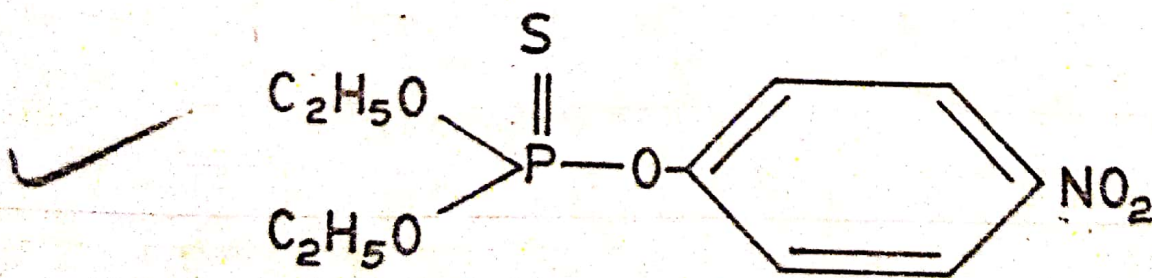


e4. Derivatives of thiophosphoric acid:

Replacement of one of the oxygen atoms by sulphur in derivatives of phosphoric acid leads to considerable decrease in mammalian toxicity without substantial change in the insecticidal and acaricidal activity. Although there are some exceptions to this general rule. This group is, therefore, very important and includes a number of insecticides widely used in agriculture for the control of pests. The derivative of thiophosphoric acid may have two structures (i) thiono and (ii) thiolo. The thiolo derivatives are more toxic to mammals than thiono.

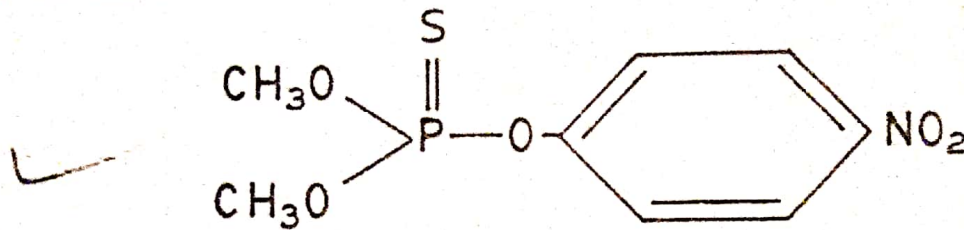
Parathion: diethyl 4-nitrophenyl phosphorothionate; $C_{10}H_{14}NO_5PS$: It is a clear oily liquid with boiling point $113^\circ C$ at 0.05 mm of Hg. The technical material is dark brown liquid with an unpleasant garlic odour and contains 90% pure parathion. It is practically insoluble in water (24 mg/l at $25^\circ C$) but soluble in organic solvents. It is an effective contact and stomach insecticide with some fumigant action. *In vivo* it is oxidised to paraoxon which is more toxic than parathion. The principal metabolic product of parathion in man is p-nitrophenol and other hydrolysis products. It is marketed under the name Folidol, Ekatox, Thiophos.



Parathion

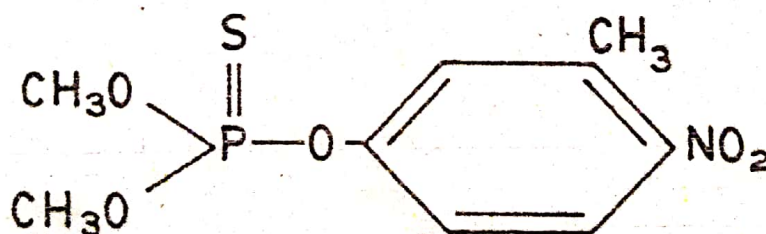
Methyl parathion: dimethyl 4-nitrophenyl phosphorothionate; $C_8H_{10}NO_5PS$: It is a white crystalline solid with melting point $35^\circ C$. It

is less stable than parathion practically insoluble in water (35 mg/l at 25°C). It is less toxic to mammals than parathion because part of methyl parathion is decomposed as a result of demethylation reaction before it reaches active centres. On plants and in other living beings it breaks down more quickly than parathion and path of conversion is the same as in parathion. It is an effective contact and stomach poison marketed under the name Metacid, Methyl parathion.



