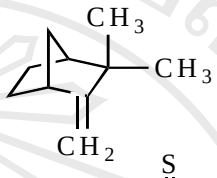
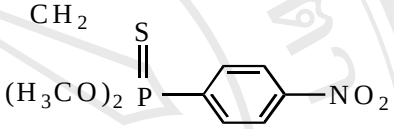
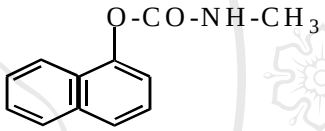
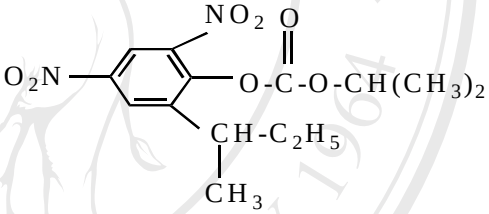
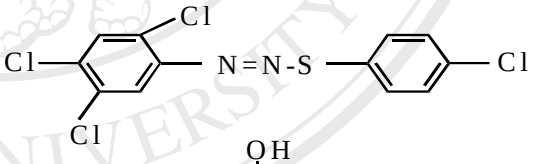
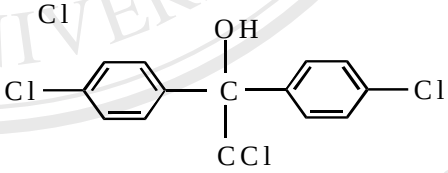
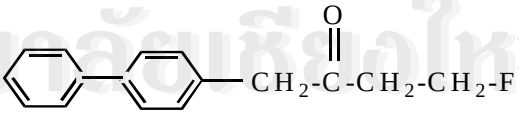
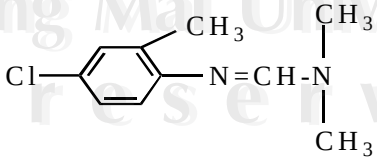
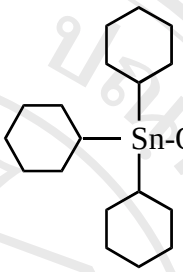
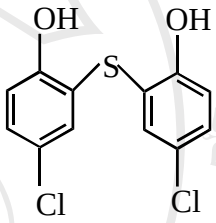
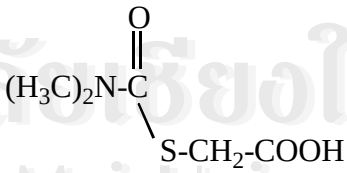
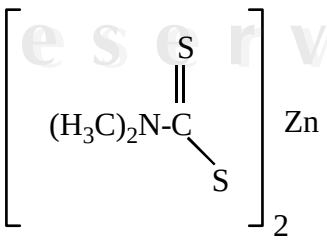
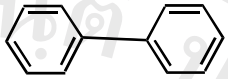
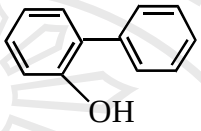
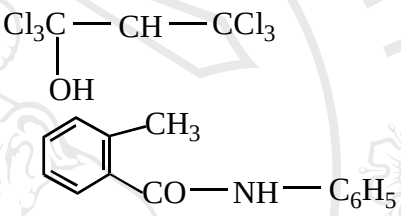
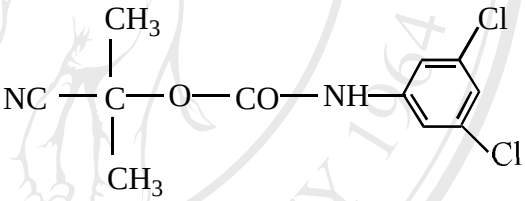
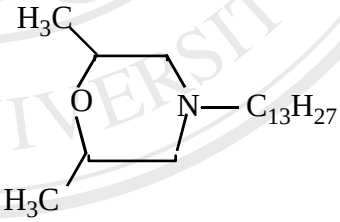
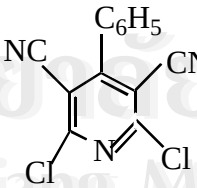
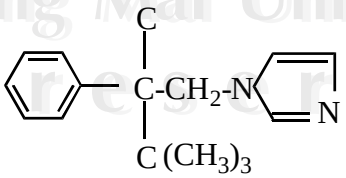
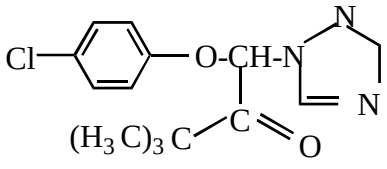
APPENDIX A

