Developed and designed by Thanal Conservation Action Information and Trading Network Private Limited

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# HIGHLY HAZARDOUS PESTICIDES

## MALATHION

**(Insecticide)**

It is a non-systemic, broad-spectrum insecticide used to control the pests like coleopterans, hemipterans, dipterans, lepidopterans, aphids and leaf hoppers on vegetables, ornamental trees, shrubs and stored produce. It is acutely toxic and is capable of inducing cytotoxic, carcinogenic and reproductive toxic effects in animals.

**IUPAC Name-** diethyl (dimethoxyphosphinothioylthio)succinate

**CAS NO: 121-75-5**

**Substance Group-** Organophosphate Insecticide

**Trade names** - Cythion (Coromandel international), HILmala (HIL), Sulmathion, Kelthion, Fyfanon (Cheminova, Inc.), Malasik (Sikko industries), MTHION (Lotus), Eagle (Sun chemical)

**Classification-**

**(WHO)-** Class III (Slightly hazardous)

**IARC-** Group 2A (Probable human carcinogen)

**Banned Countries-** It is banned in 32 countries including Switzerland, Indonesia and Palestine

**Mode of Action:**

Malathion is a pro-insecticide which bioactivates to malaoxon resulting in interruptions in other metabolic reactions**.** It acts as cholinesterase inhibitor.

**General properties**

Malathion is a non-systemic, broad-spectrum organophosphate insecticide

Malathion is a colourless to amber-coloured liquid with a garlic-like odour

Malathion is also an ingredient in shampoos to control head lice regulated by the United States Food and Drug Administration (FDA)

It is moderately soluble in water and highly soluble in many organic solvents and has high volatility

**Formulations:** 5 (Malathion 02 % House Hold Spray, Malathion 05 % DP, Malathion 25 % WP, Malathion 50 % EC, and Malathion 96 % ULV)

**GHS Hazard Statements-**

**GHS Signal word: DANGER.**

**H302:** Harmful if swallowed (Acute toxicity, oral)

**H317:** May cause an allergic skin reaction (Sensitization, Skin)

**H400:** Very toxic to aquatic life (Hazardous to the aquatic environment, acute hazard)

**H410:** Very toxic to aquatic life with long-lasting effects (Hazardous to the aquatic environment, long-term hazard)

**Exposure Route:** Exposure by dermal contact, inhalation and ingestion

**Residues-** The maximum residue limit proposed by the European Commission for malathion in citrus fruits is 2 mg/kg (Fresh and frozen) and 0.02 mg/kg for spices (applicable from 03/04/2015)

In a study on residues of malathion in greenhouse crops, the half-life (t1/2) of malathion in cucumbers was established as 2.4 days, and

2.6 days in pepper. (Hernández Torres, M. E et al, 2002)

In a study on the effect of boiling on malathion-sprayed grains, it was observed that maloaxon, a metabolite of malathion was detected in high quantities in the solvent extracts of cooked beans and maize (Lalah, J. O et al, 2002) Malathion was detected exceeding MRL (1.30) in wheat samples (0.05) from Hyderabad in the All India Network Project on Pesticide Residues, Indian Agricultural Research Institute 2018-19 ). Non-approved uses were also noted.

The Maximum Residue Limit (MRL) prescribed for Malathion according to Food safety and standards (Contaminants, toxins, and residues) Regulations, 2011 is given in mg/kg.

| | |
|---|---|
| Wheat | -10.0 |
| Maize | -0.05 |
| Fruits | -4.0 |
| Vegetables | -3.0 |
| Dried fruits | -8.0 |
| Carbonated water | -0.01 |

## Regulatory status:

**International regulation:** It is not approved by COPR regulatory status and EC regulation 1107/2009 status

Malathion wettable powder (WP) formulation is recommended by WHO for malaria vector control by indoor residual spraying (IRS)

The U.S. Environmental Protection Agency (U.S. EPA) grouped malathion under GUP (General use pesticide) and toxicity class III

Approval of malathion for the European Union market was revoked in 2008, Member States of the European Union voted in 2010 to allow malathion end-use products to be registered for the control of insect pests in agricultural crops (European Commission, 2015)

WHO in 2004, tried to set a permissible level of malathion in drinking water, however, it occurred in drinking water at concentrations much lower than the health-based value and hence concluded that the presence of malathion in drinking water under usual conditions is unlikely to represent a hazard to human health. For this reason, it is considered unnecessary to derive a guideline value for malathion in drinking water.

