes from a container, frequently changing the water.
 - If the pesticide is on the skin, remove all contaminated clothing and wash the affected area thoroughly with soap and water.
- b. If the patient is not breathing, apply artificial respiration if possible.

- c. Read the label on the pesticide container for any first aid instructions and keep the label for the doctor. It is very important to be able to tell the doctor the name of the pesticide.
- d. If the pesticide is swallowed, and only if the person is conscious, rinse the mouth with plenty of water and read the label on the pesticide container for further instructions.
- e. Quickly arrange for the doctor, or Community Nurse or Health Worker to be called or take the person to the doctor, clinic or hospital immediately.
- f. Keep the patient warm and comfortable.

Insecticides

Insecticides are substances used to kill **insects**. They include **ovicides** and **larvicides** used against insect **eggs** and **larvae**, respectively. Insecticides are used in **agriculture**, **medicine**, **industry** and by consumers. Insecticides are claimed to be a major factor behind the increase in the 20th-century's agricultural productivity. Nearly all insecticides have the potential to significantly alter ecosystems; many are toxic to humans and/or animals; some become concentrated as they spread along the food chain.

Insecticides can be classified into two major groups: systemic insecticides, which have residual or long term activity; and contact insecticides, which have no residual activity.

The **mode of action** describes how the pesticide kills or inactivates a pest. It provides another way of classifying insecticides. Mode of action can be important in understanding whether an insecticide will be toxic to unrelated species, such as fish, birds and mammals.

Insecticides may be repellent or non-repellent. Social insects such as ants cannot detect non-repellents and readily crawl through them. As they return to the nest they take insecticide with them and transfer it to their nestmates. Over time, this eliminates all of the ants including the queen. This is slower than some other methods, but usually completely eradicates the ant colony.

Insecticides are distinct from non-insecticidal **repellents**, which repel but do not kill.

Nicotine – a natural insecticide

Nicotine has been used as a natural insecticide and is the archetype for the large range of synthetic neonicotinoid insecticides.

Nicotine is an alkaloid and natural insecticide that acts as an anti-herbivore chemical in tobacco plants (*Nicotiana rustica* (wild tobacco), *Nicotiana tabacum* (cultivated tobacco) Fig.1) and other nightshade plants. In tobacco plants nicotine may constitute up to 3 % of the dry weight. The compound mimics the endogenous neurotransmitter acetylcholine and exhibits agonistic effects on most nicotinic acetylcholine receptors. Nicotine has been used as a natural insecticide and is the archetype for the large range of synthetic neonicotinoid insecticides.

While tobacco plants have been consumed for ritual purposes by the Maya people in America at least since the 10th century, they were presented as dried tobacco to Christoph Columbus in 1492. Nicotine has been isolated for the first time by Karl Ludwig Reimann and Christian Wilhelm Posselt in 1928 and named after Jean Nicot, a French ambassador in Portugal in the 16th century. He sent tobacco seeds to his king, who supported the medicinal use of the new plant.

The chemical structure of nicotine contains two linked N-heterocyclic rings, a pyridine and a pyrrolidine (Fig 2). Nicotine is a hygroscopic, oily liquid, soluble in alcohols and ethers and miscible with water. Nicotine is readily volatile with a vapor pressure of 5.5 Pa at 25°C and dibasic with p_Ka values of 3.2 and 7.9. Nicotine is optically active having two enantiomeric forms, while in nature only (S)-nicotine occurs.

