APPENDIX

Appendix - 1

COMMON OR TRADE NAMES, CHEMICAL STRUCTURES AND OTHER PROPERTIES OF SOME ORGANOPHOSPHORUS PESTICIDES.

Common or trade name, Chemical name and Chemical structure.	Physical and biological properties.
A. PHOSPHATES	
1. Dichlorvos, DDVP, Vapona(R), Nuvan (Shell Oil Co.) $(CH_3O)_2 P(O)-OCH = CCl_2$ O, O-dimethyl O-(2,2 dichlorovinyl) phosphate.	Liquid; non-systemic, contact and stomach insecticide with fumigant action and low residual activity; has also acaricidal and anthelmintic property; LD_{50}, 80 mg/kg.
2. Dibrom(R), Naled (California Spray Chemical Corporation, 1958) $(CH_3O)_2P(O)-OCH Br.CBrCl_2$ O,O-dimethyl O-(1,2- dibromo-2,2-dichloro ethyl) phosphate.	Liquid (m.p. of pure compound is 26°C); Non-systemic insecticide and acaricide; LD_{50}, 430 mg/kg.

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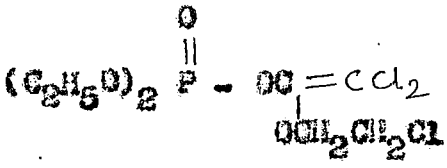
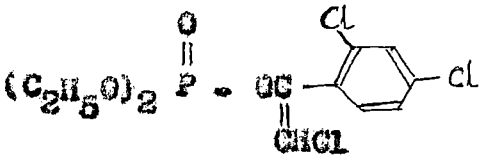
3. Forestenon



Insecticide; LD_{50}, 7-10 mg/kg.

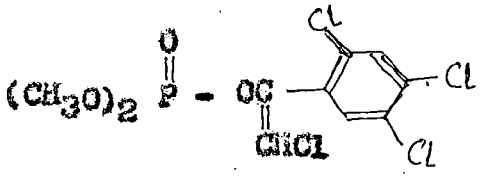
4. Chlorfenvinphos, Supona(R), Birlane(R)



O,O-diethyl O- [2- chloro-1-(2',4'-dichlorophenyl) vinyl] phosphate.

Liquid; non-systemic insecticide, used in soil and seed treatment; moderately persistent; LD_{50}, 10-40 mg/kg.

5. Tetrachlorvinphos, Gardona(R), Rabon(R) (Shell Development Co. 1966)

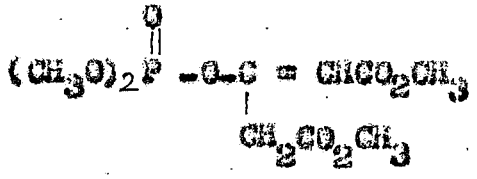


O,O-dimethyl O-[2-chloro-1-(2',4',5'-trichlorophenyl) vinyl] phosphate.

Solid, m.p. 62°C (α-isomer) 98°C (β-isomer) non-systemic, brief persistence selective insecticide, used to control diptera, lepidoptera and coleoptera and other pests; LD_{50}, 4,000 mg/kg.

(Contd.)

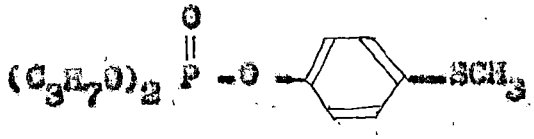
6. Bomyl(R)
(Allied Chemical Corp,
Code No. GC-3707, 1959)



1,3 di(methoxy carbonyl)-1-propen-2-yl dimethyl phosphate.

Liquid; used for contact-residual treatment of insects and mites, LD_{50}, 32 mg/kg (R).

7.(a) Kayaphos(R), Propaphos
(Nippon Kayaku Co. 1968)



Di-n-propyl p-methyl thiophenyl phosphate.

Liquid; selective contact insecticide for rice stem-borers and greenrice leaf-hoppers; synergists of other organophosphorus insecticide; LD_{50}, 70 mg/kg.

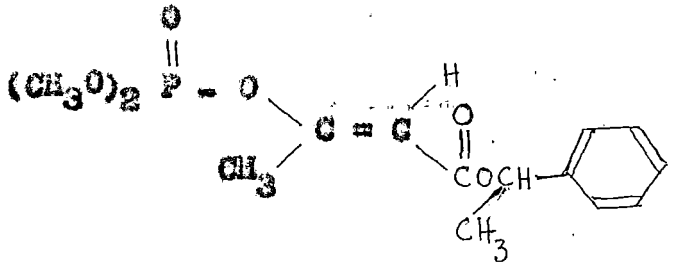
7.(b) GC-6506

Dimethyl homolog of Propahos.

Insecticide and acaricide for use in cotton; LD_{50}, 7 mg/kg.
Diethyl homolog is most toxic to mammals.

(Contd..)

8. Crotoxyphos, Ciodrin(R) (Shell Development Co. 1962).

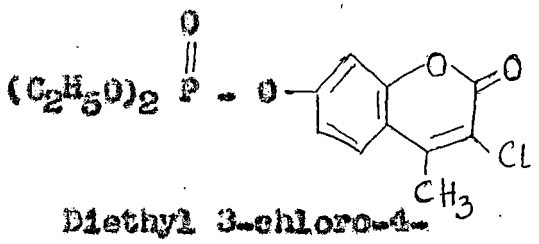


Dimethyl cis-1-methyl-2-(1-phenylethoxy carbonyl) vinyl phosphate.

Liquid; insecticide with no systemic activity, effective against ectoparasites on livestock by spray (for the control of flies, lice, mites and ticks on cattle and pigs by spray)

LD_{50}, 125 mg/kg

9. Coroxon (Copper Technical Bureau 1961).



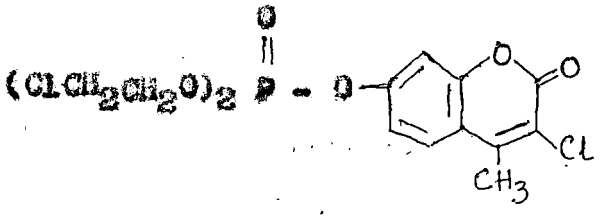
Diethyl 3-chloro-4-methylcoumarin-7 yl phosphate.

Solid, m.p. 72°C, animal systemic insecticide; LD_{50}, 12 mg/kg.

(Contd.)

10. Halozon (Copper Technical Bureau, 1962)

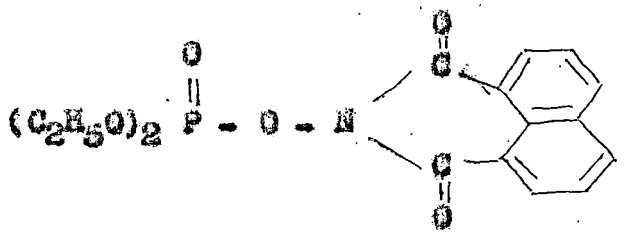
Solid, m.p. 92°C, has high anthelmintic properties but has no useful insecticidal properties; LD_{50}, 900 mg/kg.



Bis(2-chloroethyl) 3-chloro-4-methyl coumarin-7-yl-phosphate.

11. Maretin(R), Rametin(R), Napthelimide (Bayer AG.)

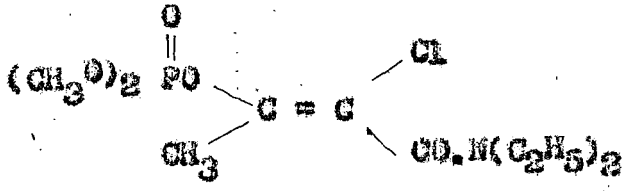
Solid, m.p. 196°C, has anthelmintic and insecticidal properties; LD_{50}, 75 mg/kg.



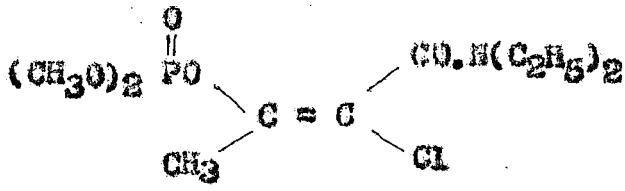
N-(diethoxyphosphinyloxy)-naphthalimide.

(Contd.)

12. Phosphamidon, Dimecron(R), Dicron(R) (Ciba Ltd.)



Cis (β-) isomer



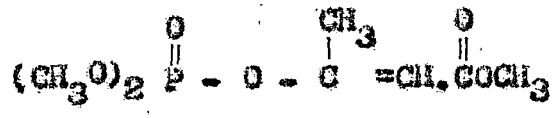
trans (α) isomer

O,O-dimethyl O-(1-methyl-2-chloro-2-diethylcarbamoyl-vinyl) phosphate.

Liquid; systematic insecticide and acaricide with a little contact action, useful against sap-feeding and leaf-eating insects, particularly aphids, bugs, caterpillars (not Noctuidae), thrips, rice stem borers etc; LD_{50}, 15-28 mg/kg.

The Cis -isomer is more biologically active than trans-isomer.

13. Phosdrin(R), Mevinphos. (Shell Development Co. 1953)



2-methoxy carbonyl-1-methylvinyl dimethyl phosphate.

Liquid; a contact and systemic insecticide and acaricide of short persistence, effective against sucking and chewing insects and mites;

LD_{50}, 4-7 mg/kg.

(Contd.)

B. PHOSPHOROTHIONATES.

14. Parathion, Folidol(R), (Bayer AG 1944)

O,O-diethyl O-paranitrophenyl phosphorothionate.

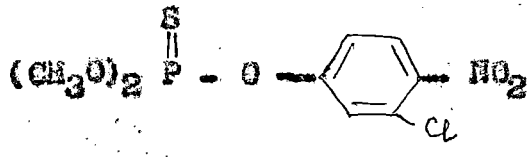
Liquid; wide spectrum insecticide; LD_{50}, 7 mg/kg.

15. Methyl parathion. (Bayer AG 1949)

O,O-dimethyl O-paranitrophenyl phosphorothionate.

Liquid; broad-spectrum; LD_{50}, 25-50 mg/kg.