The workplace permissible exposure limit (PEL) for malathion established by the Occupational Safety and Health Administration (OSHA) is 15 mg/m

It is considered a Highly Hazardous Pesticide (HHP) by PAN International and is a slightly toxic compound in EPA toxicity class III.

**National regulation**

Malathion is toxic-labelled blue colour (Slightly Hazardous)

It is recommended for mosquito control as an indoor spray to prevent the spread of malaria in India

It is recommended for 16 crops nationally which are Rice, Sorghum, Pea, Soybean, Castor, Sunflower, Okra, Brinjal, Cabbage, cauliflower, Raddish, Tomato, Turnip, Apple, Mango and grape against insect pests like Aphids, Jassids, Thrips, Whiteflies, Green leaf hopper, Leaf roller/folder, shoot borer, Pod borer, Semilooper, Beetles, Rice Hispa etc.

It is a deemed to be registered pesticide

Malathion was included among 66 pesticides reviewed under the Chairmanship of Dr Anupam Verma in 2013.

361st Special Meeting of Registration Committee held on 22nd December, 2015, considered these recommendations, and decided that 'The Certificate of Registration of technical and its formulation deemed to be invalid w.e.f. from Ist January, 2018 if studies as recommended by the Expert Committee is not submitted by December, 2017' and 'The pesticide needs to be re-evaluated for their bio-efficacy and residue data against major target pests as per approved label claims and baseline toxicity data may be generated by the Industry Associations by December, 2017'

It has a production volume of 3286 metric ton units in 2022 and a volume consumption of 305.41 metric ton units in India in the year 2021

Malathion was included among 27 pesticides considered for ban in 2020.

## Health Hazards

**Acute toxicity**: Malathion is toxic via ingestion and skin absorption (GHS)

It is moderately toxic to earthworms, fish, other aquatic organisms, and honey bees (PPDB)

Symptoms of malathion poisoning include; numbness, tingling sensations, incoordination, headache, dizziness, tremor, nausea, abdominal cramps, sweating, blurred vision, respiratory depression, and slowed heartbeat. High doses may result in unconsciousness, incontinence, convulsions, or fatality

In 1976, epidemic malathion poisoning occurred in Pakistan among 7500 field workers associated with the malaria control programme (Baker EL Jr et al,1978)

Acute rat LD50 - 5400 mg/kg in males& 5700 mg/kg in females. Acute dermal LD50 in rats is greater than 2000 mg/kg (Reregistration Eligibility Decision (RED) – Malathion)

**Chronic toxicity**: Malathion is a potent endocrine disruptor, neurotoxicant, acetylcholine esterase inhibitor and possible liver and adrenal and thyroid toxicant (PANAP FACTSHEET-Malathion)

**Carcinogenicity:** The IARC in 1987 determined that malathion is unclassifiable as to its carcinogenicity to humans and place it in group 3

However, studies which show the carcinogenic potential of malathion are available. In a study of 622 men with newly diagnosed NHL in Iowa and Minnesota and 1,245, the prevalence of NHL in individuals who handled malathion as a crop insecticide prior to 1965 was significantly higher than in nonfarmers (Cantor et al. 1992).

**Reproductive Toxicity**: Rupa et al (1991) investigated reproductive outcomes of organophosphates including malathion in 1,016 farmers and their spouses and found significantly higher percentages of stillbirths (8.73 vs 2.65% in control) and abortions (26.0 vs 15.0% in control)

Grether et al. (1987) examined the occurrence of defects and low birth weight using newborn hospital discharge data and vital records in the San Francisco Bay area after aerial malathion spraying.