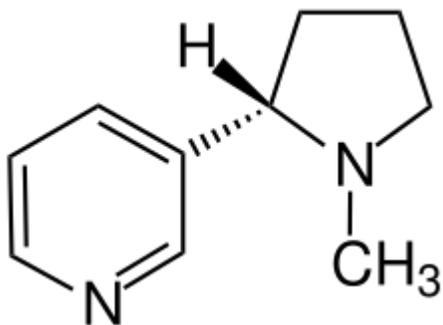


Fig 2: Structure of nicotine

While nicotine is highly toxic to insects and crustaceans, for humans the compound acts as stimulant at low doses. Toxic effects may occur at an oral dose of few mg, while the lethal dose is in the range of 500 to 1000 mg (6.5 to 13 mg/kg). One cigarette contains about 12 mg of nicotine. In the human body, nicotine is metabolized particularly to cotinine and 3-hydroxycotinine, which are found in untreated wastewaters at concentrations of 1 to 10 µg/L and in treated wastewaters at 0.01 to 0.6 µg/L. Parent nicotine concentrations up to 45 ng/L have been measured in River Guadalquivir, Spain. A no-effect concentration (NOEC) of nicotine to *Daphnia magna* of 1 µg/L has been reported.

Pyrethrum

Pyrethrum was a genus of several Old World plants now classified as *Chrysanthemum* or *Tanacetum* (e.g., *C. coccineum*) which are cultivated as ornamentals for their showy [flower](#) heads. **Pyrethrum** continues to be used as a common name for plants formerly included in the genus *Pyrethrum*. Pyrethrum is also the name of a natural [insecticide](#) made from the dried flower heads of *Chrysanthemum cinerariifolium* and *Chrysanthemum coccineum*. Its active ingredient are [pyrethrins](#).

Pyrethrum has been used for centuries as an [insecticide](#), and as a lice remedy in the [Middle East](#) ([Persian powder](#), also known as "Persian pellitory"). It was sold worldwide under the brand [Zacherlin](#) by Austrian industrialist [J. Zacherl](#). It is one of the most commonly used non-synthetic insecticides allowed in certified organic agriculture.

The flowers should be dried and then crushed and mixed with water.

- [Pyrethroids](#) are synthetic insecticides based on natural pyrethrum ([pyrethrins](#)); one common example is [permethrin](#). A common formulation of pyrethrin is in preparations containing the synthetic chemical [piperonyl butoxide](#): this has the effect of enhancing the [toxicity](#) to insects and speeding the effects when compared with pyrethrins used alone. These formulations are known as *synergized pyrethrins*.

Toxicity

- Rat and rabbit LD_{50} levels for pyrethrum are high, with doses in some cases of about 1% of the animal's body weight required to cause significant mortality. This is similar to fatal levels in synthetic

pyrethroids. Nevertheless, pyrethrum should be handled with the same caution as synthetic insecticides.

- People can be exposed to pyrethrum as a mixture of [cinerin](#), [jasmolin](#), and [pyrethrin](#) in the workplace by breathing it in, getting it in the eyes or on the skin, or swallowing it. The [Occupational Safety and Health Administration](#) (OSHA) has set the legal limit ([Permissible exposure limit](#)) for pyrethrum exposure in the workplace as 5 mg/m³ over an 8-hour workday. The [National Institute for Occupational Safety and Health](#) (NIOSH) has set a [Recommended exposure limit](#) (REL) of 5 mg/m³ over an 8-hour workday. At levels of 5000 mg/m³, pyrethrum is [immediately dangerous to life and health](#). People exposed to pyrethrum may experience symptoms including [pruritus](#) (itching), [dermatitis](#), [papules](#), [erythema](#) (redskin), [rhinorrhea](#) (runny nose), [sneezing](#), and [asthma](#).
- People using pyrethrum should wear safety equipment. It is a chemical that should be kept apart from other chemicals.

Rotenone

Rotenone is an odorless, colorless, [crystalline isoflavone](#) used as a broad-spectrum [insecticide](#), [piscicide](#), and [pesticide](#). It occurs naturally in the seeds and stems of several plants, such as the [jicama](#) vine plant, and the roots of several members of [Fabaceae](#). It was the first described member of the family of chemical compounds known as [rotenoids](#). Evidence has come to suggest that rotenone may cause [Parkinson's disease](#) to develop from both acute and prolonged exposure.