16. Chlorothion(R) (Bayer AG 1952)



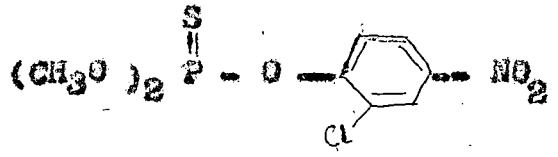
O,O-dimethyl O-(3-chloro-4-nitrophenyl) phosphorothionate.

Crystalline powder; for control of beetles, aphids, caterpillars LD_{50}, 880 mg/kg.

(Contd.)

17. Di-capten(R), Dicapthon

(American Cyanamid Co. 1954)

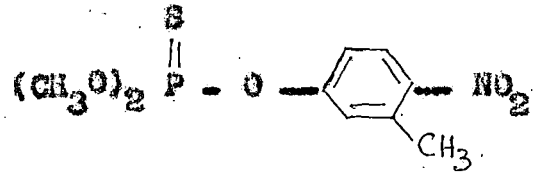


O,O-dimethyl O-(2-chloro-4-nitrophenyl) phosphorothionate.

Crystalline powder; for controlling household insects, aphids and boll weevils.

18. Sumithion(R), Folithion(R), Fenitrothion.

(Sumitomo Chemical Co. 1959)

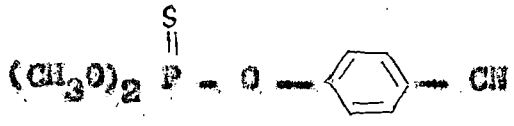


O,O-dimethyl O-(3-methyl-4-nitrophenyl) Phosphorothionate.

Liquid; broad-spectrum (as methyl parathion), specially for rice-stem borers, flies and mosquitoes in public health programme; LD_{50}, 250-500 mg/kg.

(Contd.)

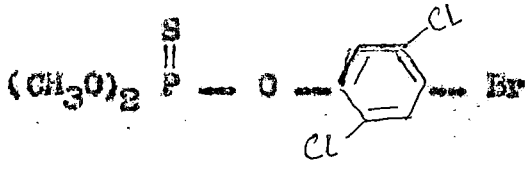
19. Cyanox(R), Cyanophos, CYAP (Sumitomo Chemical Co. 1966)



O,O-dimethyl O-paracyanophenyl phosphorothionate.

Liquid; useful for controlling of rice-stem borers and pests of vegetables, fruits and ornamentals.

20. Bromophos, Nexion(R), Brofene (Boehringer Sohn and Cela Landwirtschaftliche Chem; Germany; 1961)



O, O-dimethyl O-(4-bromo-2, 5-dichlorophenyl) phosphorothionate.

Crystalline solid; m.p. 64°C non-systemic persistent insecticide and acaricide, particularly effective against diptera; ectoparasite control in livestock; LD_{50}, 3750 to 6100 mg/kg.

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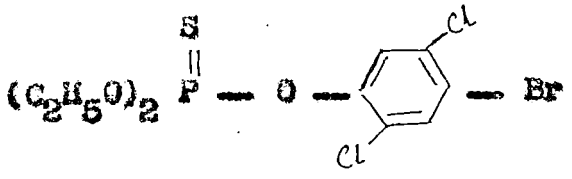
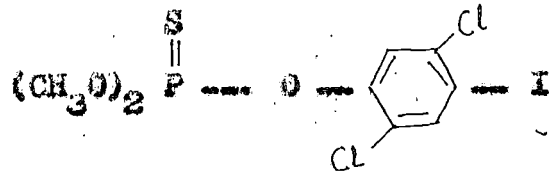
21. Bromophos ethyl.



O,O-diethyl O-(4-bromo-2, 5-dichlorophenyl) phosphorothionate.

Insecticide and acaricide; LD_{50}, 238 mg/kg.

22. Iodofenphos, Alfacron(R), Nuvanol N(R), Elocril (Ciba Ltd. 1966)

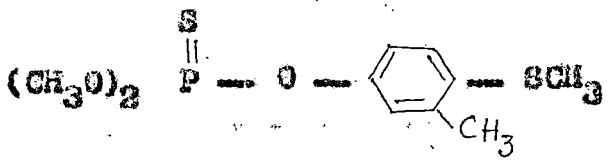


O,O-dimethyl O-(4-iodo-2, 5-dichlorophenyl) phosphorothionate

Colourless crystalline solid; m.p. 76°C; non-systemic contact and stomach insecticide and acaricide effective against a wide range of insect pests, LD_{50}, 2100 mg/kg.

(Contd.)

23. Baytex(R), Lebayacid(R), Fenthion. (Bayer AG, 1958)

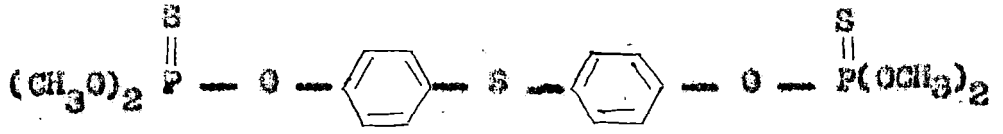


0,0-dimethyl 0-(3-methyl-4-methylthiophenyl) phosphorothionate.

Liquid; general purpose insecticide with systemic action; particularly for fly and mosquito; LD_{50}, 215 mg/kg (Male R) 615 mg/kg (Female R)

24. Abate(R), Biothion(R) (American Cyanamid Co. 1965)

White solid; m.p. 30°C; control of mosquito larvae LD_{50}, 2000-4000 mg/kg.



0,0,0',0'-tetramethyl 0,0'-thiodi-p-phenylene phosphorothionate.

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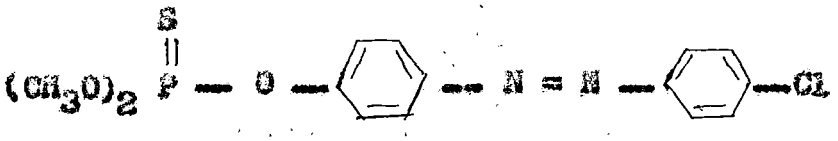
25. Alamos(R), Siam(R), Azothoate (Soc. Montecatini, Italy, 1964).

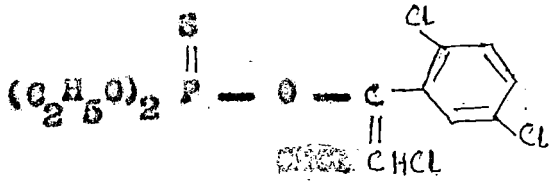
Experimental insecticide and acaricide, particularly nontoxic to mammals.



O,O-dimethyl O-[P-(P-chlorophenylazo) phenyl] phosphorothionate.

26. Akton(R) (Shell Development Co.)

Brown liquid; non-systemic insecticide, effective particularly for soil insects such as lawn chinch bugs; LD_{50}, 146 mg/kg.

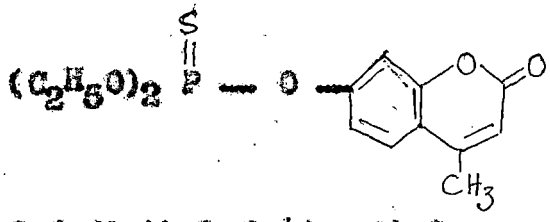


O,O-diethyl O-[2-chloro-1-(2',5'-dichlorophenyl) vinyl] phosphorothionate.

The methyl homolog and 2',4',5' trichloro analog of Akton are effective as housefly larvicide.

(Contd.)

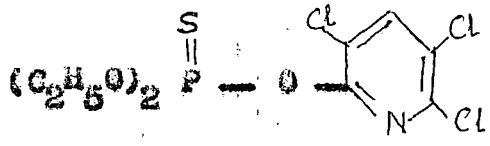
27. Potasan(R) (1947)



O,O-diethyl O-(4-methyl-7-cumarinyl) phosphorothionate.

Colourless crystalline solid, m.p. 38°C; stomach insecticide with weak contact activity; particularly effective against colorado potato beetles; LD_{50}, 42 mg/kg.

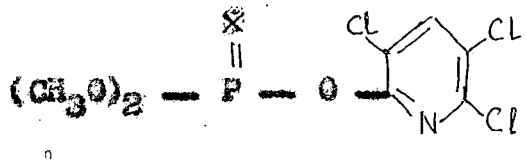
28. Dursban(R), Chloropyrifos (Dow Chemical Co. 1965)



O,O-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothionate.

White crystalline solid, m.p. 43°C, moderately persistent insecticide, effective for controlling mosquito and fly larvae, sucking and chewing plant pests and soil pests, ticks on livestock;
LD_{50} , 163 mg/kg.

29.



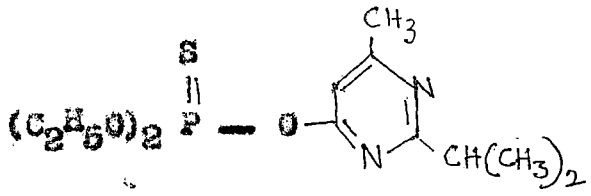
X = S Dowco 214

X = O Dowco 217

The methyl homolog (Dowco(R) 214) is more effective against adult mosquitoes but less effective against the larvae than chloropyrifos; its LD_{50} is 1,500 mg/kg.

(Contd.)

30. Diazinon, Basudin(R), Srolex(R) (1952)

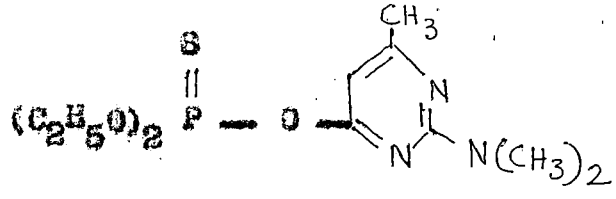


O,O-diethyl O-(2-isopropyl-4-methylpyrimidin-6 yl) phosphorothionate.

Liquid; it has long residual action and effective against soil, fruit, vegetable and rice-insects; LD_{50}, 108-250 mg/kg.

The n-propyl isomer of diazinon (Pyrazinon) is also effective as an insecticide; LD_{50}, 261 mg/kg.

