MICROBIAL INSECTICIDES

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Introduction

Microbial insecticides are comprised of microscopic living organisms (viruses, bacteria, fungi, protozoa, or nematodes) or the toxins produced by these organisms. They are formulated to be applied as conventional insecticidal sprays, dusts, liquid drenches, liquid concentrates, wettable powders, or granules.

Microbial agents affecting insect health are handled mostly in textbooks dealing with insect pathology, some of the agents are now being registered as insecticides and are being used in a similar manner as synthetic pesticides in the field.

Microbial insecticides are especially valuable because their toxicity to non-target animals and humans is extremely low. Compared to other commonly used insecticides, they are safe for both the pesticide user and consumers of treated crops.

Bacillus Thuringiensis (B.T.)

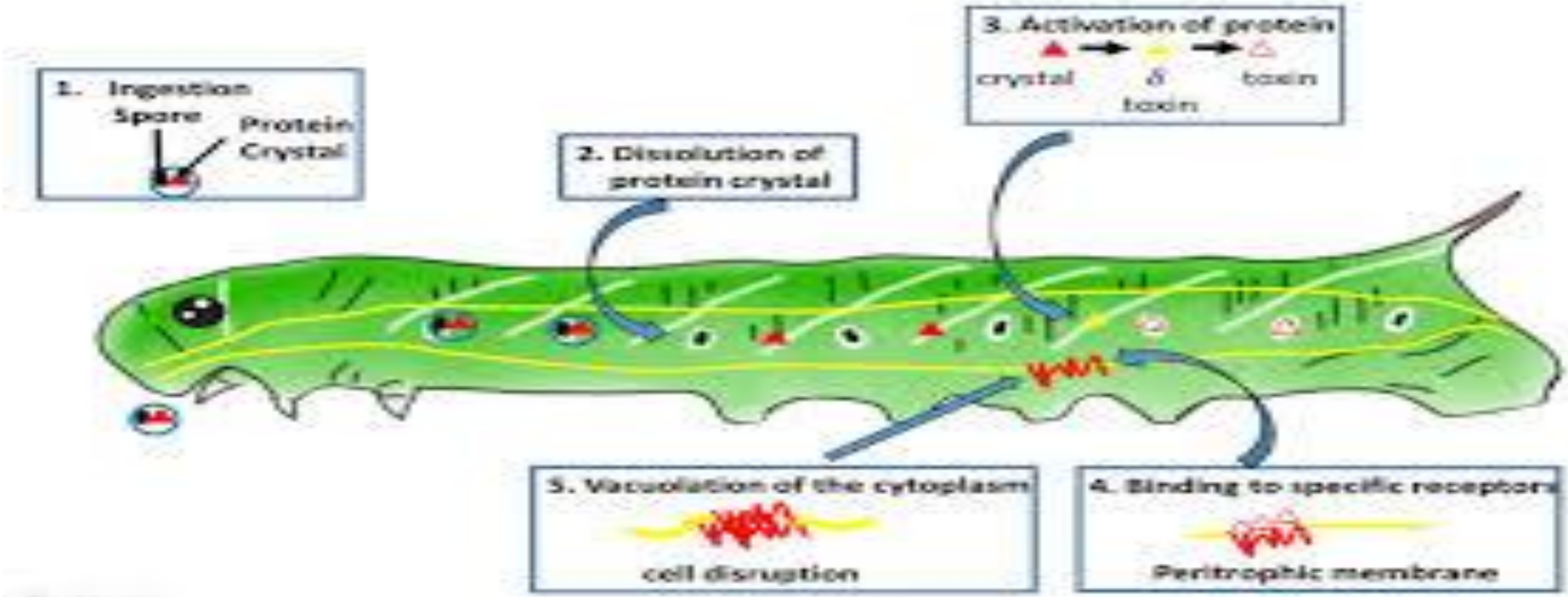
Bacillus thuringiensis, a bacterium species related to Bacillus cereus, produces substances that are extremely toxic mostly to lepidopterous larvae.

The most important of all is 8-endotoxin, which assumes a crystalline form.

The commercially available preparations are a mixture of spores and crystals. To be toxic the material must be ingested by the larvae. Therefore, it is usually sprayed at the feeding period of the pest insects.

