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

A project of Savitri

Technical support by PAN India

HIGHLY HAZARDOUS PESTICIDES

MONOCROTOPHOS

(Insecticide/Acaricide)

It is a broad-spectrum organophosphate contact insecticide used for mitigation of Aphids, Jassids, Thrips, Whiteflies, Green leaf hopper etc in emergence control of broadleaf weeds and grasses in crops like Maize, rice, coffee, coconut, sugarcane etc. It is known to cause acute and chronic toxic effects (neurotoxic and carcinogenic effects) in animals and humans.

IUPAC Name - dimethyl (E)-1-methyl-2-(methylcarbamoyl)vinyl phosphate

CAS NO: 6923-22-4

Substance group-
Organophosphate Insecticide

Trade names - Monoset (Ayushi), Monocil (IIL), Monosol (NCS), Monoguard (Lotus), Phoskill (UPL), Monocel (Swisston), Monostar (SWL)

Classification

WHO - it is characterized as highly hazardous (Class Ib)

E.C -Mutagenic category 3; R 40: possible risks of irreversible effects (1985)

USEPA-Category 1 (highly toxic) (USEPA, 1985)

GHS Signal word: DANGER.

Bans: Banned in 129 countries including Bangladesh, Brazil, China, and Pakistan and is an HHP according to JMPM criteria

Mode of action- Systemic insecticide with stomach and contact action. It is involved in the inhibition of acetylcholinesterase (AChE).

General properties

Monocrotophos is a reddish-brown crystalline solid with a mild odour

It has a high solubility in water, alcohol, and acetone. It is stable when stored in glass and polyethylene containers

Formulations - 2 Formulations; Monocrotophos 15 % SG, Monocrotophos 36 % SL.

GHS Hazard Statements-

GHS SIGNAL WORD: DANGER

H300: Fatal if swallowed [Danger Acute toxicity, oral]

H311: Toxic in contact with skin [Danger Acute toxicity, dermal]

H330: Fatal if inhaled [Danger Acute toxicity, inhalation]

H341: Suspected of causing genetic defects [Warning Germ cell mutagenicity]

H400: Very toxic to aquatic life [Warning Hazardous to the aquatic environment, acute hazard]

H410: Very toxic to aquatic life with long-lasting effects [Warning Hazardous to the aquatic environment, long-term hazard]

Exposure root- Exposure may occur through dermal contact, inhalation, and ingestion. Easily absorbed.

Residues- The maximum residue limit proposed by the European Commission for Monocrotophos in fruits (Fresh and frozen) and nuts is 0.01 mg/kg and 0.05 mg/kg for spices (applicable from 26/04/2013)

Monocrotophos residues in cabbage after spraying persisted for more than 30 days at both recommended and double the recommended dose in a study.

Monocrotophos when fed to lactating dairy cows at a level of 45 ppm in the diet, was later found

in milk and urine along with other metabolites (Potter, 1965)

It was found in exceeding levels in green chilli (2.78) which exceeds the MRL limit of 2 mg/kg, collected from Tamil Nadu in the Annual project report of All India Network Project on Pesticide Residues, Indian Agricultural Research Institute 2018-19

Breast milk samples from 127 women in Punjab state of India, analysed using gas chromatography showed higher levels of Monocrotophos (1.63 ng/lipid weight) (Sharma. A et al,2014)

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

Food grains	-0.03
Citrus fruits	-0.2
Cotton seed	-0.1
Meat	-0.02
Eggs	-0.02
Chilli	-0.2
Cardamom	-0.5

Regulatory status:

International regulation: It is not approved by U.K COPR regulation and EU regulation (1107/2009)

Monocrotophos is included in the interim PIC procedure as a severely hazardous pesticide formulation, based on the recommendation of the fifth meeting of the FAO/UNEP Joint Expert Group (October 1992) of the Rotterdam Convention. It is also an HHP according to JMPM criteria

In compliance with Article 3,5 and 7.5 of the International Code of Conduct on the Distribution and Use of Pesticides, WHO and FAO recommends countries consider banning this hazardous insecticide.

National regulation: Monocrotophos is Toxic-labelled red colour (Extremely Hazardous)

It is banned in India for use in vegetables in an order dated 10, October 2005

The national insecticide Banning Order, 2020 which includes 27 pesticides has monocrotophos listed in it, which is under review

It is recommended for 13 crops nationally which are rice, cotton, green gram, maize, red gram, black gram, pea, sugarcane, citrus, mango, coconut, coffee, and cardamom against insect pests like Aphids, Jassids, Thrips, Whiteflies, Green leaf hopper, Leaf roller/folder, shoot borer, Pod borer, etc.