31. Primiphos - ethyl (Imperial Chemical Industries, 1972)

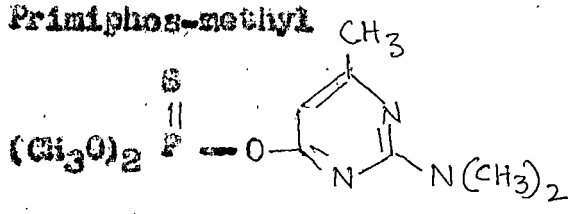


O,O-diethyl O-(2-dimethylamino-4-methylpyrimidin-6-yl) phosphorothionate.

Primiphos-ethyl is a liquid with broad insecticidal spectrum, particularly effective against diptera and coleoptera, it has also fungicidal activity; LD_{50}, 140-200 mg/kg.

(Contd.)

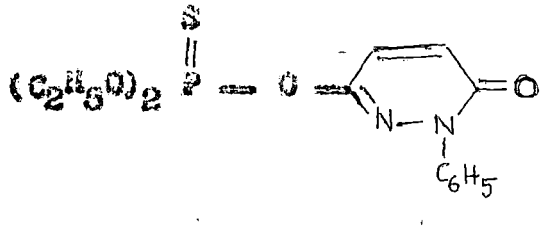
32. Primiphos-methyl



O,O-dimethyl O-(2-dimethylamino-4-methylpyrimidin-6-yl) phosphorothionate.

Primiphos-methyl is a liquid; it is an insecticide and acaricide with contact and fumigant activity; it is also used for stored products and for public health. LD_{50}, 2050 mg/kg.

33. Pyridafenthion, Ofunack (R) AC-12, 503 (Mitsui-Toatsu Chemicals, 1973).



O,O-diethyl O-(3-oxo-2-phenyl-2H-pyridazin-6 yl) phosphorothionate.

It is used for the control of rice stem borers.

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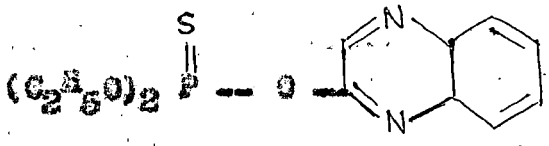
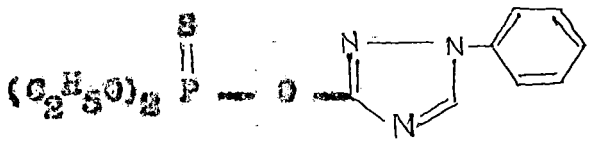
34. Quinalphos, Bayrusil (R),
Diethquinalphion
(Bayer AG. 1965)



O,O-diethyl O-(2-quinoxalyl) phosphorothionate.

White crystalline powder, m.p. 36°C; contact and stomach activity, effective against both biting and sucking pests, especially against diamond-back moth; for control of mosquitoes and mites;
LD_{50}, 66 mg/kg.

35. Hostathion (R),
Triazophos, HOE 2960;
(Farbwerke Hoechst 1967)

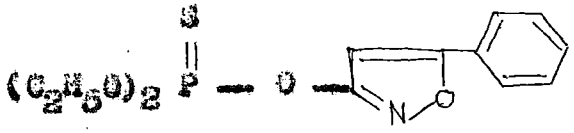


O,O-diethyl O-(1-phenyl-1,2,4-triazol-3yl) phosphorothionate.

Liquid; a non-systemic insecticide and acaricide, acting as a contact and stomach poison;
LD_{50}, 82 mg/kg.

(Contd.)

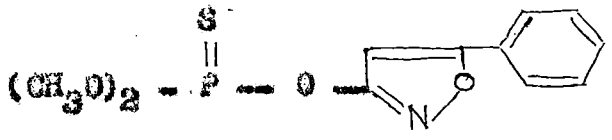
36. Isoxathion, Karphos(R)
(Sankyo Co. 1972)



0,0-diethyl 0-(5-phenyl-3-isoxazolyl) phosphorothionate.

Liquid; a broad spectrum insecticide including scale insects and soil insects; LD_{50}, 112 mg/kg.

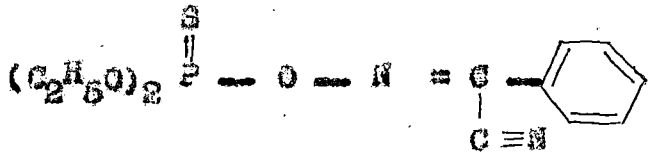
37. Dimex(R)



0,0-dimethyl 0-(5-phenyl-3-isoxazolyl) phosphorothionate.

It is less toxic than the diethyl homolog; LD_{50}; 593-697 mg/kg (M).

38. Phoxim, Baythion(R), Valexon(R)
(Bayer AG. 1966)

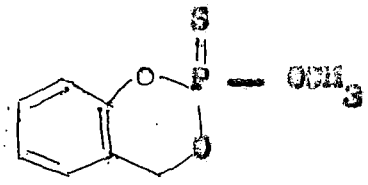


(Diethoxy phosphinothioyloxyimino) phenylacetonitrile.

Liquid; broad spectrum, contact and stomach poison; most useful against soil insects and stored products pests; LD_{50}, 2000 mg/kg.

(Contd.)

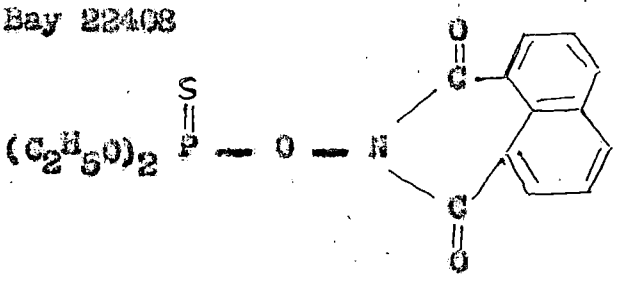
39. Salithion
(Sumitomo Chemical Co. 1968)



2-methoxy-4H-1,3,2-benzodioxaphosphorin-2-sulphide.

White crystalline powder, m.p. 56°C, a short lived insecticide for protection of fruits and vegetables;
LD_{50}, 102 mg/kg.

40. Bay 22408

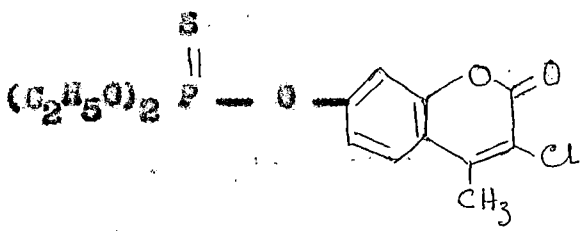


N-(diethoxyphosphinothioyloxy)-naphthalimide

Solid; insecticide, effective against mediterranean fruit flies;
LD_{50}, 500 mg/kg.

(Contd.)

41. Coumaphos, Co-Ral(R), Asuntol(R), Muscatox(R) (Montecatini, 1956)

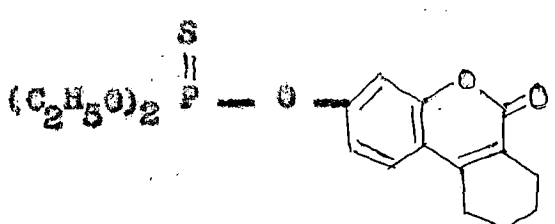


Diethyl 3 chloro-4-methyl-coumarin-7-yl phosphorothionate.

Solid, m.p. 95°C, insecticide, useful to control ectoparasites on cattle, goats etc. by feed or spray; also effective against flies, mosquito larvae; active against gastro-intestinal nematodes and has synergistic activity with the anthelmintic agent phenothiazine;

LD_{50}, 90 to 110 mg/kg.

42. Coumithioate, Dition(R) (Montacatini 1956)



O,O-diethyl O-(3,4-tetramethylene-7-coumarinyl) phosphorothionate.

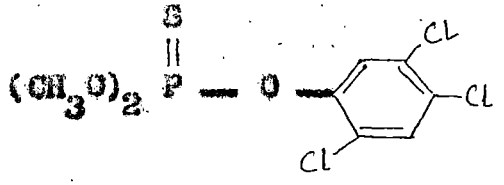
Solid, m.p. 88-89°C; insecticide and miticide, useful for livestock pest control and for public health;

LD_{50}, 150 mg/kg.

(Contd.)

43. Ronnel, Trolene(R), fenchlorphos, Nemtor(R), Korlan(R)

(Dow Chem. Co. 1954)

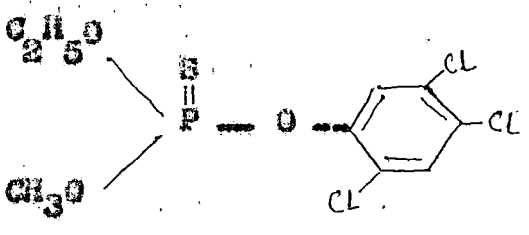


0,0-dimethyl 0-(2,4,5-trichlorophenyl) phosphorothionate.

Solid, m.p. 40-42°C; animal systemic insecticide, effective to control cattle grub, lice, hornfly, screw-worm and ticks on livestock by oral administration; LD_{50}, 1250 - 1750 mg/kg.

44. Trichlormetaphos-3

(USSR)

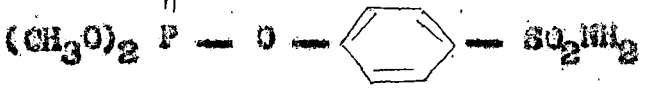


0-ethyl 0-methyl 0-(2,4,5-trichlorophenyl) phosphorothionate.

Liquid, insecticide, effective to control warble flies on cattle; useful against sucking insects, mites and midge larvae; LD_{50}, 330 - 800 mg/kg.

(Contd.)

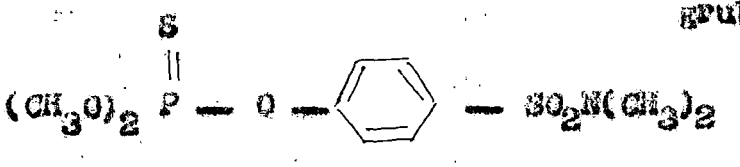
45. Proban(R), Cythionate



O,O-dimethyl O-(P-sulfamoyl) phenyl phosphorothioate.