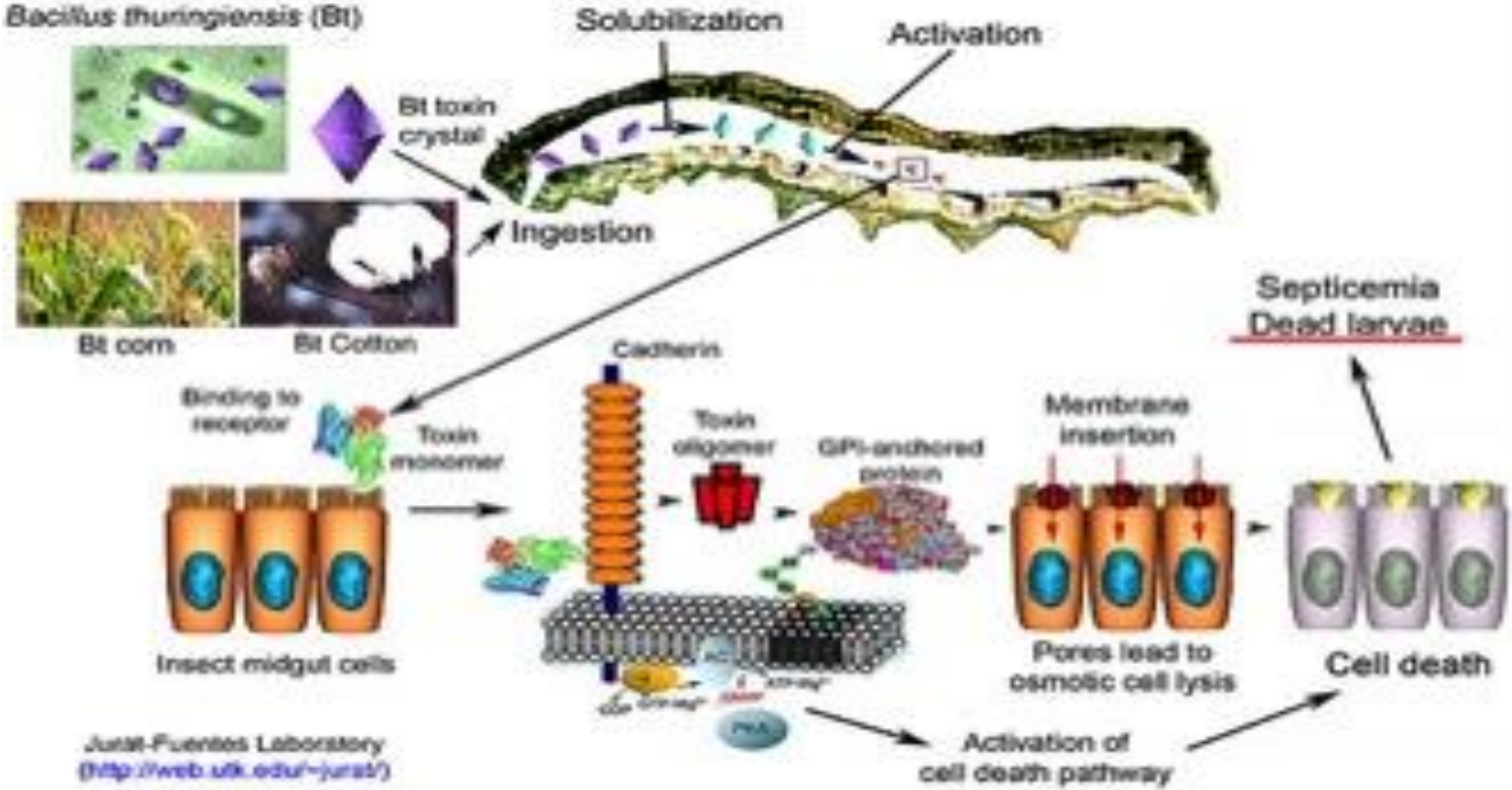
These B. T. preparations are quite effective and its efficacy records are well established.

It produced 70% mortality by feeding guinea pigs with the wash of a slant culture that contained many more spores as well as other substances.