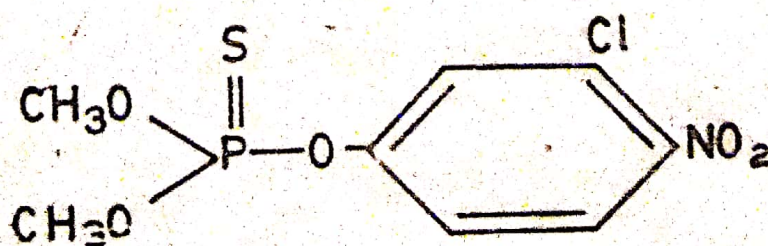
Methyl Parathion

Fenitrothion: dimethyl 3-methyl-4-nitrophenyl phosphorothionate; $C_9H_{12}O_5NPS$: Its insecticidal properties were discovered in 1959 in Japan. Pure form is a clear liquid with unpleasant odour. The technical material is 95% pure yellowish brown oily liquid with faint smell. It is insoluble in water (30 mg/l at 20°C) but soluble in alcohol and ether. It is less toxic to mammals but highly toxic to bees. It is a contact and stomach poison. Its chemical properties are similar to those of methyl parathion. It is marketed under the trade name Sumithion, Folithion.



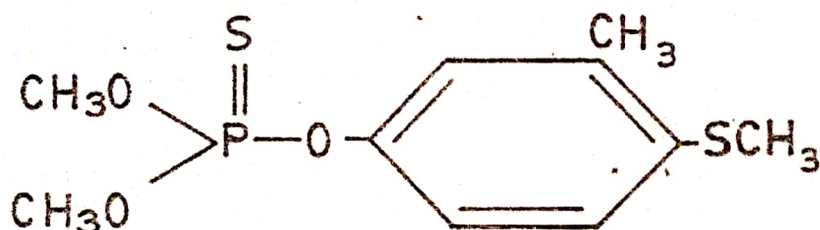
Fenitrothion

Chlorthion: dimethyl 3 chloro 4-nitrophenyl phosphorothionate; $C_8H_9NO_5PSCl$: It is a yellow crystalline solid with melting point 21°C. It is highly soluble in aromatic hydrocarbons but practically insoluble in water (40 mg/l at 20°C). It is a contact and stomach insecticide with low mammalian toxicity. Other properties are similar to methyl parathion.



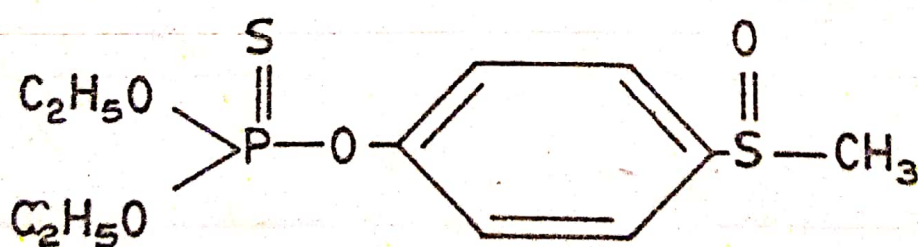
Chlorthion

Fenthion: dimethyl 3-methyl-4 (methylthio) phenyl phosphorothionate; $C_{10}H_{15}O_2PS_2$: It is a colourless oily liquid practically insoluble in water (54 mg/l at 20°C) but highly soluble in organic solvents. It is a contact and stomach poison having high mammalian toxicity. In animals and plants it is oxidised to sulfoxide and sulfon which have insecticidal property; the latter is hydrolysed to harmless products. It is marketed under the trade name Lebaycid, Baytex.