Solid, m.p. 43-42°C; useful for the control of ticks; LD_{50}, 160 mg/kg.

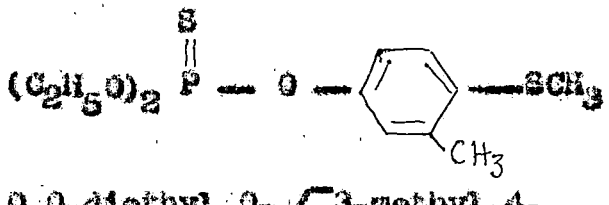
46. Famophos(R), Famphur (American Cyanamid Co.)



O,O-dimethyl O-[P-(dimethylsulfamoyl) phenyl] phosphorothionate.

Solid, m.p. 55°C; systemic insecticide for cattle grubs; LD_{50}, 35 mg/kg.

47. Lucijet(R)

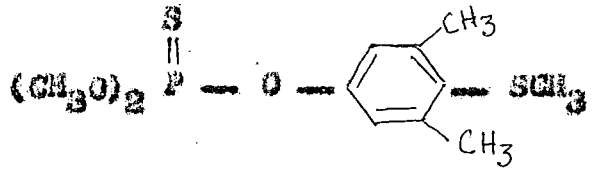


O,O-diethyl O-[3-methyl-4-methylthiophenyl] phosphorothionate.

Liquid; insecticide effective against sheep blowfly larvae; LD_{50}, 25 to 100 mg/kg.

(Contd.)

48. Bay 37342

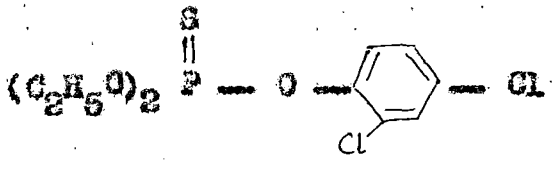


O,O-dimethyl O-(3,5-dimethyl-4-methylthiophenyl) phosphorothionate.

Liquid; animal systemic insecticide for the control of sheep botfly.

LD_{50}, 1000 mg/kg.

49. Nemacide(R), Dichlofenthion, VC-13 (Virginia-Carolina Chem. Corp.)



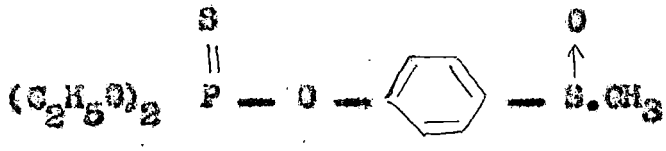
O,O-diethyl O-(2,4-dichlorophenyl) phosphorothionate.

Liquid; systemic, persistent nematocide and soil insecticide;

LD_{50}, 270 mg/kg.

(Contd.)

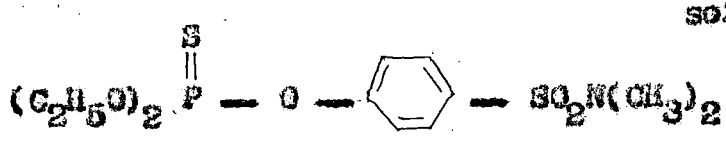
50. Dasanit(R), Fensulfothion, Terracur P(R)



O,O-diethyl O-(P-methylsulfinylphenyl) phosphorothionate.

Liquid; systemic, persistence nematocide and soil insecticide, it has also contact activity; LD_{50}, 4 to 10 mg/kg.

51. DSP; Kaya - ace(R) (Nippon Kayaku Co. 1966)

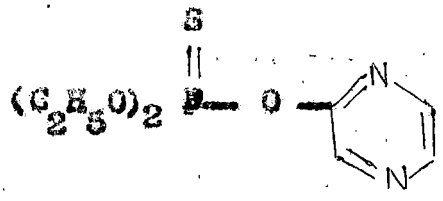


O,O-diethyl O-(P-dimethylsulfamoylphenyl) phosphorothionate.

Solid, m.p. 68 - 69°C; persistence nematocide and soil insecticide; LD_{50}, 65.4 mg/kg.

(Contd.)

52. Thionazin, Zinophos(R), Nemafos(R), Cynem(R) (American Cyanamid Co. 1966)



O,O-diethyl O-(Pyrazin-2-yl) Phosphorothionate.

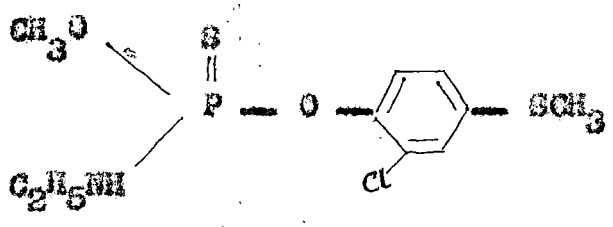
Liquid; systemic soil insecticide and nematocide; persists about 4 weeks in soil;

LD_{50}, 12 mg/kg.

(Contd.)

C. PHOSPHORAMIDES

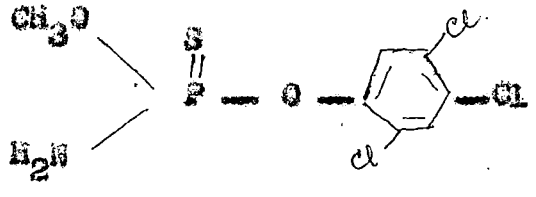
53. Amidothioate, Mitemate(R)
(Nippon Kayaku Co. 1965)



O-methyl O-(2-chloro-4-methylthiophenyl) N-ethyl-phosphoramidothionate.

Yellow oil; miticide, long residual activity and can be mixed with Bordean mixture; kills both eggs and active mites;
LD_{50}, 33 mg/kg (M).

54. Dow ET-15
(Dow Chem. Co.)



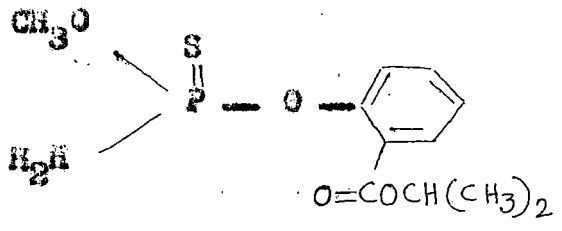
Methyl 2,4,5-trichlorophenyl phosphoramidothionate.

Insecticide;
LD_{50}, 710 mg/kg.

(Contd.)

55. Optunal(R), isocarbophos.

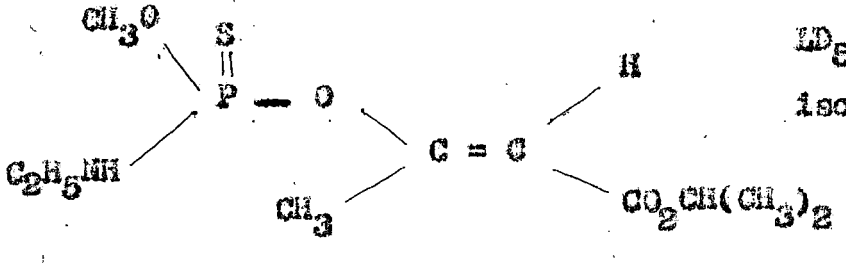
Effective for colorado potato beetle and cotton insects; shows systemic activity against aphids and leaf rollers; LD_{50}, 50-100 mg/kg.



O-(Isopropoxy carbonyl) phenyl methyl phosphoramidothionate.

56. Compound 577 (Sandoz, 1972)

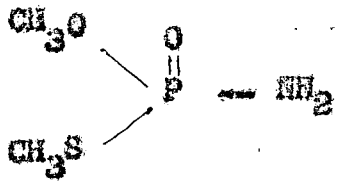
Experimental insecticide; trans isomer is more toxic than cis-isomer. LD_{50}, 122 mg/kg (Cis-isomer).



1-Isopropoxy carbonyl-1-propen-2-yl methyl N-ethyl phosphoramidothionate.

(Contd.)

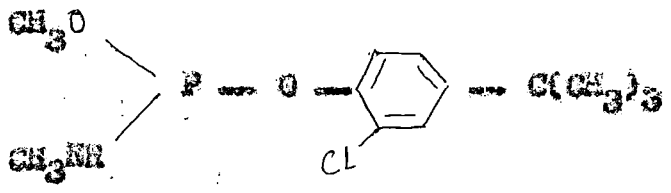
57. Monitor(R), Tamaron(R), Methamidophos. (Bayer AG. 1964; Chevron Research Co. 1969)



O,S-dimethyl phosphoramidothiolate.

Solid, m.p. 44.5°C; acaricide and broad spectrum insecticide with contact and systemic action; LD_{50}, 30 mg/kg.

58. Crufomate, Ruelene(R) (Dow Chem. Co. 1959)

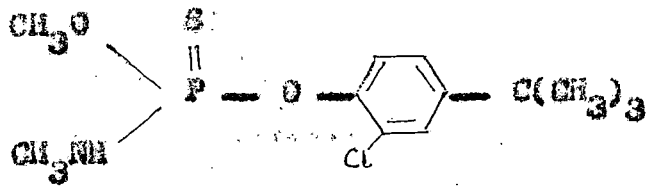


O-methyl O-(2-chloro-4-tert-butylphenyl) N-methylphosphoramidate.

Solid, m.p. 60°C; useful for the control of intestinal worms and warble flies. LD_{50}, 770 to 1000 mg/kg.

(Contd.)

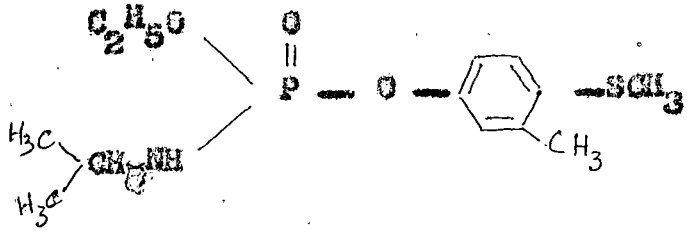
59. Narlene(R), Dowco 109(R)
(Dow Chem. Co. 1968)



O-methyl O-(2-chloro-4-tert-butylphenyl) N-methylphosphoramidothionate.