1. Ingestion
Spare
Protein
Crystal
2. Dissolution of
protein crystal
3. Activation of protein
crystal
δ
toxin
toxin
5. Vacuolation of the cytoplasm
cell disruption
4. Binding to specific receptors
Peritrophic membrane

Bacillus thuringiensis berlin

- gram-positive, aerobic
- **parasporal body** (known as the crystal) that is proteinaceous and possesses insecticidal properties.
- The parasporal body comprises of **crystals** and tightly packed with proteins called **protoxins or endotoxins**.
- over 60,000 isolates of Bt are being maintained in


Bacillus thuringiensis (Bt)
Bt toxin crystal
Solubilization
Activation
Ingestion
Bt corn
Bt Cotton
Septicemia
Dead larvae
Cadherin
Binding to receptor
Toxin monomer
Toxin oligomer
GPI-anchored protein
Membrane insertion
Insect midgut cells
Pores lead to osmotic cell lysis
Cell death
Activation of cell death pathway
Jurat-Fuentes Laboratory
(http://web.utk.edu/~jurat/)

Bacillus thuringiensis (Bt) is a species of bacteria that lives in soil.

It makes proteins that are toxic to some insects when eaten, but not others. The proteins are not toxic to humans because, like all mammals, we cannot activate them.

Bt is not toxic to non-target wildlife. However, one type of Bt (aizawi) can be toxic to honeybees. Bt is used as an insecticide, typically, for insect larvae.

With Bt pesticides, routine testing is required to ensure that unwanted toxins and microbes are not present. Bt has been registered for use in pesticides by the US Environmental Protection Agency (EPA) since 1961.

Bacillus thuringiensis (Bt) work

Bt makes toxins that target insect larvae when eaten. In their gut, the toxins are activated. The activated toxin breaks down their gut, and the insects die of infection and starvation. Death can occur within a few hours or weeks.

The different types of Bt create toxins that can only be activated by the target insect larvae. In contrast, when people eat the same toxins, the toxins are not activated and no harm occurs.

Each type of Bt toxin is highly specific to the target insect.