**Endocrine Disruption**: Malathion was listed in the final group of substances to be tested as part of the U.S. EPA Endocrine Disruptor Screening Program (EDSP) because of the potential for people to be exposed to malathion

Exposure towards malathion reduced the thyroxine, triiodothyronine, growth hormone, insulin-like growth factor, testosterone, and oestradiol levels in freshwater catfish, *Clarias batrachus* (Lal et al, 2013).

The effects of thyroid disruption of malathion were seen in Fischer rat thyroid follicular cell line FRTL-5in terms of inhibition of mRNA and protein expression levels. Cellular cAMP and TSH receptor expression were also reduced which directly disrupted thyroid hormone biosynthesis (Xiong et al, 2018).

**Neurotoxicity**: Malathion is a potent neurotoxicant with choline esterase inhibition activity

Exposure of rabbits to 123 mg malathion/m3 as an aerosol for 6 hours inhibited plasma cholinesterase activity by 37% (Weeks et al. 1977).

In a 13-week malathion exposure study in Sprague-Dawley rats, decreased brain and plasma cholinesterase activity, prominent in females was noted (Beattie. G, 1994).

Malathion is observed to induce the elevation of oxidative stress, apoptosis and BDNF (Brain-derived neurotrophic factor) level in female rats (Salama et al, 2019).

**Poisoning Data**

Malathion was responsible for 1 death and 5 admissions to hospital in 2002, Warangal poisoning.

**Antidote-** Pralidoxime and atropine sulphate are the antidotes recommended, which are common antidotes available for organophosphate treatment

**Environmental fate and effects:** Malathion have a soil half-life of 1-25 days. Biodegradation is expected as the primary process.

It is considered non-persistent, less mobile with low leachability (PPDB)

Degradation of malathion in organic-rich soils was 3 to 6 times higher than in soils not containing organic matter (Gibson and Burns, 1977)

In soil, malathion was degraded by Arthrobacter sp. to malathion monoacid, malathion dicarboxylic acid, potassium dimethyl phosphorothioate and potassium dimethyl phosphorodithioate (Walker and Stojanovic, 1974)

**Ecotoxicity**

**Mammals**- Moderate acute toxicity

**Birds**- Moderate acute toxicity

**Earthworms**- Moderate acute toxicity

**Honeybees**- High acute toxicity

**Fish** - High acute toxicity

**Aquatic crustaceans**- High acute Toxicity

**Aquatic invertebrates**- High acute toxicity

### Alternate pest management

Sustainable ecological solutions to replace chemical Pesticides include the use of bio-pesticides and numerous cultural, mechanical and biological solutions to pest control, as well as natural sprays that can be used depending on the pest and the situation that relies on the utilization of agroecological practices.

**Notes on HHPs**

Highly Hazardous pesticides or HHPs are a group of pesticides, that can pose serious risks to humans and cause irreversible damage to the environment. They are listed in international conventions and are banned in many countries. The handling and use of these HHPs are beyond the safety level of PPE as stated by SAICM.

HHPs upon exposure enter the body through food, inhalation, or dermal contact. These pesticides cause lethal effects, especially when exposed for the long term. It includes acute toxicity (Headache, Nausea, Vomiting etc) to Chronic hazards (Gene mutations, Cancer, Reproductive dysfunction etc). Farmers, applicators, and their families are mostly exposed to pesticides. The increased closeness of residents to farming areas worsens the situation and their exposure can occur under deplorable conditions, such as handling, storing, mixing, loading, spraying, disposing, and washing pesticide containers or pesticide-soaked clothes.

Women are the most affected by the ill effects of HHP use, as they have a higher proportion of hormone-sensitive tissues, fats, and primary reproductive tasks. HHPs can cause birth defects, miscarriage, early onset of puberty, sexual maturation, infertility, and abortions in female children. Children are exposed to the HHP-contaminated environment as they consume more air, water and food per unit of body weight. They have a higher metabolism and their immunity and developing functions are compromised at a young age.

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