Solid; effective to control cattle grubs and botflies on livestock and also as an anthelmintic.
LD_{50}, 1000 mg/kg.

60. Nemacur(R), Phenamiphos
(Bayer AG)

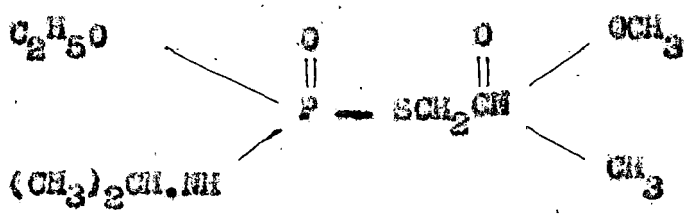


O-ethyl O-(3-methyl-4-methyl thiophenyl) N-isopropylphosphoramidate.

Solid, m.p. 49°C; systemic nematocide, effective against almost all nematode species below 5 ppm in soil for a long time (3 to 4 months)
LD_{50}, 15.3 - 19.4. mg/kg.

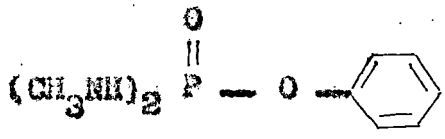
(Contd.)

61. FCS 13. — Nematocide.



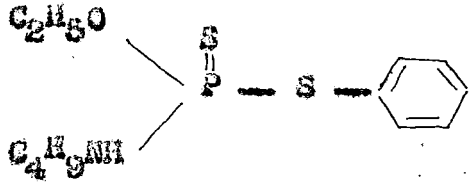
O-ethyl S-(N-methoxy-N-methyl carbamoylmethyl) N-isopropyl phosphoramidothiolate.

62. Nellite (R), Dowco 169 (Dow Chem. Co) — Solid, m.p. 105-106°C; systemic nematocide, specifically effective against root-knot nematode larvae; LD_{50}, 250 mg/k.



O-Phenyl N, N'-dimethyl phosphorodiamidate.

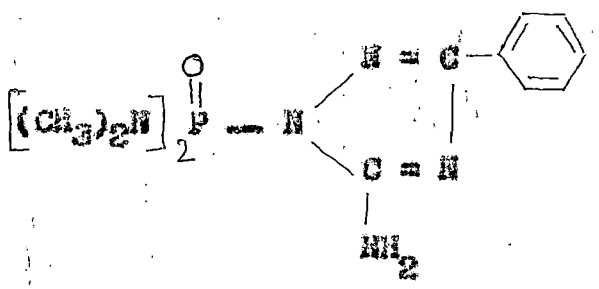
63. Phosbutyl — Liquid; fungicide, effective against mycelial cell formation, but not active against spore germination, LD_{50}, 300 mg/kg.



O-ethyl S-phenyl N-butyl-phosphoramidothiolothionate.

(Contd.)

64. Triamiphos, Wepsyn(R), Wepsin(R)



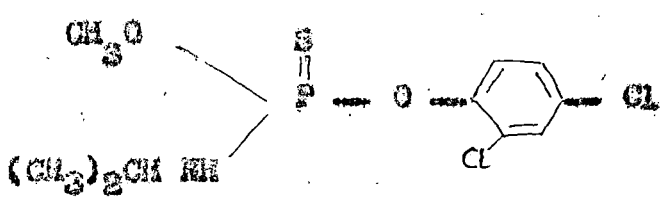
5-amino-1-[bis-(dimethylamino) phosphinyl]-3-phenyl-1,2,4-trazole.

Solid, m.p. 167 - 168°C insecticide and fungicide, effective against powdery mildew on apples and roses; useful as an acaricide with systemic properties.

LD_{50} , 20 mg/kg.

65. DMPA, Zytron(R)

(Dow Chem. Co. 1959)



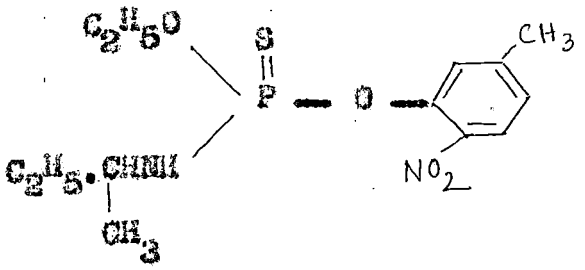
O-methyl O-(2,4 dichlorophenyl) N-isopropylphosphoramidothionate.

Solid, m.p. 51°C, pre-emergence selective herbicide for control of crabgrass in turf; LD_{50}, 270 mg/kg; it shows delayed neurotoxicity.

(Contd.)

66. Cremart, S-2846
(Sumitomo Chem. Co)

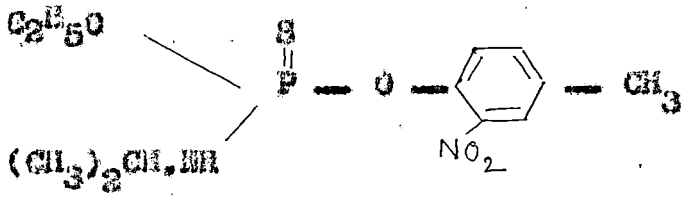
Liquid; pre-emergence herbicide, used in cereal, beans, cottons, carrot etc;
LD_{50}, 790 mg/kg.
(male rat)



O-ethyl O-(3-methyl-6-nitrophenyl) N-Sec-butyl-phosphoramidothionate.

67. Amiprophos
(Nihon Tokushu Noyaku Co. 1971)

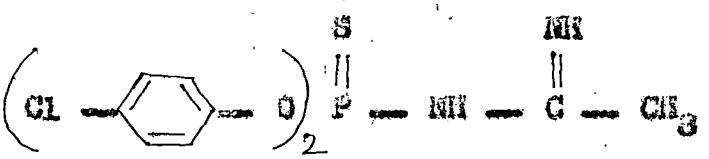
Herbicide;
LD_{50}, 720 mg/kg.



O-ethyl O-(2-nitro-4-methyl) N-isopropyl-phosphoramidothionate.

(Contd.)

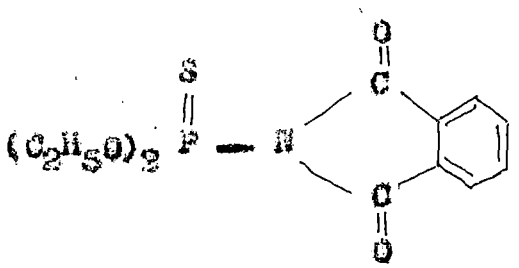
68. Gophacide (R)
(Bayer AG)



O,O-di-(P-chlorophenyl) N-acetimidophosphoramidothionate.

Solid, m.p. 104-106°C; rodenticide; LD_{50}, 7.5 mg/kg.

69. Dowco 139



O,O-diethyl phthalimidophosphonothionate.

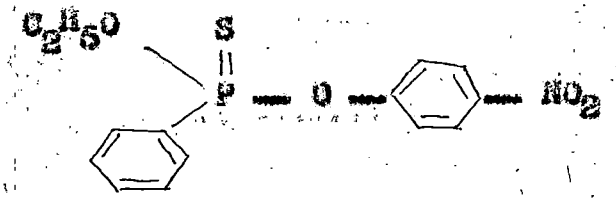
Solid, m.p. 83-84°C; fungicide, effective to control powdery mildew; shows curative and protective action; LD_{50}, 6,660 mg/kg.

(Contd.)

D. PHOSPHONOTHIONATES

70. EPN

(Du Pont. 1949)

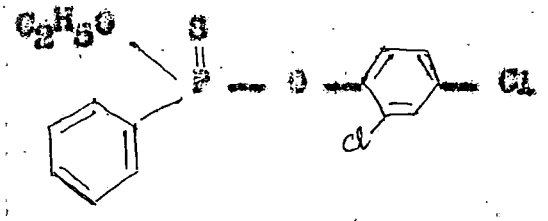


Ethyl P-nitrophenyl phenylphosphonothionate.

Light yellow crystalline solid, m.p. 36°C; insecticide and acaricide; potentiates the toxicity of malathion; shows delayed neurotoxicity; LD_{50}: 40 mg/kg (male rat) 12 mg/kg (female rat)

71. EPBP, S-Seven (R)

(Nissan Chemical Co. 1969)

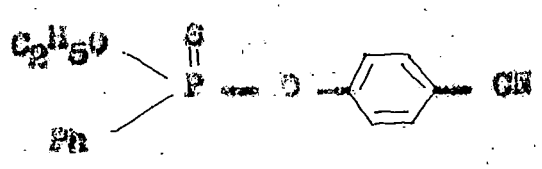


2,4 dicholorophenyl ethyl phenylphosphonothionate.

Liquid; soil insecticide (onion maggot); LD_{50}, 274 mg/kg (M)
Methyl ester homolog is more toxic than EPBP

72. Cyanofenphos, CYP, Surecide (R)

(Sumitomo Chemical Co. 1966)

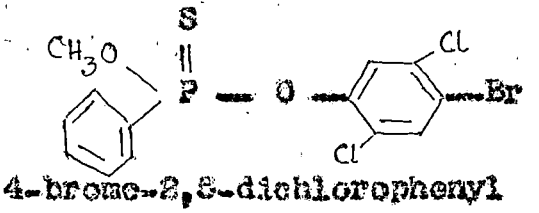


P-Cyanophenyl ethyl phenylphosphonothionate.

White crystalline powder, m.p. 83°C; insecticide rice stem borer, cotton boll worm etc; LD_{50}, 80 mg/kg.

(Contd.)

73. Phosvel(R), Leptophos, VCS - 566 (Velsicol Chemical Crop. 1965)

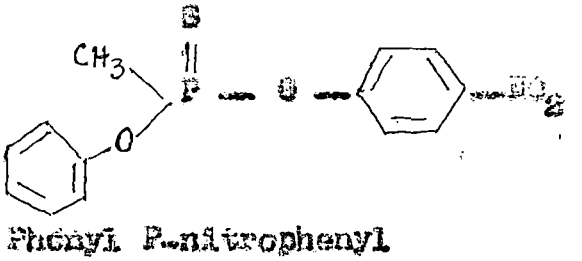


4-bromo-2,5-dichlorophenyl methyl phenylphosphonothionate.