It is a deemed to be registered pesticide

Monocrotophos 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 Monocrotophos and its formulation deemed to be invalid w.e.f. from Ist January, 2018 if studies as recommended by the Expert Committee if not submitted by December, 2017'

It has a production volume of 7487 metric ton units in 2022 and a volume consumption of 351.91 metric ton units in India in the year 2021

Health Hazards

Acute toxicity: Monocrotophos is Toxic via ingestion, inhalation, and skin absorption (GHS)

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

It is a highly toxic phosphate ester with the following toxic parameters (CAS Database list)

- LD50 oral (rat): 8 mg/kg
- LD50 oral (mouse): 15 mg/kg
- LD50 skin (rat): 112 mg/kg
- LC50 inhalation (rat): 63 mg/m3 /4 h.

Monocrotophos is highly toxic to birds and is used as a bird poison (Meister, R.T, 1992)

Monocrotophos is a direct-acting cholinesterase inhibitor capable of penetration through the skin (American Conference of Governmental Industrial Hygienists, 1991)

Symptoms of monocrotophos poisoning are similar to those of other organophosphate compounds. Its cholinesterase-inhibiting activity causes nervous system effects. Cases of human poisoning are characterized by muscular weakness, blurred vision, profuse perspiration, confusion, vomiting, pain, and

small pupils and a risk of death due to respiratory failure (Senanayake, N. and L. Karalliedde, 1987)

Chronic toxicity: Monocrotophos has targeted effects on the respiratory system, central nervous system, cardiovascular system, blood cholinesterase and reproductive system (Skripsky, T and Loosli, R, 1994)

Monocrotophos affect the nervous system by inhibiting acetylcholinesterase, an enzyme essential for normal nerve impulse transmission

In a feeding study in Wistar rats, the survival rate of mice was reduced, and body weight gains and feed consumption were also decreased at 10 ppm. Cholinesterase activities in plasma, erythrocytes, and the brain were also diminished (Robinson et al,1983)

Carcinogenicity: Not classifiable as a human carcinogen. However, there are evidences reporting the carcinogenic effects of monocrotophos. It is reported to cause the growth of human breast cancer cells and induced mutagenic effects.

Neurotoxicity: Tripathi et al. (2017) studied the neurotoxic effects of monocrotophos on cultured neural and glial cells, where monocrotophos exposure triggered the apoptotic cell death

Studies suggest that exposure to these pesticides may increase the neurodegeneration intensity in patients suffering from AD (Alzheimer's disease) and PD (Parkinson's disease) (Kumar et al, 2015). Since it is an organophosphate, it can cause neurobehavioral problems and delayed neuropathy in mammals.

Reproductive toxicity: In the study by Borders et al. (1983), monocrotophos was given to pregnant Sprague-Dawley rats on gestational days 6 through 15, by gavage, and dams were killed on pregnancy day 20. Maternal toxicity was evident in muscle tremors and twitching, salivation, and decreased foetal body weight indicating foetal toxicity. Brain defects occurred in all groups.

Concern was raised at the 1991 Joint Food and Agriculture Organization (FAO)/WHO Meeting on Pesticide Residues (JMPR) (WHO 1991) about the brain defects based on this teratology study

Similar studies also showed the involvement of monocrotophos in the interruption of the oestrous cycle in rats. Reduced healthy follicles and increased atretic follicles were observed following the exposure. Reduced fertility, depressed lactation, and teratogenicity were also observed.

Cardiovascular effects: Monocrotophos induced oxidative stress in cardiac tissue and elevated expression of cardiac markers in the blood of rats. Inflammatory changes and oedema between muscle fibres were also noted (Velmurugan et al, 2012).

Genotoxicity: Monocrotophos is genotoxic to Meretrix ovum and induces retardation of the somatic growth of the mussel (Revankar and Shyama 2009).

Poisoning data

In India, 23 children died from eating Monocrotophos contaminated mid-day meals in 2013

In 2018, 14 people died and 107 were hospitalized after consuming prasad reportedly contaminated by Monocrotophos at the Kichugutti Maramma temple near Mysuru, Karnataka.

Monocrotophos along with other HHPs were involved in the death of 23 farmers and 450 poisoning cases in the Yavatmal district, Maharashtra in 2017.

In the WHO study, carried out in 4 South Indian States, 'Health implications from monocrotophos use: a review of the evidence in India', (data collected from July 1999 to June 2000) has shown that 89 of the 1531 cases of pesticide poisoning in these states was due to Monocrotophos, the largest for any insecticide.

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

Environmental fate and effects: The half-life of monocrotophos in the soil is estimated to be 1-5 days. Biodegradation is expected to be the primary process.

Monocrotophos has a low environmental persistence. It does not accumulate in the soil

Monocrotophos was found to decompose in plants forming the N-hydroxy compound in small amounts (Hartley and Kidd, 1987). It emits toxic fumes of phosphorus and nitrogen oxides when heated to decomposition (Sax and Lewis, 1987)

It is a non-persistent pesticide with high leachability.

Ecotoxicity

Mammals- High acute toxicity

Birds - High acute toxicity

Earthworms- Moderate acute toxicity

Honeybees - High acute toxicity

Fish - Moderate acute toxicity

Aquatic invertebrates High acute toxicity

Alternate Pest management

Sustainable ecological solutions to replace chemical Pesticides include the use of biopesticides 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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