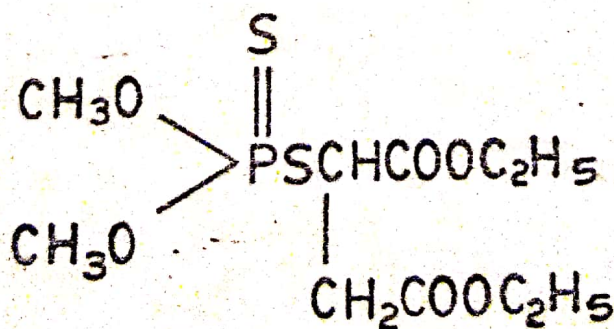


e5. Derivatives of dithiophosphoric acid:

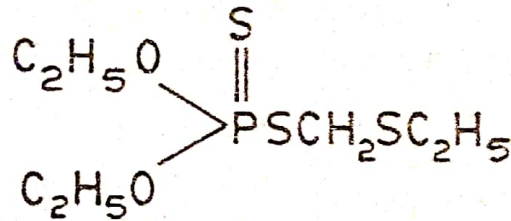
Going from the derivatives of thiophosphoric acid to the corresponding derivatives of dithiophosphoric acid in most of the cases the toxicity of the compound is decreased but its chemical stability is increased. Therefore, the residual toxicity of the compound under field conditions is also increased. Moreover, the spectrum of the compound is also changed and many of them, especially those containing heterocyclic radicals, are not only effective against sucking pests but against chewing pests also.

Malathion: $C_{10}H_{19}O_6PS_2$: S-1,2 di(ethoxy carbonyl) ethyl-dimethyl phosphorothiolothionate. : It is a colourless liquid with unpleasant odour slightly soluble in water (145 mg/l at $20^\circ C$) but highly soluble in organic solvents except saturated hydrocarbons. The toxicity of the compound depends on two metabolic processes, activation by oxidation and detoxification by hydrolysis. It has got different routes of metabolism in insects and vertebrates. In insects it is oxidised to more toxic ester of thiophosphoric acid while in vertebrates the hydrolysis of the group in the side chain takes place by the hydrolytic enzymes carboxyesterase and carboxy amidase producing non-toxic products. These enzymes are not found in insects. Therefore, hydrolysis is outstripped by oxidation. It is one of the safest insecticides having stomach and contact action. It is marketed under the name Malathion, Cythion etc.



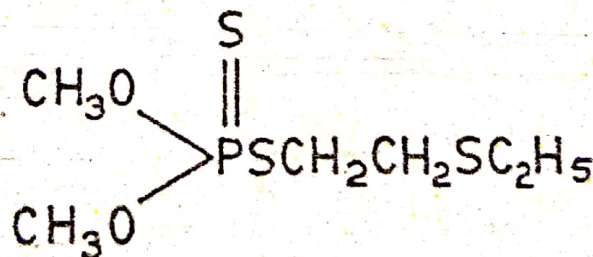
Malathion

Phorate: $C_7H_{17}O_2PS_3$: diethyl S-ethylthiomethyl phosphorothiolothionate: It is a clear liquid. Technical grade contains 95% phorate. It is slightly soluble in water (70 mg/l) but highly soluble in organic solvents. It is easily oxidised to corresponding sulfoxide which is insecticidal in action and is more resistant to hydrolysis than the parent compound. This enables the phorate to have a long residual action. The final products of metabolism are diethyl hydrogen phosphate and free phosphoric acid which are biologically inactive. It is very effective against soil insects and is used to protect the crop at seedling stage. It is marketed under the trade name Thimet.



Phorate

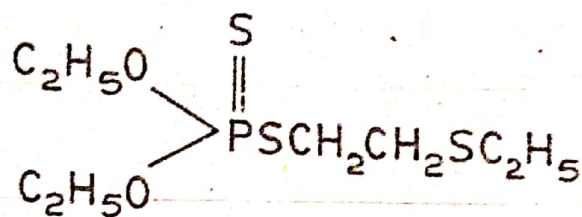
Thiometon: $C_6H_{15}O_2PS_3$: S-2 ethylthioethyl dimethyl phosphorothiolothionate: It is colourless oil with a strong unpleasant odour. It is soluble in water (200 mg/l) and highly soluble in most of the organic solvents. It is metabolised to dimethyl hydrogen phosphate and then to phosphoric acid. It is a good systemic insecticide and marketed under the name Ekatin.