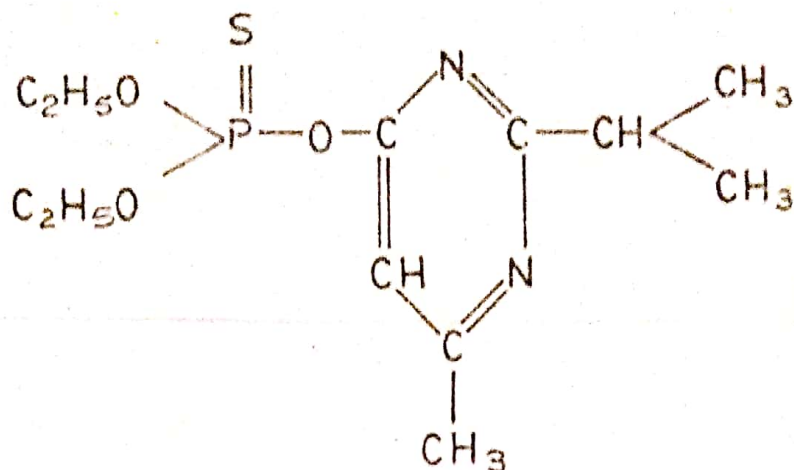
Fenthion

Fensulfothion: diethyl-4 (methylsulphinyl) phenyl phosphorothionate; $C_{11}H_{17}O_4PS_2$: It is yellowish brown liquid soluble in most organic solvents and slightly soluble in water (154 mg/l. at 25°C). It is a systemic and contact insecticide. It is also a nematicide with long residual effect. It is marketed under the name Dasanit.



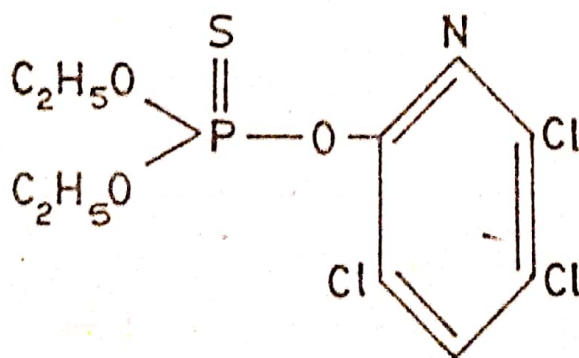
Fensulfothion

Diazinon: diethyl-2-isopropyl-6-methyl-4-pyrimidinyl phosphorothionate; $C_{12}H_{21}N_2O_3PS$: The pure material is colourless liquid practically insoluble in water (40 mg/l at 20°C) but highly soluble in organic solvents. The technical product is yellowish liquid containing 90% diazinon. It is a contact and stomach poison. It is marketed under the trade name Basudin.



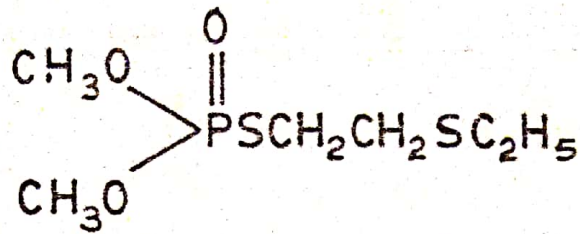
Diazinon

Chlorpyrifos: diethyl 3,5,6 trichloro-2 pyridyl phosphorothionate; C₉H₁₁Cl₃NO₃PS : It is a white crystalline solid with melting point 41-43°C. It is highly soluble in organic solvents but almost insoluble in water (2 mg/l at 20°C). It is a contact and stomach poison. It is slowly hydrolysed by water forming diethylthiophosphoric acid, ethyl thiophosphoric acid and trichlorohydroxy pyridine. It is marketed under the name Dursban, Danusban.