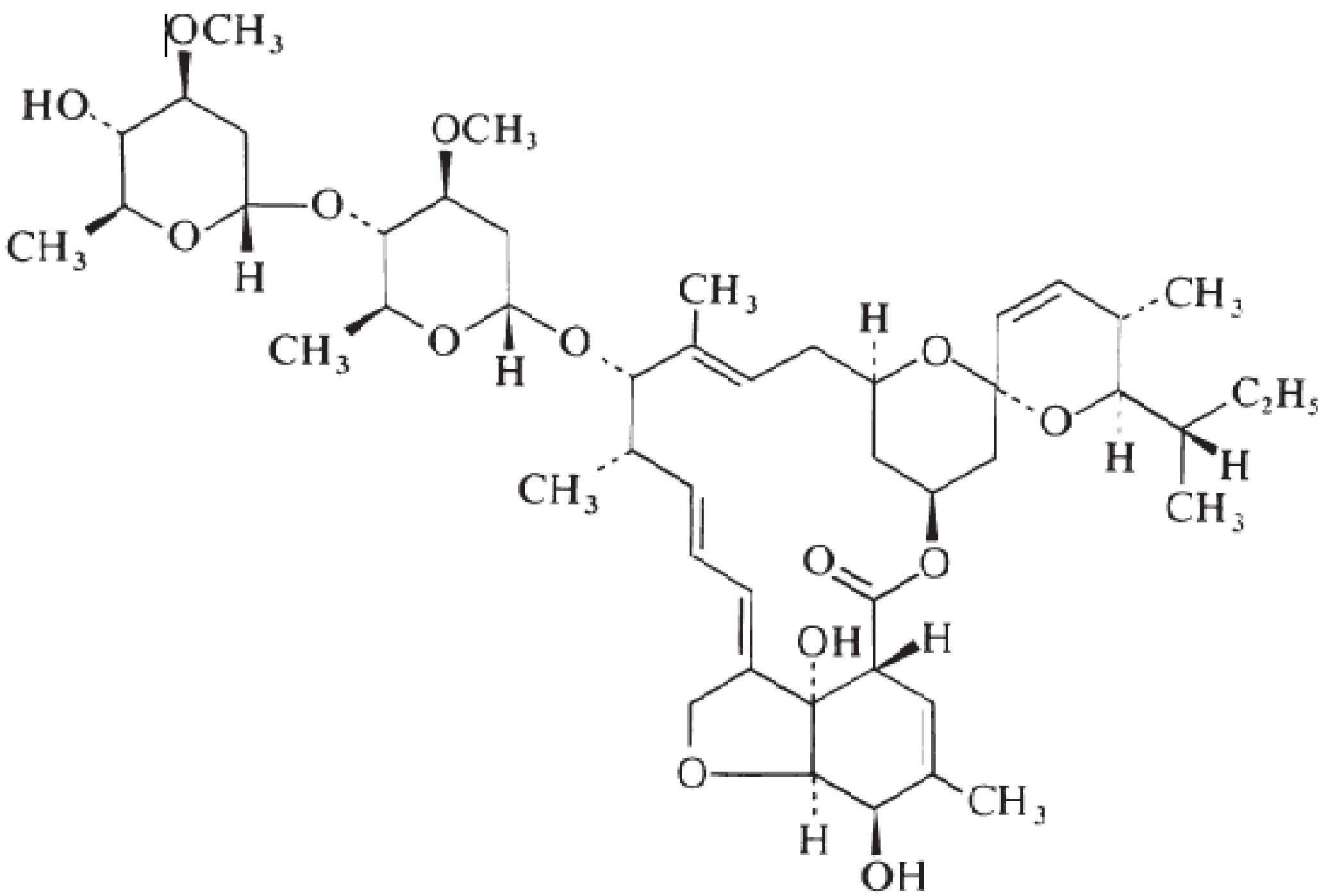
Avermectin Bla

Avermectin Bla (AVM) is a macrocyclic lactone derived from the mycelia of Streptomyces avermilitis.

It has been shown to be anthelmintic, insecticidal, and acaricidal. The original extract of the fungus culture contains several analogues.

As a pesticide, it is relatively slow acting, but its paralytic effect takes place rapidly.

It is being tested by Merck, Sharp & Dohme Research Laboratories against a variety of pests, including soil nematodes, various herbivorous mites, fireants, Colorado potato beetles, aphids, pea psylla, vegetable leafminers (Liriomyza sativae), sheep blowflies, and other ectoparasites of food animals.


OCH3
HO
CH3
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OCH3
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CH3
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C2H5
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H
CH3
CH3
O
O
OH
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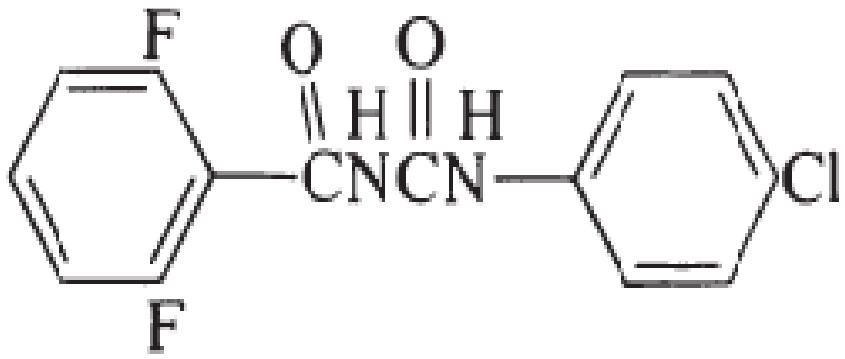
O
CH3
H
OH

INHIBITORS OF CUTICLE FORMATION

Dimilin is a unique pesticide known to act on the formation of cuticles. The compound was synthesized by Philips-Duphar B. V. Company. Its common name is diflubenzuron.



DIMILIN®, TH6040, DIFLUBENZURON

1-(CHLOROPHENYL)-3-(2,6-DIFLUOROBENZOYL) UREA

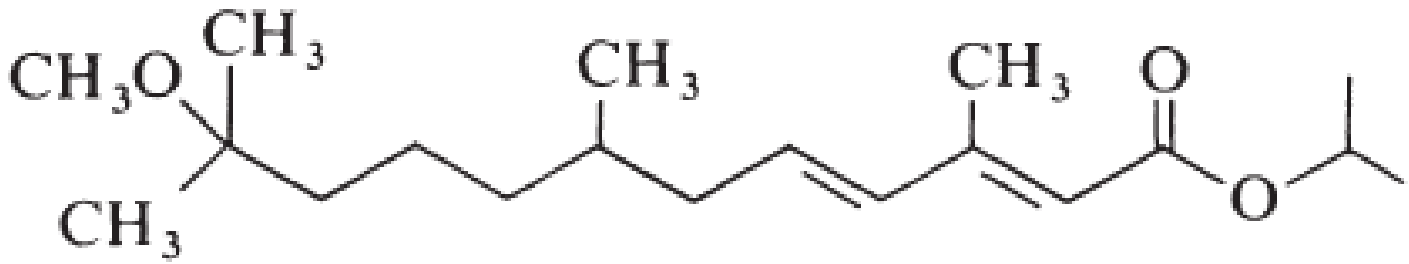
It has a water solubility of 0.2 ppm. Its toxicity is quoted as > 10,000 mg/kg for rats (oral).