Thiometon

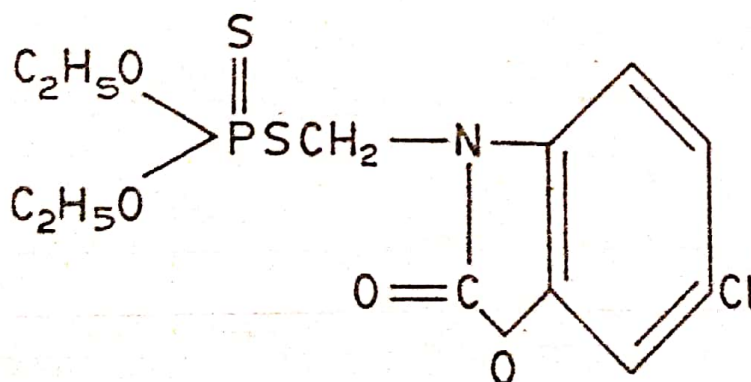
Disulfoton or Thiodemeton: $C_8H_{19}O_2PS_3$: S-2 ethylthioethyl diethyl phosphorothiolothionate: It is a colourless liquid with unpleasant odour, slightly soluble in water but highly soluble in organic solvents. It is a systemic insecticide with acaricidal property. It is metabolised in plants to sulfonium compounds which are very toxic to mammals. It is

effective against soil insects and is marketed under the trade name Disyston, Dithiosystox.



Disulfoton

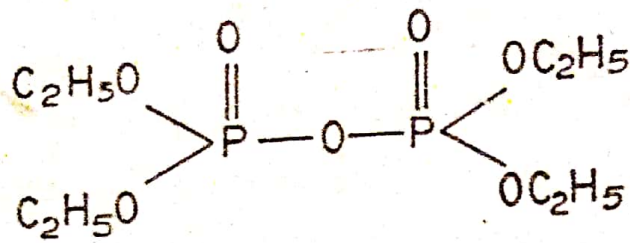
Phosalone: $\text{C}_{12}\text{H}_{15}\text{CNO}_4\text{PS}_2$: S-6-chloro-2-oxobenzodiazolin methyl diethyl phosphoro thiolothionate): It is white crystalline substance with garlicky odour. It is practically insoluble in water but soluble in organic solvents. It is very persistent and is used as a substitute of DDT. In plants it is oxidised to a relatively unstable compound which quickly breaks down. In animal tissue it is degraded rapidly. It is marketed as Zolone.



Phosalone

e6. Derivatives of pyrophosphoric acid:

TEPP: Tetraethyl phosphosphate: $\text{C}_8\text{H}_{20}\text{O}_7\text{P}_2$: The insecticide was first synthesized by Clearmont in 1854 but its insecticidal properties were discovered by Schrader in 1939. It is a colourless, odourless hygroscopic liquid, rapidly miscible with water and most organic solvents. It is readily hydrolysed by water so it should be used immediately after mixing with water. It is rapidly hydrolysed to inactive diethyl-phosphoric acid and, therefore, does not leave any harmful residue on treated plants. Its mammalian toxicity is high. It is marketed under the name Bladan.



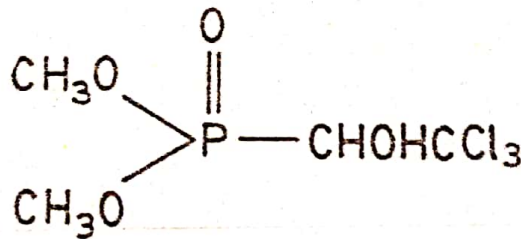
TEPP

tetraethyl pyrophosphate

Other insecticides of this group are TEDP (tetraethyl dithio pyrophosphoric acid), Schradan and mephospholan (Cytrolane).

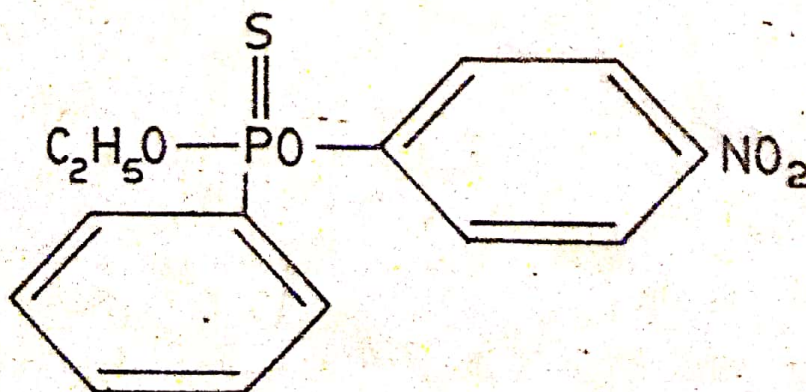
e7. Derivatives of phosphonic acid: Only few compounds of this group are used in agriculture.

Trichlorfon: $\text{C}_4\text{H}_8\text{Cl}_3\text{PO}_4$: dimethyl 1-hydroxy-2-trichloroethyl phosphonate: It is white crystalline substance soluble in aromatic hydrocarbons. It is a stomach and contact poison, very effective against Lepidoptera, Diptera and Hemiptera. It is also used in baits and marketed as Dipterex, Tugon.



Trichlorfon

EPN: O-ethyl-o-p-nitrophenyl phenylphosphonothionate: It is white crystalline substance with melting point 36°C . The technical material is a brown liquid. It is insoluble in water. It is a powerful acaricide with insecticidal property also. It has less residual effect than parathion.



EPN