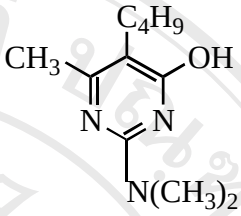
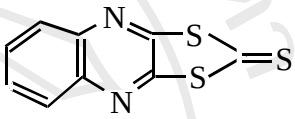
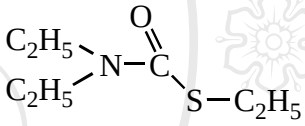
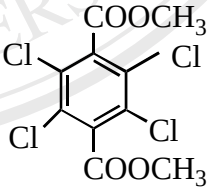
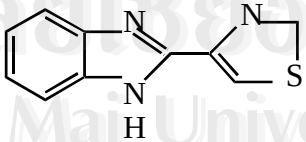
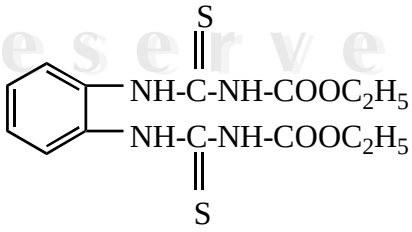
The major chemical categories of pesticides are as follow: chlorohydrocarbons, organophosphates, carbamates, nitrophenols, azo and hydrazines, diphenylcarbinols, fluorinated, formamidines, organometallic, mercaptans, sulfoxides, sulfones and sulfonates, thiocarbonates, dithiocarbamates, heterocyclicsulfur, hydrocarbons, alcohols and phenols, carboxamides, carboximides, amine derivatives, pyridine heterocyclics, imidazoles, triazoles, benzimidazoles and thiophanates, pyrimidines, quinozaline, S-alkyl dialkylcarbamothioates, ureas, carboxylic acids and derivatives, dinitroanilines, and triazines . An example of the structures of each chemical type is shown in Table A1 (3).

Table A1 Chemical categories of pesticides

Name	Structures
Chlorohydrocarbons	
Organophosphates	
Carbamates	
Nitrophenols	
Azo and Hydrazines	
Diphenylcarbinols	
Fluorinated	
Formamidines	

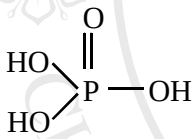
Name	**Structures**
Organometallic	
Mercaptans and thioethers	
	C_6H_5-S-CH_2-SO_2-NH_2
Sulfoxides, sulfones, and sulfonates	Cl_2CH-CH-SO-CH-$CHCl_2$ (Cl, Cl)
	H_3C-SO_2-S-CH_2-CH-CH_3 (OH)
Thiocarbonates	Cl_3C-SO_2-CCl_3
	
Dithiocarbamates	

Name	Structures
Hydrocarbon	
Alcohols and phenols	
Carboxamides	
Amine derivatives	 
Pyridine heterocyclics	
Imidazole and triazole	 

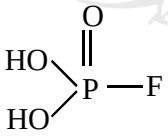
Name	Structures
Pyrimidines	
Quinoxalines	
S-Alkyl dialkylcarbamothioates	
Ureas	
Carboxylic acids and derivatives	 
Benzimidazoles and thiophanates	 

APPENDIX B

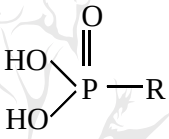
The organic phosphorus compounds constitute the second important group of pesticides. These compounds are either derivatives of phosphoric acid, pyrophosphoric acid, fluorophosphoric acid, the two isomers, thiophosphoric acid and thionophosric acid, and dithionopyrophosphoric acid. Phosphonates are also to be found among the organic phosphorus pesticides (19).



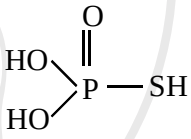
Phosphoric acid



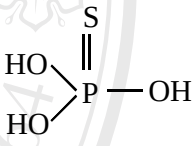
Fluorophosphoric acid



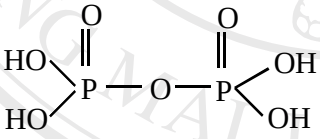
Phosphonate



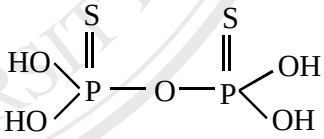
Thiophosphoric acid



Thionophosphoric acid



Pyrophosphoric acid



Dithionopyrophosphoric acid

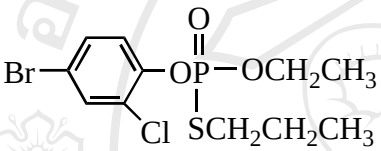
A list of some organophosphorus pesticides including of their strusture properties, toxicology, nomenclature and uses are in page 89-94 (58).