White solid, m.p. 70.2°C; insecticide; controlling lepidopteran such as tobacco bud worms, cotton leaf worms, rice stem borers; has also fungicidal effect. LD_{50}, 90 mg/kg. It has no mutagenic or teratogenic properties.

74. Colep(R) (Monsanto Co. 1962)

Insecticide.

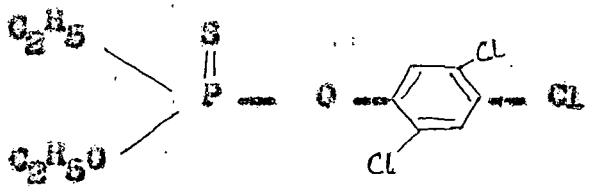


Phenyl P-nitrophenyl methylphosphonothionate.

(Contd.)

75. Trichloronate, Agritox (R), Agrisil (R), Phytosol (R)
(Bayer AG 1960)

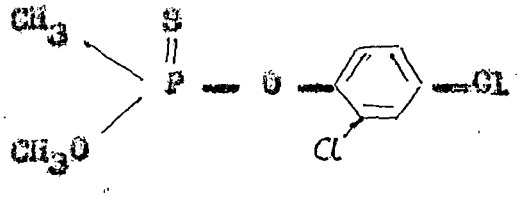
Liquid; nonsystemic, persistent soil insecticide (root maggots and wire - worms);
LD_{50}, 50 mg/kg.



Ethyl 2,4,5 - trichlorophenyl ethylphosphonothionate.

76. Bay 30911

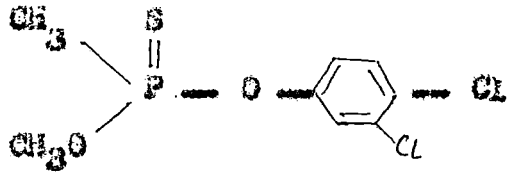
Systemic and contact insecticide with nematocidal activity;
LD_{50}, 140 mg/kg.



Methyl 2,4 - dichlorophenyl methylphosphonothionate.

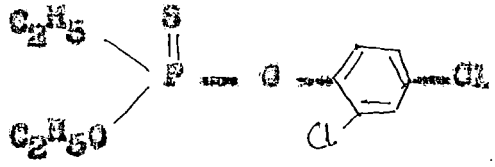
(Contd.)

77. Bay 80833 — Soil insecticide.



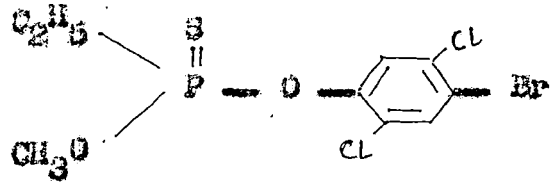
Methyl 3,4-dichlorophenyl methylphosphonothionate.

78. Stauffer N 3054 — Insecticide; LD_{50}, 75 mg/kg.



Ethyl 2,4-dichlorophenyl ethylphosphonothionate.

79. CELA K-41 — Insecticide and acaricide, 7 times more active than trichloro analog; LD_{50}, 80 mg/kg.

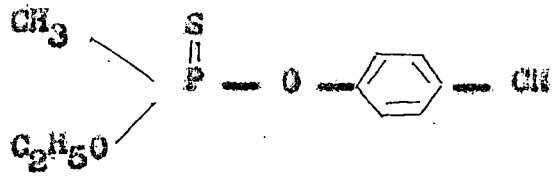


4-bromo 2,5-dichlorophenyl methyl ethylphosphonothionate.

(Contd.)

80. Stauffer B-10341

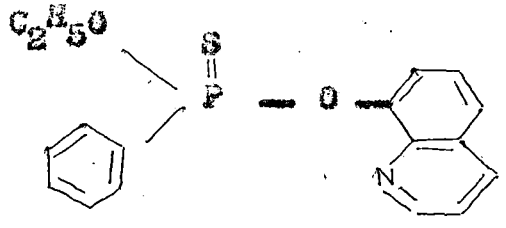
Insecticide, effective to resistant strain houseflies.



Ethyl 4-cyanophenyl methylphosphonothionate.

81. Baydip(R)
(Bayer AG)

Acaricide; can be used to control ticks on livestock; LD_{50}, 150 mg/kg.

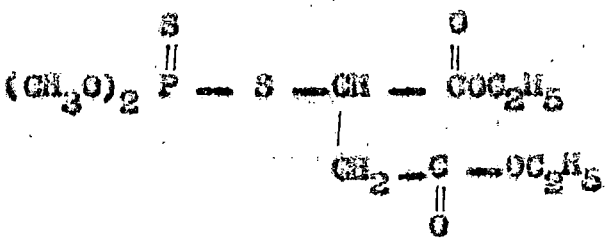


O-ethyl O-(quinolin-8-yl) phenylphosphonothionate.

(Contd.)

E. PHOSPHOROTHIOLOTHIONATES.

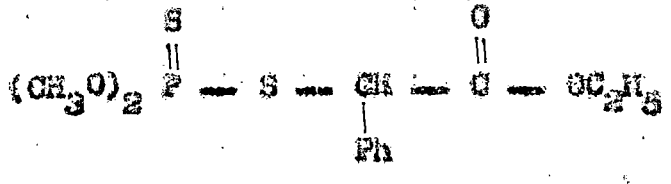
82. Malathion, Cythion(R), Karbophos.
(American Cyanamid Co, 1950)



Liquid; safe general purpose insecticide with low mammalian toxicity; LD_{50}, 1375 mg/kg; contact and stomach poison.

O,O-dimethyl S-[1,2-di(ethoxycarbonyl) ethyl] phosphorothiolothionate.

83. Phenthoate, Cidial(R), dimephenthoate, Papthion(R), Elsan(R)
(Soc. Montecatini, Italy 1964).



Liquid; broad spectrum insecticide and acaricide; LD_{50}, 4,700 mg/kg.

O,O-dimethyl S-[(α-ethoxycarbonyl) benzyl] phosphorothiolothionate.

(Contd.)

84. Acethion

$$(C_2H_5O)_2\overset{\overset{\displaystyle S}{\|}}{P} - S - CH_2 - \overset{\overset{\displaystyle O}{\|}}{C} - OC_2H_5$$

O,O-diethyl S-[ethoxy carbonyl-methyl] phosphorothiolothionate.

Liquid; selective insecticide; LD_{50}, 1100 mg/kg; it is not used practically.

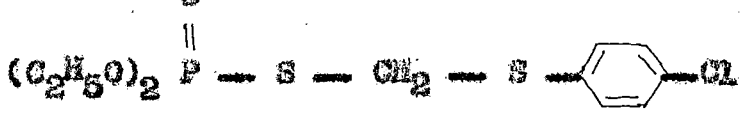
85. Chlormephos (Murphy Chemical Co. 1968).

$$(C_2H_5O)_2\overset{\overset{\displaystyle S}{\|}}{P} - SCH_2Cl$$

O,O-diethyl S-chloromethyl phosphorothiolothionate.

Liquid; non systemic soil insecticide, particularly for control of larvae of coleoptera (wire worms); LD_{50}, 7 mg/kg.

86. Trithion(R), Gerrathion(R) Carbophenothion, Akarithion(R) (Stauffer Chemical Co. 1955)



$$(C_2H_5O)_2\overset{\overset{\displaystyle S}{\|}}{P} - S - CH_2 - S - C_6H_4 - Cl$$

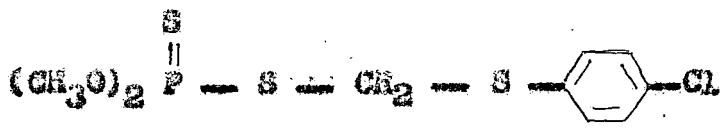
O,O-diethyl S-(P-chloro-phenyl-thiomethyl) phosphorothiolothionate.

Liquid; insecticide and acaricide with long residual action; used for sucking plant pests, particularly mites; useful as a dip for cattle tick; LD_{50}, 30 mg/kg.

(Contd.)

87. Methyl trithion(R), methyl carbophenothion (Stauffer Chem. Co. 1958)

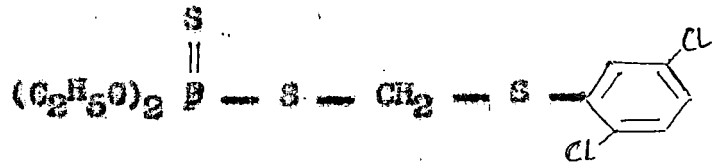
Liquid; for control of variety of insects and mites; particularly cotton boll weevil; LD_{50}, 150 mg/kg.



O, O-dimethyl homolog of trithion(R)

88. Phenkapton, Phencapton(R) (Geigy AG. 1956)

Liquid; nonsystemic, selective acaricide with prolonged action and effective against all development stages including eggs ; LD_{50}, 200 mg/kg.



O,O-diethyl S-(2,5-dichlorophenylthiomethyl) phosphorothiolothionate.

(Contd.)

89. Azothion

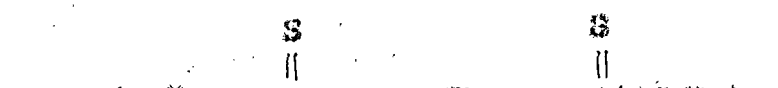
(Farbwerke Hoechst, 1957)

O,O-diethyl S-(N,N-dimethyl thiocarbamyl thiomethyl) phosphorothiolothionate.

Insecticide and acaricide; LD_{50}, 150 mg/kg.

90. Ethion, Nialate (R)

(Food Machinery and Chemical Corp. 1956)



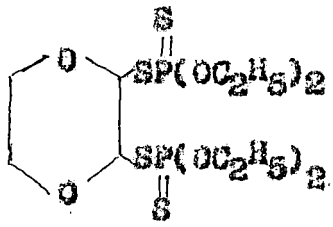
O,O,O',O'-tetraethyl S,S'-methylene bis (phosphorothiolothionate).