Its major use is on cotton pests, but it is being developed for other pests of economic importance, such as soybean insects and forest and veterinary pests. Because of its unique mode of action, many scientists have been studying various effects produced by the administration of this compound.

HORMONE MIMICS

METHOPRENE

Methoprene is a juvenile hormone mimic that has achieved commercial success. It has a water solubility of 1.3 ppm. Its major market is for mosquito larval control. An unusual usage was developed in Japan where methoprene is used for increasing the cocoon size of silkworms.



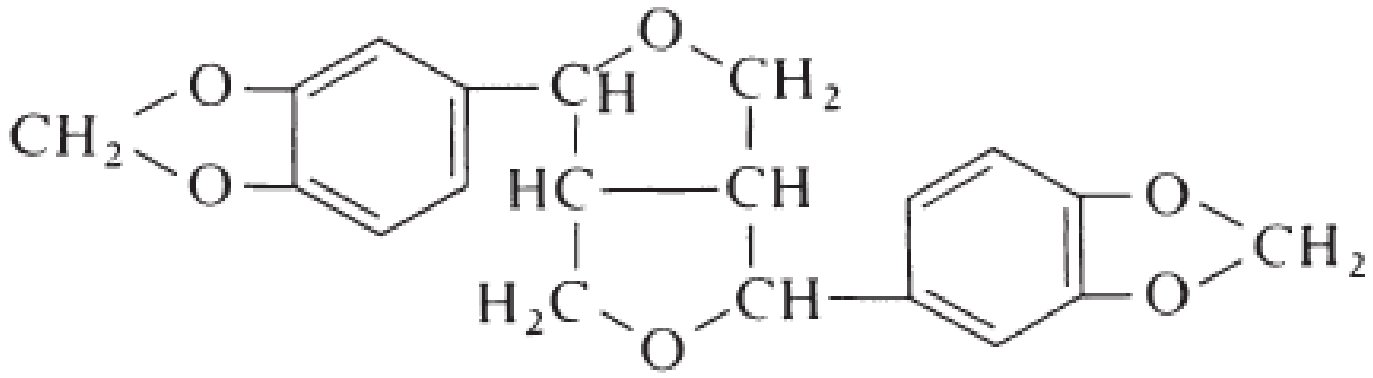
METHOPRENE
ISOPROPYL (2E,4E)-11-METHOXY-3,7,11-TRIMETHYL-2,4-DODECADIENOATE

SYNERGISTS

The toxicity of certain insecticides, notably pyrethrin, can be enormously increased by the addition of compounds which may not be insecticidal at all. These compounds are called synergists (e.g., pyrethrin synergists). The majority of the synergists contain an active moiety, a methylenedioxyphenyl group.