B.1 profenofos

Common name profenofos.

Chemical name *(IUPAC)* 0-=4-bromo-2-chlorophenyl*O*-ethyl S-propyl phosphorothioate.

Structural formular



Empirical formular **$C_{11}H_{15}BrClO_3PS$ (373.6)**

Development **Insecticide**

Properties

Pure profenofos is a pale yellow liquid; **b.p.** 110 °C/0.001 mmHg; **v.p.** 1.3 mPa (20°C); ρ 1.455 g/cm^3 at 20 °C; n_D^{25} 1.5493 – 1.5495. **Solubility** (20°C): 20 mg/1 water; miscible with most organic solvents. **Stability :** on hydrolysis (20°C) DT_{50} (calculated) 93 d (pH5), 14.6 d (pH7), 5.7 h (pH9).

Uses

Non-systemic broad spectrum insecticide for use against insect pests and mites on cotton. Effective by contact and ingestion and, due to its translaminar effect, it kills lepidopterous larvae on the untreated side of the leaves. Rates of application for sucking insects and mites are 250-500 g AI/ha; for chewing insects 400-1200 g/ha.

The separate optical isomers, due to the chiral phosphorus atom, show different types of insecticidal activity and ability to inhibit acetylcholinesterase

Toxicology

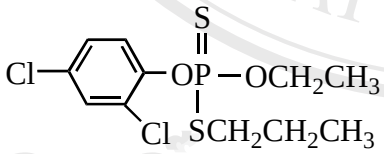
Mammalian toxicity. Acute oral LD_{50} for rats 358 mg TC/kg. **Acute percutaneous** LD_{50} for rats c. 3300 mg/kg; slight **irritant** to skin and eyes of rabbits. **Acute inhalation** LC_{50} (4-h) for rats c. 3 mg/1 air. In **feeding trials** NOEL (EC formulation 380 g AI/l) for rats (2-y) 0.3 mg AI/kg diet, for lifetime study 1.0 mg AI/kg diet.

B.2 prothiofos.

Common name prothiofos

Chemical name (IUPAC) O-2,4-dichlorophenyl O-ethyl S-propyl phosphorodithioate.

Structural formular



Empirical formular $C_{11}H_{15}Cl_2O_2PS_2$ (345.2)

Development Insecticide

Properties

Prothiofos is a colourless liquid; **b.p.** 125-128°C/0.1 mm Hg; **v.p.** <1.0 mPa (20°C); d_4^{20} 1.3; n_D^{20} 1.5694. **Solubility** (20°C) : 0.05 mg/1 water: > 200 g/1 dichloromethane, propan-2-ol, toluene.

Uses

Insecticide used against leaf-eating lepidopteran larvae, generally in fruits and vegetables at 50-75 g AI/hl. Also for public health use against Homoptera.

Toxicology

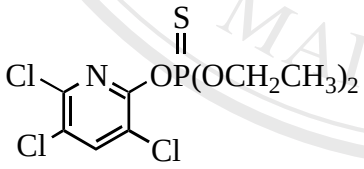
Mammalian toxicity. Acute oral LD_{50} : for rats c. 1500 mg/kg; for mice c. 200 mg/kg. **Acute percutaneous LD_{50}** for rats > 5000 mg/kg. **Acute inhalation LC_{50}** (4-h) for rats > 2.7 mg/l air (aerosol). In 2-y **feeding trials** NOEL for rats 5 mg/kg diet.

B.3 Chlorpyrifos

Common name Chlorpyrifos

Chemical name (IUPAC) O,O-diethyl O-3,5,6 = trichloro-2-pyridyl phosphorothioate.

Structural formular



Empirical formular **$C_9H_{11}Cl_3NO_3PS$ (350.6)**

Development Insecticide

Properties

Chlorpyrifos forms colourless crystals with a mild mercaptan odour; **m.p.** 42-43.5 °C; **v.p.** 2.5 mPa (25°C). **Solubility** (25°C) : 2 mg/l water; 6.5 kg/kg acetone; 7.9 kg/kg benzene; 6.3 kg/kg chloroform; 450 g/kg methanol. **K_{ow}** 50 000. **Stability**

: rate of hydlorysis increases with pH, the presence of copper and possibly of other metals that can form chelates, hydrolysis DT_{50} 1.5 d (water at pH8 and 25°C) to 100 d (phosphate buffer at pH7 and 15°C). Persists in soil for 60-120 d, being degraded initially to 3,5,6-trichloropyridin-2-ol. **Corrosive** to copper and brass.