Uses

Rotenone is used as a pesticide, insecticide, and as a nonselective piscicide (fish killer)

It is commercialized as *cubé*, *tuba*, or *derris*, in single preparation or in [synergistic](#) combination with other insecticides. In the United States and Canada, all uses of rotenone except as a piscicide are being phased out. In the UK, rotenone insecticides (sold under the trade name Derris) were banned for sale in 2009.

Rotenone has historically been used by indigenous peoples to catch fish. Typically, rotenone-containing plants in the legume family, [Fabaceae](#), are crushed and introduced into a body of water, and as rotenone interferes with cellular

respiration, the affected fish rise to the surface in an attempt to gulp air, where they are more easily caught.

Rotenone has been used by government agencies to kill fish in rivers and lakes in the United States since 1952.

Small-scale sampling with rotenone is used by fish researchers studying the biodiversity of marine fishes to collect cryptic, or hidden, fishes, which represent an important component of shoreline fish communities. Rotenone is the most effective tool available because only small quantities are necessary. It has only minor and transient environmental side effects.

Rotenone is also used in powdered form to treat [scabies](#) and [head lice](#) on humans, and [parasitic mites](#) on [chickens](#), [livestock](#), and [pet](#) animals.

Rotenone has been used as an [organic](#) pesticide dust for gardens. Unselective in action, it kills [potato beetles](#), [cucumber beetles](#), [flea beetles](#), [cabbage worms](#), [raspberry beetles](#), and [asparagus beetles](#), as well as most other arthropods. It biodegrades rapidly in soil, with 90% degraded after 1–3 months at 20 °C (68 °F) and three times faster at 30 °C (86 °F)

Toxicity

Rotenone is classified by the [World Health Organization](#) as moderately hazardous. It is mildly toxic to [humans](#) and other [mammals](#), but extremely toxic to insects and aquatic life, including fish. This higher toxicity in fish and insects is because the [lipophilic](#) rotenone is easily taken up through the [gills](#) or [trachea](#), but not as easily through the skin or the [gastrointestinal tract](#). Rotenone is toxic to [erythrocytes](#) *in vitro*.

The lowest lethal dose for a child is 143 mg/kg. Human deaths from rotenone poisoning are rare because its irritating action causes vomiting. Deliberate ingestion of rotenone can be fatal.

The compound [decomposes](#) when exposed to sunlight and usually has an activity of six days in the environment. It oxidizes to [rotenolone](#), which is about an order of magnitude less toxic than rotenone. In water, the rate of decomposition depends upon several factors, including temperature, pH, water hardness and sunlight. The half-life in natural waters ranges from half a day at 24 °C to 3.5 days at 0 °C

Petroleum Oil

Petroleum is a [naturally occurring](#), yellowish-black [liquid](#) found in [geological formations](#) beneath the [Earth's](#) surface. It is commonly refined into various types of [fuels](#). Components of petroleum are separated using a technique

called [fractional distillation](#), i.e. separation of a liquid mixture into fractions differing in boiling point by means of distillation, typically using a [fractionating column](#).

It consists of naturally occurring [hydrocarbons](#) of various molecular weights and may contain miscellaneous [organic compounds](#). The name *petroleum* covers both naturally occurring unprocessed **crude oil** and [petroleum products](#) that are made up of refined crude oil. A [fossil fuel](#), petroleum is formed when large quantities of dead organisms, mostly [zooplankton](#) and [algae](#), are buried underneath [sedimentary rock](#) and subjected to both intense heat and pressure.

Petroleum has mostly been recovered by oil drilling (natural petroleum springs are rare). Drilling is carried out after studies of structural geology (at the reservoir scale), sedimentary basin analysis, and reservoir characterisation (mainly in terms of the [porosity](#) and [permeability](#) of geologic reservoir structures) have been completed. It is refined and separated, most easily by [distillation](#), into numerous consumer products, from [gasoline](#) (petrol) and [kerosene](#) to [asphalt](#) and chemical [reagents](#) ([ethylene](#), [propylene](#), [butene](#), [acrylic acid](#), [para-xylene](#)) used to make [plastics](#), [pesticides](#) and [pharmaceuticals](#). Petroleum is used in manufacturing a wide variety of materials, and it is estimated that the world consumes about 95 million [barrels](#) each day.