Sesamin

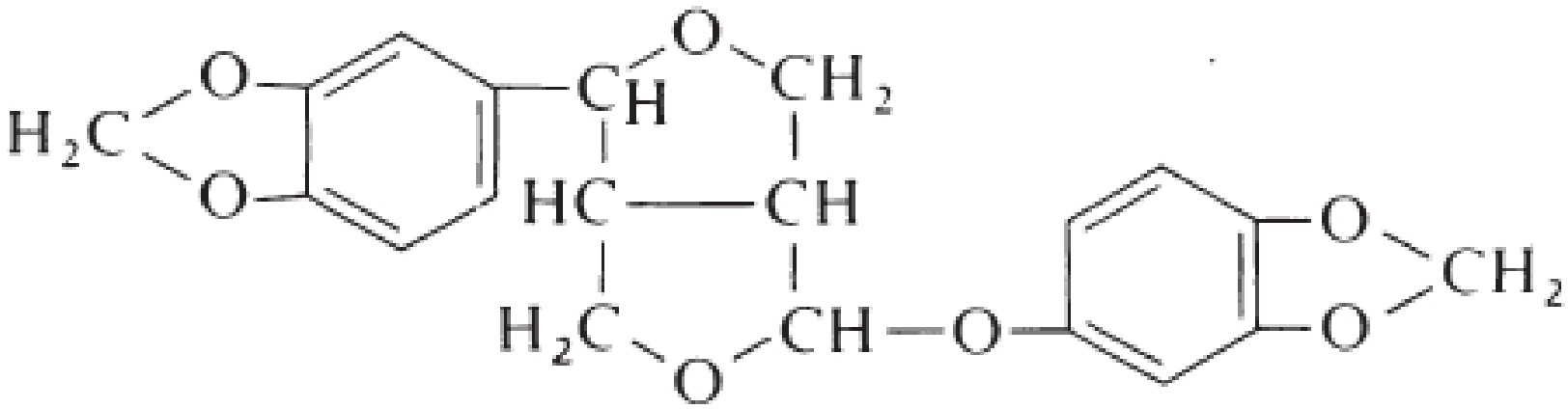
Sesamin is one of the active principles of sesame oil, which has long been known to synergize the action of pyrethrin. It is a crystalline oleoresin.



SESAMIN

Sesamolin

Sesamolin is another active principle of sesame oil. It is a noncrystalline residue and is more effective than sesamin as a synergist with pyrethrin.

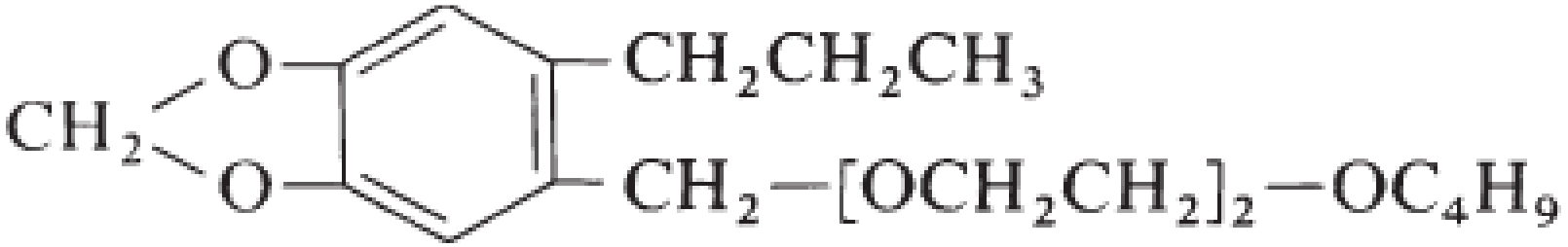


SESAMOLIN

Piperonylbutoxide

Perhaps the most widely used synthetic pyrethrin synergist is piperonylbutoxide.

Its effectiveness is cited as around a tenfold increase in pyrethrin toxicity when it is mixed with pyrethrin in the ratio of 10: 1. Its solubility in petroleum oils and in Freon is acceptable enough for the preparation of aerosols.



α-[2-(2-BUTOXYETHOXY)ETHOXY]-4,5-METHYLENEDIOXY-2-PROPYLTOLUENE

INORGANIC INSECTICIDES

Inorganic insecticides are relatively nonspecific, and since they are not too toxic to insects, large quantities are required to control insect pests in the field. Because of these limitations, inorganic insecticides have been gradually replaced by organic, particularly synthetic chemicals.

Nevertheless, two groups of inorganic chemicals are used today as insecticides:

- Arsenicals
- Fluorides.

Arsenicals

Arsenicals are still widely utilized inorganic insecticides.

The insecticidal activity of this group of compounds is generally directly related to the percentage content of metallic arsenic. These chemicals can be very phytotoxic, if the portion of water-soluble arsenic is high.

Two forms of arsenicals are important today:

- ❖Lead arsenate
- ❖Calcium arsenate

All arsenicals are stomach poisons to insects and leave water-insoluble residues on the top soil layers and on plant leaves.

Lead Arsenate

Lead arsenate is sometimes referred to as "acid lead arsenate."

It contains about 20 % arsenic. It is 0.25 % soluble in water, and it sometimes can cause phytotoxicity, particularly in the presence of alkali in water.

The commercial preparations contain 14% arsenic and are therefore less active than "acid lead arsenate.