Liquid; for control of aphids, scales and mites; LD_{50}, 208 mg/kg.

Tetramethyl homolog is effective to bean leaf-lice and *Tetranychus telarius*.

(Contd)

91. Dioxathion, Delnav(R), Navadel(R) (Hercules Incorporated, 1954)

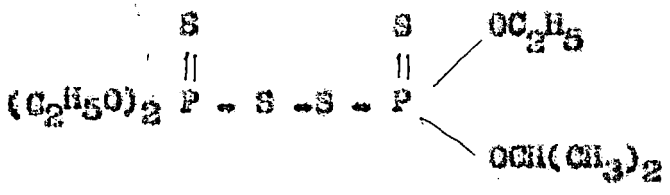


1,4 dioxan-2,3-ylidene bis (O,O-diethyl phosphorothiolothionate).

The methyl ester homolog has high insecticidal activity but low mammalian toxicity (LD_{50}, 300 mg/kg).

Liquid; non systemic acaricide and insecticide with a long residual effect and particularly useful to control mites on cotton and fruits and ticks, lice and hornfly on cattle; the cis-isomer is more toxic to both insects and mammals than the trans isomer; LD_{50}, 65-240 mg/kg (mixture of cis & trans).

92. Phostex(R) (Food Machinery and Chemical Corp. 1954)

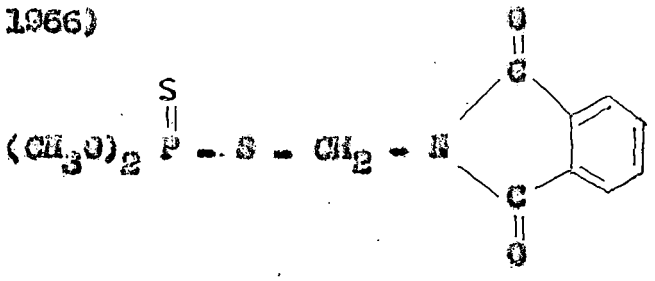


Diethoxy phosphinothionyl ethoxy isopropoxyphosphinothionyl disulphide.

Weak contact insecticide, but a highly effective miticide with a good ovicidal activity; LD_{50}, 2,500 mg/kg.

(Contd.)

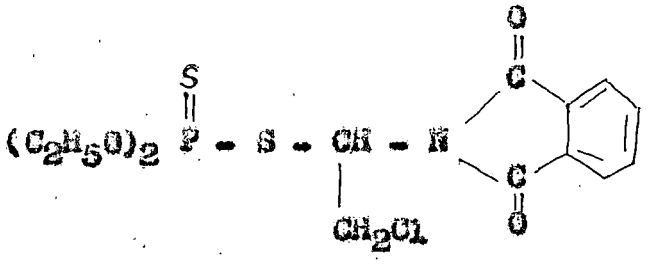
93. Phosmet, Imidan(R), phthalophos, Prolate(R) (Stauffer Chemical Co. 1966)



White crystalline solid, m.p. 72°C, acaricide and broad spectrum insecticide for sucking and chewing insects; LD_{50}, 230 mg/kg.

O,O-dimethyl S-(phthalimidomethyl) phosphorothiolothionate.

94. Dialifor, Torak(R) (Hercules Incorporated, 1965)



Crystalline solid m.p. 67 - 69°C, insecticide and acaricide; LD_{50}, 5-97 mg/kg (depending on species and sex)

O,O-diethyl S-(2-chloro-1-phthalimidoethyl) phosphorothiolothionate.

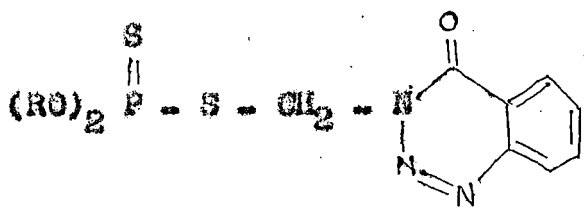
(Contd.)

95. (a) Azinphosmethyl, Guthion(R), Gusathion(R)

Aziphosmethyl: white crystalline solid m.p. 73-74°C, LD_{50}, 15 mg/kg.

(b) Azinphosethyl, Ethyl guthion, Gusathion A(R) (Bayer AG. 1953)

Aziphosethyl: Colourless needles, m.p. 53°C; LD_{50}, 17.5 mg/kg.



(a) R = CH_3 azinphosmethyl

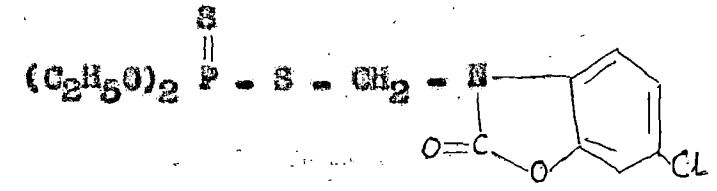
(b) R = C_2H_5 azinphosethyl

Both are non-systemic insecticide and acaricide with long residual activity under neutral contition.

(a) Azinphosmethyl: O,O-dimethyl S-(~~[illegible]~~ ~~[illegible]~~-4-oxobenzo [redacted] - [1,2,3]- triazin-3 yl methyl) phosphorothiolothionate.

(Contd.)

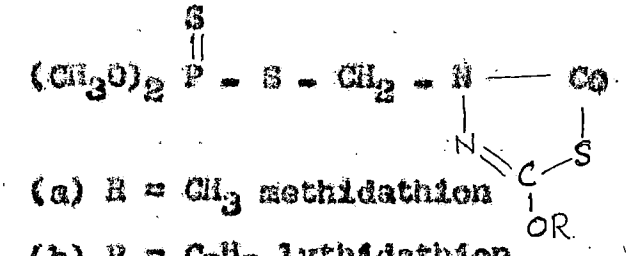
96. Zolone(R), Phosalone (Rhone-Poulenc, France 1961)



0,0-diethyl S-(6-chloro-2-oxobenzoxazolin-3-ylmethyl) phosphorothiolothionate.

Solid; m.p. 48°C; broad spectrum, non-systemic insecticide and acaricide; sap-feeding pests; LD_{50}, 120 mg/kg.

97. Methidathion, Supracide(R), Ustracide(R) (Geigy AG. 1963).



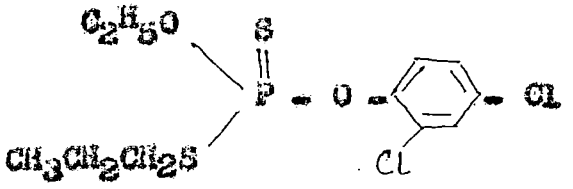
(a) R = CH_3 methidathion
(b) R = C_2H_5 lythidathion
Methidathion:

0,0-dimethyl S-[5-methoxy-2-oxo-1,3,4-thiadiazol-3-yl methyl] phosphorothiolothionate.

(a) Methidathion: Solid, m.p. 39-40°C; non-systemic insecticide and acaricide with a wide spectrum; for controlling aphid, lepidopterous larvae (codling moth) and scales on fruit trees and cotton; LD_{50}, 26-48 mg/kg.
(b) Ethoxy homolog (lythidathion), LD_{50}, 268-443 mg/kg) is useful specially against lepidopterous and dipterous larvae and orthoptera.

(Contd.)

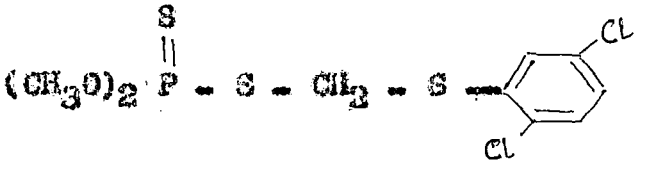
98. Tekuthion



O-ethyl S-propyl O-(2,4 dichlorophenyl) phosphorothiolothionate.

Experimental insecticide, effective to control mulbery mealybug, smaller tea tortrix, caterpillars etc; less toxic than the corresponding phosphorothionate.

99. Methyl Phenkapton (Geigy AG)



O,O-dimethyl S-(2,5-dichlorophenylthiomethyl) phosphorothiolothionate.

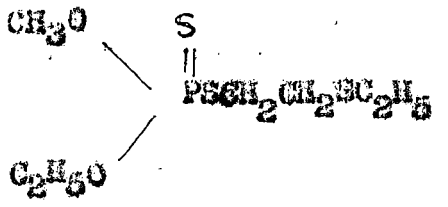
Acaricide and insecticide; LD_{50}, 375 mg/kg.

(Contd.)

100. Thiometon, Ekatin(R), Dithiometasystox(R) (Sandoz Ltd.) $(CH_3O)_2\ \overset{S}{\overset{\|}{P}}SCH_2CH_2SC_2H_5$ O,O-dimethyl S-(2-ethylthio-ethyl) phosphorothiolothionate.	Liquid; a systemic insecticide and acaricide with contact action; effective against aphids, sawflies, thrips, and mites; LD_{50}, 70-120 mg/kg.
101. Disulfoton, thiodemeton, Disyston(R), Dithiosystox (Bayer AG. 1966) $(C_2H_5O)_2\ \overset{S}{\overset{\|}{P}}SCH_2CH_2SC_2H_5$ O, O-diethyl S-(2-ethylthio-ethyl) phosphorothiolothionate.	Liquid; a systemic insecticide and acaricide, used mainly for soil pest; seed dressing or granules to protect seedlings; effective against aphids on vegetables and fruits and carrot fly, leaf-hoppers on rice, vegetables, cotton and for some other pests.

(Contd.)

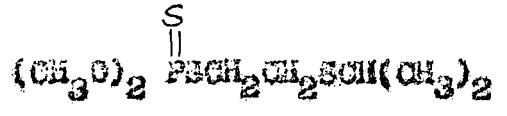
102. Tetrathion
(in Czechoslovakia)



O-methyl O-ethyl S-(2-ethylthioethyl) phosphorothiolothionate.