The use of petroleum as fuel is a major cause of [global warming](#) and [ocean acidification](#). According to the UN's [Intergovernmental Panel on Climate Change](#), without [fossil fuel phase-out](#), including petroleum, there will be "severe, pervasive, and irreversible impacts for [people](#) and [ecosystems](#)"

Neem oil

Neem oil insecticide is often a great solution if you are having problems with insects, mites, or fungi bothering your plants. What organic gardeners love about it is that it is safe to use: It will not harm you, your kids, your pets, or your livestock. It is safe even for most wildlife, its insecticidal properties being targeted to specific [pests](#) that damage garden plants. Learn examples of pests that neem is effective against.

Neem oil is pressed out of the seeds obtained from neem trees. The botanical name for this tree is *Azadirachta indica*. The tree is a [broadleaf evergreen](#) that is [indigenous](#) to India and adjacent areas. The tree belongs to the mahogany family and commonly becomes 50 to 60 feet tall. Neem oil and the tree from which it is derived are so called from the Sanskrit, *nimba*.

Neem oil insecticide kills some pests after they have eaten leaves sprayed with it, while it repels others with its strong smell. Neem oil is used to control [many pests](#), including whitefly, aphids, Japanese beetles, moth larvae, scale, and [spider mites](#). As it kills mites, which are not insects but, instead, related to spiders and [ticks](#), it is listed as a "miticide." Sprays containing clarified hydrophobic extract of neem oil are also used as fungicides against rust, [black spot](#), mildew, leaf spot, scab, anthracnose, blight, and botrytis.

Besides being an organic insecticide, using this product allows you to target pests specifically as opposed to [beneficial insects](#) such as bees and lady beetles. By definition, "pests" are the insects eating your plants, and neem oil, when properly applied, kills an insect only if it ingests the sprayed foliage (bees and lady beetles do not eat plant leaves).

Neem Oil on Trees

- [Flowering dogwood trees \(*Cornus florida*\)](#) are highly susceptible to powdery mildew. Because powdery mildew is a fungus, the fungicidal properties of neem oil make the product effective for fighting this problem.
- [Blue Star juniper \(*Juniperus squamata* Blue Star\)](#) can succumb to infestations of spider mites. Take advantage of neem oil's miticidal properties to kill spider mites on the plant.
- Spraying [Colorado blue spruce trees \(*Picea pungens*\)](#) with neem oil can work as an insecticide against Cooley spruce gall adelgid and aphids.

Panchakavyam

Panchagavya or **panchakavyam** is a mixture used in traditional [Hindu](#) rituals that is prepared by mixing five ingredients. The three direct constituents are cow [dung](#), [urine](#), and [milk](#) the two derived products are [curd](#) and [ghee](#). These are mixed in proper ratio and then allowed to ferment. The [Sanskrit](#) word *panchagavya* means "five cow-derivatives". When used in [Ayurvedic](#) medicine, it is also called **cowpathy**.

Efficacy

Proponents claim that cow urine therapy is capable of curing several diseases, including certain types of cancer, although these claims have no scientific backing. In fact, studies concerning ingesting individual components of panchagavya, such as [cow urine](#), have shown no positive benefit, and significant side effects,

including convulsion, depressed respiration, and death. [Cow's urine](#) can also be a source of harmful bacteria and infectious diseases, including [leptospirosis](#).

Applications

Panchgavya is also used as a [fertilizer](#) and [pesticide](#) in agricultural operations. Proponents claim that it is a growth promoter in the poultry diet, that it is capable of increasing the growth of plankton for fish feed, and that it increases the production of milk in cows, increases the weight of pigs, and increases the egg laying capacity of poultry. It is sometimes used as a base in cosmetic products