Lead arsenates are the least phytotoxic members of the arsenicals. effective against chewing-type insects in orchards. The most popular formulation is dust containing 32 % or more arsenic.

Calcium Arsenate

Calcium arsenate may contain up to 37 % arsenic and therefore can be quite insecticidal.

Commercial products contain about 25 % arsenic and are considered to be in the safe basic form.It is soluble in water to 0.4--0.5 %.

Generally, calcium arsenates are more apt to cause phytotoxicity than lead arsenates.

The toxicity of the calcium arsenates is on the order of 35 mg/kg. They are formulated as 25% dusts, 15% bait, on 70% wettable powder and sprayed against the cotton boll weevil and insects in orchards and garden crops.

Inorganic Fluorides

Two types of inorganic fluorides are available as insecticides.

- ❖Sodium fluoride
- ❖Silicate.

GeneraIIy, the degree of toxicity of these compounds is related to their fluorine content, but their phytotoxic action increases as their water solubilities increase, in analogy to arsenicals.

They are also stomach poisons.

Sodium Fluoride

Sodium fluoride has been used as an insecticidal stomach poison since 1896.

It contains 45.2 % fluorine and is soluble in water at 4.3 %. Its toxicity to man is cited as 75 mg/kg.

It is formulated as powder (25-95 %) or bait and is used against cockroaches, silverfish, ticks, and lice.

Because of phytotoxic problems, it is not used on plants. In the household and on premises where animals are kept, powders are spread at 10 oz/1000 ft 3 .

FUMIGANTS

Fumigant, any volatile, poisonous substance used to kill insects, nematodes, and other animals or plants that damage stored foods or seeds, human dwellings, clothing, and nursery stock.

All fumigants are extremely volatile substances. Their usefulness is mainly in the area of control of stored-product insects and scale insects on citrus. Two factors play important roles in characterizing the fumigants:

(1) Flammability

(2) Self-warning properties.

Commonly Used Fumigants

METHYL BROMIDE

- Methyl bromide is still the most widely used fumigant.
- It is a colorless, odorless liquid. It is not self-warning since it has no odor in the gaseous form at room temperature.
- It is extremely toxic and flammable (safe vapor limit 17 ppm). It is stable and is heavier than air.
- It is most widely used for insect pests in grain elevators and warehouses.
- It is also useful for soil pests including nematodes, although its high volatility somewhat restricts its use.

DIBROMOCHLOROPROPANE

- DBCP is a soil fumigant for nematode control.
- Its proper chemical name is 1,2-dibromo-3-chloropropane.
- The vapor toxicity is 103 ppm (8 hr exposure) to 368 ppm (l hr exposure).
- It is used on a variety of crops, vegetables, and ornamentals, such as cotton, soybeans, and fruits.
- It is used either as a pre-planting or a post-planting soil fumigant, depending upon the susceptibility of the intended plants.
- It has been found to cause temporary male sterility among some workers in manufacturing plants.

CHLOROPICRIN

- Chloropicrin was developed as a tear gas, but its usefulness as a fumigant was discovered in 1918 in France.
- It is self-warning because of its irritant effects, and is nonflammable.
- It is lethal at a concentration of 0.8 mg/liter for rats.
- Its main usefulness is against soil pests and to some extent stored-product insects.
- It cannot be used for vegetables and other fresh crops and fruits.

TABLE 3-5. Physical Properties of Commonly Used Fumigants

	Safe limit (ppm)	Boiling point (°C)	Relative weight (as air = 1)	Vapor pressure (mm Hg, 20°C)	Remarks (% in air flammability)
Chloropicrin	0.1	112	5.7	20	Corrosive, nonflammable
Methyl bromide	17	4.5	3.3	1420	Nonwarning, flammable (13.5)
Cyanide gas (HCN)	10	26	0.9	630	Flammable (6)
Ethylene dichloride	50	84	3.4	78	Highly flammable (6)
Ethylene oxide	50	11	1.5	1095	Explosive (3)
Carbon disulfide	20	46	2.6	314	Explosive (1)
Phosphine	0.3	−87.4	1.2	—	Flammable (2)

Reference

https://www.youtube.com/watch?v=3aLj1WmzL98

Https://www.youtube.com/watch?v=mNs3vJAXx3Y

https://www.youtube.com/results?search_query=microbial+insecticides