Chlorpyrifos

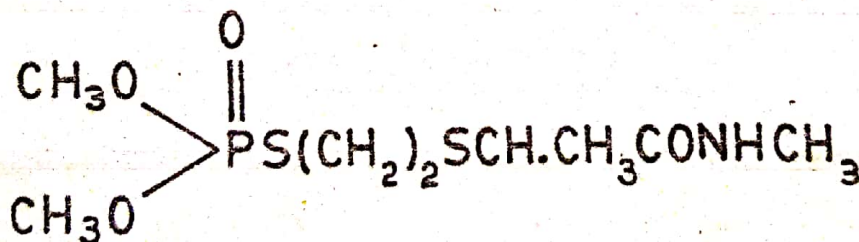
Methyl demeton: diethyl S-2 ethylthio ethyl phosphorothiolate; (CH₃O)₂ PSO (CH₂)₂ SC₂H₅: The technical grade is a mixture of thiono- and thiolo- isomer. The thiono-isomer is a liquid with unpleasant odour, soluble in water (330 mg/l at 20°C) and most of the organic solvents. It is a systemic insecticide effective against sucking pests. In plants it is rapidly isomerised to thiolo-isomer which is further metabolized to non-insecticidal products as a result the duration of insecticidal activity usually does not exceed three weeks. It is marketed under the name Metasystox.



Methyl demeton

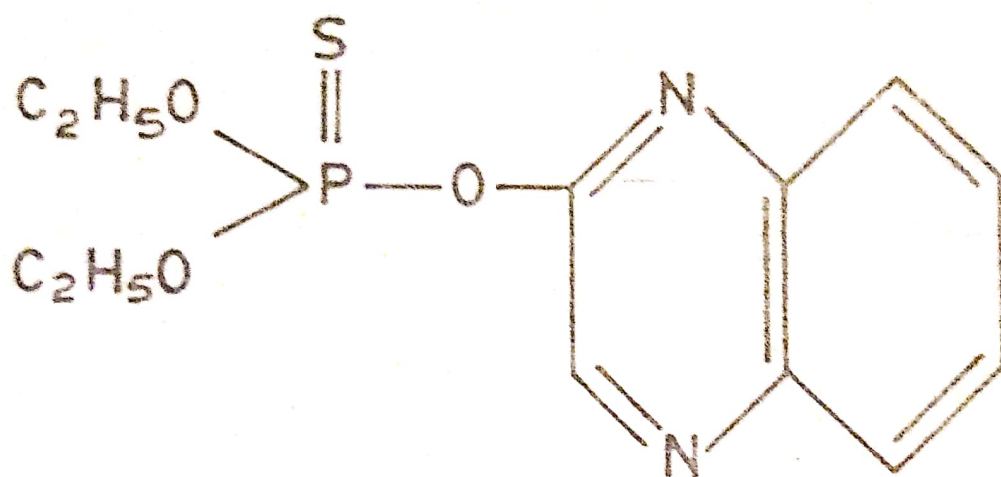
The demeton, oxydemeton-methyl, and demetox-s-methyl are other insecticides having more or less similar properties as methyl demeton.

Vamidothion: dimethyl S-2-1 methyl carbamoylethylthio ethyl phosphorothiolate; $\text{C}_8\text{H}_{18}\text{O}_4\text{NPS}_2$: It is a white crystalline solid with melting point $46-48^\circ\text{C}$. The technical grade having melting point $33-36^\circ\text{C}$ is highly soluble in water (4 kg/l), acetone but less soluble in hexane. The insecticidal properties of vamidothion is similar to methyl demeton but having long residual effect. In plants it is metabolised to sulfoxide. Hydrolysis also occurs simultaneously within the plants with the formation of dimethyl phosphoric and phosphoric acid. It is a systemic insecticide with acaricidal action. It is marketed under the name Kilval.



Vamidothion

Quinalphos: diethyl 2-quinoxalinyll phosphorothionate; $\text{C}_{12}\text{H}_{15}\text{O}_3\text{H}_2\text{PS}$: It is an odourless white crystalline solid with melting point 30°C practically insoluble in water (22 mg/l) but readily soluble in organic solvents. It is a wide spectrum insecticide with acaricidal property. It is marketed under the trade name Ekalux.



Quinalphos