Liquid; a systemic insecticide and acaricide, used mainly for soil pests; chemical and insecticidal properties are similar to thiometon and Disulfoton;
LD_{50}, 1.2 - 22.3 mg/kg (various animals)

103. Isothioate, Hosdon(R)
(Nihon Noyaku Co. 1972)



O,O-dimethyl S-(2-isopropylthioethyl) phosphorothiolothionate.

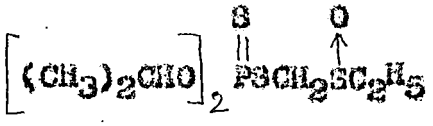
Liquid; a systemic insecticide and acaricide, effective against sucking plant pests by soil treatment or foliage spray;
LD_{50} , 200 mg/kg.

(Contd.)

104. Phorate, Thimet(R), timet (American Cyanamid Co. 1954) $(C_2H_5O)_2\ \overset{S}{\overset{\|}{P}}SCH_2SC_2H_5$	Liquid; a persistent systemic insecticide, used for the protection of seedlings from sap-feeding and soil insects; it has also some contact and fumigant action; LD_{50}, 2-4 mg/kg.
105. Am. Cy. 12008 (American Cyanamid Co. 1954) $(C_2H_5O)_2\ \overset{S}{\overset{\|}{P}}SCH_2SCH\ (CH_3)_2$ O,O-diethyl S-(isopropylthiomethyl) phosphorothiolothionate.	Liquid; systemic insecticide with some contact activity; LD_{50}, 4 to 16 mg/kg (M).

(Contd.)

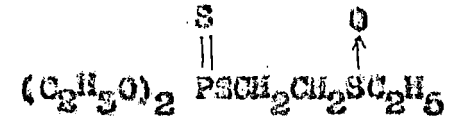
106. Aphidan, IPSP, PSP-204
(Hokko Chemical Co. 1964)



O,O-diisopropyl S-(ethylsulfinylmethyl) phosphorothiolothionate.

Liquid; a systemic insecticide, applied in soils to protect the plant from the attack of aphid; potatoes can be protected from aphid vector of virus diseases by treating the seed potatoes.
LD_{50}, 84.5 mg/kg.

107. Oxydisulfoton,
Disyston-S (R),
Disyston-Sulfoxide (R)
(Bayer AG. 1965)

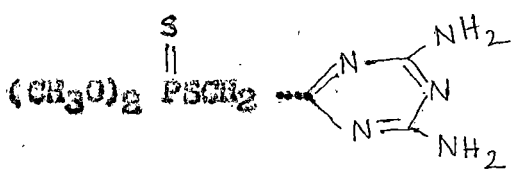


O,O-diethyl S-(2-ethylsulfinylethyl) phosphorothiolothionate.

Liquid; a persistent systemic insecticide and acaricide, particularly suitable for seed treatment against various vector (sap-sucking insects);
LD_{50}, 3.5 mg/kg.

(Contd.)

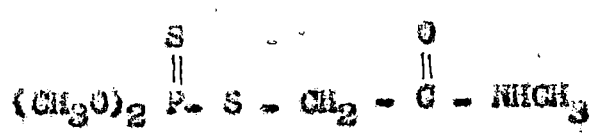
108. Menazon, azidithion, Saphizon(R), Sayfos(R) (Plant Protection Ltd. 1959)



O,O-dimethyl S-(4,6-diamino 1,3,5-triazin-2-ylmethyl) phosphorothiolothionate.

Crystalline solid, m.p. 166°C systemic aphicide, used by foliar spray, soil treatment, seed dressing and root dip; LD_{50}, 900 to 1,950 mg/kg.

109. Dimethoate, Rogor(R), Cygon(R),

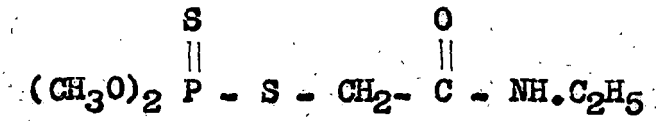


O,O-dimethyl S-(N-methylcarbamoylmethyl) phosphorothiolothionate.

Solid, m.p. 51-52°C; systemic and contact broad-range insecticide and acaricide; LD_{50}, 600 mg/kg (pure compd.) 150-300 mg/kg (technical product).

(Contd.)

110. Ethoate - methyl, Fitios B/77 (Bombrini Parodi-Delfino, Italy).

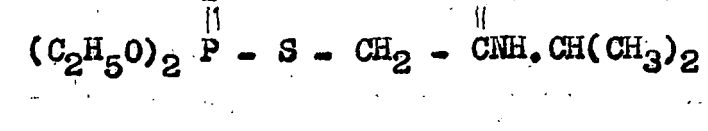


$$(CH_3O)_2\overset{S}{\overset{\|}{P}} - S - CH_2 - \overset{O}{\overset{\|}{C}} - NH.C_2H_5$$

0,0-dimethyl S-(N-ethylcarbamoylmethyl) phosphorothiolothionate.

Solid, m.p. 67-68°C; insecticide and acaricide with contact action, particularly effective against fruit-fly; LD_{50}, 340 mg/kg.

111. Prothoate, Fostion(R), Fac 20(R) (Soc. Montecatini. 1956)



$$(C_2H_5O)_2\overset{S}{\overset{\|}{P}} - S - CH_2 - \overset{O}{\overset{\|}{C}}NH.CH(CH_3)_2$$

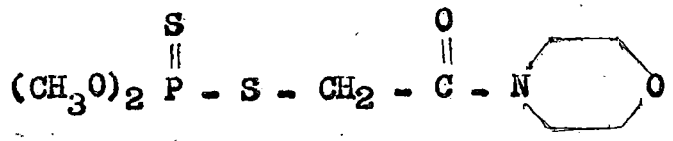
0,0-diethyl S-(N-isopropylacarbamoylmethyl) phosphorothiolothionate.

Crystalline solid, m.p. 28.5°C, acaricide and insecticide with systemic action, used mainly against phytophagous mites and some sap-sucking insects; olive fly, cherry maggot; LD_{50}, 10 mg/kg.

(Contd.)

112. Morphothion, Ekatin M(R), Ekatin F(R), Morphotox(R) (Sandoz Ltd. 1956)

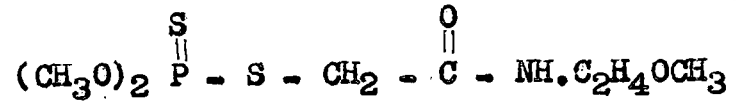
Crystalline solid, m.p. 63-64°C; a systemic and contact insecticide; LD_{50}, 190 mg/kg.



0,0-dimethyl S-(morphilino carbonylmethyl) phosphorothiolothionate.

113. Amidothion, Thiocron(R), Medithionate. (Ciba Ltd. 1963)

Solid, m.p. 46°C; insecticide, sucking pests on cherries and vegetables; LD_{50}, 600-660 mg/kg.

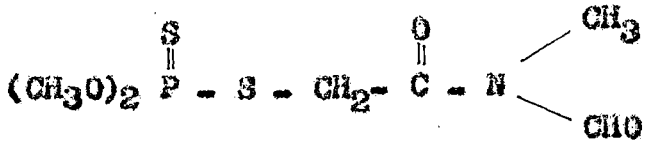


0,0-dimethyl S-(N-Methoxyethylcarbamoylmethyl) phosphorothiolothionate.

(Contd.)

114. Formothion, Anthio(R), Aflix(R)

(Sandoz Ltd. 1963)

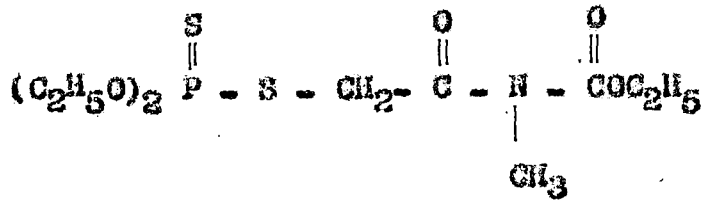


O,O-dimethyl S-(N-formyl-N-methylcarbamoylmethyl) phosphorothiolothionate.

Liquid; contact and systemic acaricide and insecticide, effective against both sucking and chewing pests; LD_{50} 375-535 mg/kg.

115. Mecarbam, Pestan(R), Murfotox(R), Afos(R)

(Murphy Chemical Ltd. 1961)

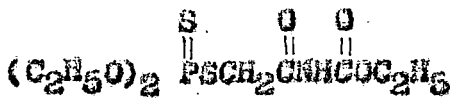


O,O-diethyl S-(N-ethoxycarbonyl-N- methylcarbamoylmethyl) phosphorothiolothionate.

Liquid; contace insecticide and acaricide with slight systemic action; persists in soil for several weeks; useful for control of sucking and chewing pests and root maggots of vegetables; LD_{50}, 36 mg/kg.

(Contd.)

116. Bay 19596

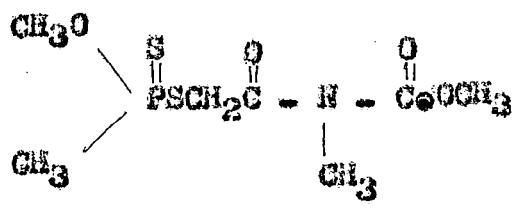


N-desmethyl homolog of Mecarbam

Insecticide, effective against the oriental fruit fly and the melon-fly.

117. Mecarphos, Mecarphon (Murphy Chemical Ltd.)

Systemic insecticide; LD_{50}, 57 mg/kg.



[S-(N-methoxycarbonyl-N-methylcarbamoylmethyl)] methyl methylphosphorothiolothiolate.

(Contd.)

118. DAMP, Amiphos(R)
(Nippon Soda Co. 1966)

$$(CH_3O)_2\overset{S}{\overset{\|}{P}}SCH_2CH_2NH\overset{O}{\overset{\|}{C}} - CH_3$$

Dimethyl S-(2-acetamido-ethyl) phosphorothiolo-thionate.

Solid, m.p. 22-23°C; systemic acaricide and insecticide, useful to control sucking pests on fruits, vegetables, and ornamentals; LD_{50}, 400 mg/kg.

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