Use

A broad range of insecticide effective by contact, ingestion and vapour action, but not systemic. Controls Coleoptera, Diptera, Homoptera and Lepidoptera in soil or on foliage of citrus, coffee, cotton, maize and sugar beet. Also used against household pests (Blattellidae, Muscidae, Isoptera) mosquitoes (larvae and adults) and the control of ectoparasites on cattle and sheep. Volatile enough to form insecticidal deposits on nearby, untreated surfaces. Typical rates: 240-1200 g AI/ha for EC and 500-2500 g/ha for GR.

Toxicology

Mammalian toxicity. Acute oral LD_{50}: for rats 135-163 mg/kg; for guinea-pigs 500 mg/kg; for rabbits 1000-2000 mg/kg. **Acute percutaneous LD_{50}** (in solutions) for rabbits c. 2000 mg/kg. **Acute inhalation LC_{50}** (4-h) for rats > 0.2 mg/l (max. achievable level). In 2-y **feeding trials NOEL,** based on blood plasma cholinesterase activity: for rats 0.03 mg/kg daily; for dogs 0.01 mg/kg daily. Rapidly detoxified in rats, dogs and other animal species. **ADI** for man 0.01 mg/kg body weight.

B.4 Dichlorvos

Common name Dichlorvos.

Chemical name *(IUPAC)* 2,2-dichlorovinyl dimethyl phosphate (I).

Structural formular

Empirical formular **$C_4H_7Cl_2O_4P$ (221.0)**

Development **Insecticide**

Properties

Dichlorvos is a colourless to amber liquid, with an aromatic odour; **b.p.** 74°C/l mmHg; **v.p.** 290 mPa (20°C); d_4^{25} 1.42; n_D^{25} 1.45. **Solubility** (20°C): c. 10 g/l water; 2-3 g/kg kerosene; miscible with most organic solvents and aerosol propellants. **Stable** to heat but is hydrolyzed by water, a saturated aqueous solution at room temperature is converted to dimethyl hydrogen phosphate and dichloroacetaldehyde at rate of c. 3%/d, more rapidly in alkali**. Corrosive** to iron and mild steel.

Uses

A contact and ingested insecticide with fumigant and penetrant action. It is used: as a household and public health fumigant, especiall y against Diptera and Culicidae, to protect s tored products at 0.5-1.0 g AI/100 m^3 ; for crop protection against sucking and chewing Coleoptera, Homoptera and Lepidoptera

in cotton, fruit, ornamentals and vegetables at 300-1000 g/ha. It is non-persistent. Also used as an anthelmintic by incorporation in animal feeds.

Toxicology

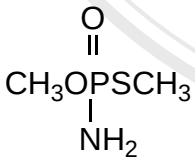
Mammalian toxicity. Acute oral LD_{50}: for rats c. 50 mg/kg; for mice 140-275 mg/kg. **Acute percutaneous LD_{50}** for rats c. 300 mg/kg. **Acute inhalation LC_{50}** (4-h) : for rats > 0.1 mg/l air (vapour), c. 0.5 mg/l air (aerosol). In 2-y **feeding trials NOEL** for rats 10 mg/kg diet. **ADI** for man 0.004 mg/kg body weight.

B.5 Methamidophos

Common name Methamidophos.

Chemical name (IUPAC) O,S-dimethyl phosphoramidothioate (I).

Structural formular



Empirical formular **$C_2H_8NO_2PS$ (141.1)**

Development Insecticide

Pure methamidophos forms colourless crystals; **m.p.** 46.1 °C; **v.p.** 2.3 mPa (20°C); n_D^{40} 1.5092; d_4^{20} 1.31. **Solubility** (20°C) : > 200 g/l water, dichloromethane, propan-2-ol. **Stable** at ambient temperature but decomposes on heating without boiling;

hydrolysis DT_{50} 40 h (pH2, 40°C), 120 h (pH9, 37°C).TC grade and TK are **corrosive** to mild steel and copper-containing alloys. **Incompatible** with alkaline pesticides.

Uses

Acaricide and insecticide effective against a broad range of Acarina, Diptera, Homoptera and Lepidoptera on cotton, fruits, potatoes, tobacco and vegetables. It is systemic in action when applied to the base or trunk of deciduous trees; defoliation has occurred when applied as a foliage spray to deciduous fruit. At 0.5-1.0 kg/ha its contact activity persists for 7-21 d.

Toxicology

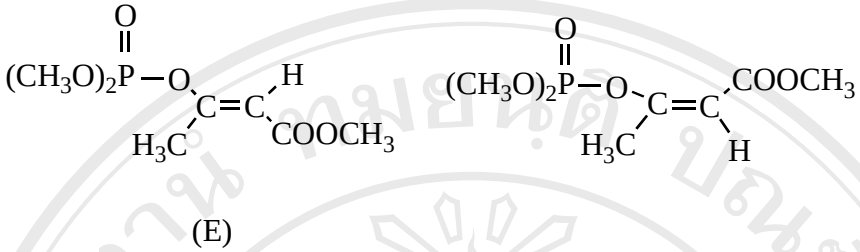
Mammalian toxicity. Acute oral LD_{50}: for rats, mice and dogs c. 20 mg/kg. **Acute percutaneous LD_{50}** : for rats c.130 mg/kg ; for rabbits c.100 mg/kg. **Acute inhalation LC_{50}** (4-h) for rats 0.2 mg/l (aerosol). In 2-y **feeding trials NOEL** for dogs and rats 2 mg/kg diet. **ADI** for man 0.0006 mg/kg.

B.6 Mevinphos

Common name Mevinphos.

Chemical name *(IUPAC)* methyl 3-(dimethoxyphosphinoyloxy) but –2 –enoate; methyl 3-dimethyloxyphosphinyloxy)but-2-enoate:2-methoxycarbony l-1-methylvinyldimethyl phosphate).

Structural formular



(E)

Empirical formular **$C_7H_{13}O_6P$ (224.1)**

Development **Insecticide**

Properties

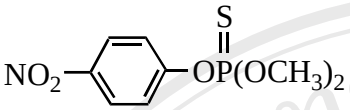
TC contain > 60% m/m of the (E)-isomer and c. 20% m/m of the (Z)-isomer. It is a pale yellow liquid; **b.p.** 99-103 °C/0.3 mmHg; **v.p.** 17 mPa (20 °C); d_{20}^{20} 1.24. The (E)-isomer has **m.p.** 21 °C, n_D^{20} 1.4452, d^{20} 1.2345; the (Z)-isomer, **m.p.** 6.9 °C, n_D^{20} 1.4524, d^{20} 1.245. *Solubility***:** TC mevinphos miscible with water, alcohols, ketones, chlorinated hydrocarbons, aromatic hydrocarbons: slightly soluble in aliphatic hydrocarbons. **Stable** when stored at ambient temperatures but hydrolysed in aqueous solution,DT_{50} 120 d (pH6), 35 d (pH7), 3 d (pH9), 1.4 h (pH11). Not compatible with Bordeaux mixture, lime sulfur or other alkaline products.Corrosive to cast iron, mild and some stainless steels and brass; non - corrosive to glass and many plastics by passes slowly through thin films of polythene.

B.7 Parathion-methyl

Common name .Parathion-methyl;

Chemical name *(IUPAC)* o,o- dimethyl o-4-nitrophenyl phosphorothioate.

Structural formular



Empirical formular **$C_8H_{10}NO_5PS$ (263.2)**

Development **Insecticide**

Properties

Pure parathion-methyl forms colourless crystals; **m.p.** 35-36°C; **v.p.** 0.2 mPa (20°C); d_4^{25} 1.358; n_D^{25} 1.5515. **Solubility** (20°C): 55 mg/l water;> 200 g/l dichloromethane, propan-2-ol ;TC(c.80% pure) a light to dark tan-coloured liquid; f.p.c 29 °C;d^{20} 1.20-1.22. **Stablility**: isomerised to the O,S-dimethyl analogue on heating ; hydrolysed by alkali

Uses

A non-system contact and ingested insecticide with some fumigant action. It is generally recommended at 15-25 g AI/hl to control Coleoptera, Homoptera and Lepidoptera on cereals, cotton, fruits, grapes and vegetables .

Toxicology

Mammalian toxicity. Acute oral LD_{50}: for rats c. 6 mg/kg; for male mice c.25 mg/kg. **Acute percutaneous LD_{50}** (24-h) for rats c. 50 mg/kg. **Acute percutaneous LC_{50}** (4-h) : for rats 0.17 mg/l (aerosol). In 2-y **feeding trials NOEL** for rats 2 mg/kg diet. **ADI** for man 0. 02 mg/kg body weight.

CURRICULUM VITAE

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