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

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HIGHLY HAZARDOUS PESTICIDES

ACEPHATE

(Insecticide)

It is a broad-spectrum systemic insecticide used for the control of pests like Leaf hopper, Thrips, Bollworms, Aphid, Jassids and Stem borer in cotton, safflower, chilli and soybean. It is known to cause acute and chronic toxic effects (neurotoxic and carcinogenic effects) in animals and humans.

IUPAC Name- N- [methoxy (methyl sulfanyl) phosphoryl] acetamide

CAS NO: 30560-19-1

Substance Group- Organophosphate insecticide

Trade names - Tamaron Gold (Heranba Industries), Asataf (TATA), Ace gold (Crop chemicals), Ambastar (Ambachem), Hunk (Rallis India Ltd)

Classification-

(WHO)- Class II- Moderately hazardous

Banned countries- Acephate is banned in 35 countries including China, Indonesia

Mode of action- Acephate binds and inhibits the enzyme acetylcholinesterase (AChE) in the nervous system resulting in the accumulation of enzyme in synapses. Insects metabolize Acephate into methamidophos by hydrolysis while such bioactivation in mammals are immediately turned off resulting in its selective toxicity in insects.

General Properties

It is an organophosphate systemic insecticide which was first registered for use by USEPA in 1973.

It is also used in greenhouses, on turf and on commercially grown ornamentals

It is a white solid having a strong odour and is highly volatile

Technical Acephate is more acutely toxic than the purified form, because technical Acephate contains as much as 30% of a more toxic breakdown product, methamidophos

It is highly soluble in water and organic solvents and is highly volatile

Formulations - 3 (Acephate 75 % SP 3, Acephate 95 % SG 4, Acephate 97 % DF)

GHS Hazard Statements-

GHS SIGNAL WORD: Warning

H302: Harmful if swallowed [Warning Acute toxicity, oral]

Exposure root- Occupational exposure may occur through dermal contact.

Residues: Acephate has a maximum residue limit of 0.01 mg/kg in tree nuts and 0.02 mg/kg for citrus fruits as of 26/04/2013 (European Commission)

In a study of different commonly used vegetables in the market (eggplant, ladyfinger, cauliflower, cabbage, tomato and chilli) in Hyderabad (2012), almost all of

the vegetable samples contain Acephate

Acephate was detected in many fruits and vegetables from different states of India, exceeding MRL as well as in non-approved uses in commodities (Annual project report of All India Network Project on Pesticide Residues, Indian Agricultural Research Institute 2018-19)

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

Rice	-1.0
Safflower seeds	-2.0
Cotton seed	-2.0
Meat	-0.05
Milk	-0.02

Regulatory status:

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

EPA has assessed the risks of Acephate and reached an Interim Reregistration Eligibility Decision (IRED) where it stated that its risks are within acceptable levels. Acephate was made eligible for reregistration (EPA Acephate facts, September 2000).

National regulation: Acephate is a toxicity colour labelled blue (Moderately Toxic)

It has a volume consumption of 356.9 metric tons in the year 2021 and a production of 29556 metric tons in 2022 in India

It is approved for 4 crops nationally which are cotton, safflower, chilli and soybean and is used to control pests like Leaf hopper, Thrips, Bollworms, Aphid, Jassids Stem borer, Leaf folder, Brown Plant Hopper Leaf folder and white flies

TNAU, Coimbatore has reported that repeated application causes a resurgence of BPH (*Nilaparvata lugens*) in rice; red-spotted spider mite (*Tetranychus cinnabarunyus*) in cotton and brinjal; muranai mite (*Polyphagotarsonemus latus*) in chilli. PAU, Ludhiana has reported a resurgence of whitefly and American bollworm in cotton.

Acephate 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 Acephate 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'

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

Health Hazards

Acute toxicity: It is classified as category 4 for acute toxicity when swallowed (GHS)

It has moderate to low toxicity in birds, honeybees, earthworms, and most aquatic organisms and is moderately toxic to mammals and has a low potential for bioaccumulation (PPDB).

Methylthioacetate (MTA), can be found in small amounts in Acephate formulations. An acute dermal toxicity study in rabbits found that MTA could cause blindness when applied at concentrations between 1500 and 3000 mg/ kg

Chronic toxicity: Acephate can cause cholinesterase inhibition in humans where it can overstimulate the nervous system resulting in nausea, dizziness, confusion, and at very high exposures and respiratory paralysis and death in severe cases (U.S EPA)

The oral dose of Acephate when administered to rats in gestation at a concentration of 40 mg/kg resulted in immediate death, where higher uptake of radioactive Acephate by placenta than foetus concentration was observed. Milk was found to be the major route of elimination of Acephate and therefore suckling pups are more affected (Ahmed et al,1992)

Acephate induced moderate skin irritation in New Zealand white rabbits and developed erythema on unbraided skin (Levi et al,1970)

It is also reported to cause eye irritation and slight corneal opacity in rabbits treated with Acephate (Narcisse et al,1971)

Carcinogenicity: EPA has classified acephate as a Category C or possible human carcinogen

Neurotoxicity: Suspected choline esterase inhibitor (USEPA)

Potential neurotoxicity for every life stage and route of exposure (Revised Draft Human Health Risk Assessment (ORA) in support of Registration Review. March 28, 2018 USEPA)

Brain cholinesterase activity was inhibited in multiple studies conducted in beagle dogs, rabbits, and rats

In a short-term study of neurotoxicity in rats fed diets containing acephate at a concentration of 50 to 1000 ppm, brain acetylcholinesterase activity was inhibited at the lowest dietary concentration tested (50 ppm)

Reproductive toxicity: In considering environmental risks, the U.S. EPA concluded that chronic exposure to acephate and methamidophos may decrease offspring survival and body weight in wild mammals (RED, EPA, 2006)

Acephate decreased embryo chorion surface tension at 24 hours, along with the increase in hatching rate at 72 hours in Zebrafish studies (Liu. X et al,2018)

Endocrine disruption: Acephate is suspected of endocrine disruption (Pesticide info, PANNA)

Acephate induces disruption of hormone expression in the hypothalamus in rats (Singh AK, 2002)

Female Wistar rats when injected with 500 mg/kg acephate showed

elevated serum corticosterone and aldosterone, and decreased serum glutamate and histidine levels (Spassova. D et al, 2000)

Reversible hyperglycaemia and adrenal cortex hyperactivity were observed two to six hours after fasted male rats were fed with 140 mg/kg Acephate (Joshi A.K et al,2009)

Mutagenicity: Acephate (50 mg/kg) induced significant bone marrow chromosome aberrations after 24 h exposure in chicks. They induced significant increases in micronuclei in both bone marrow and peripheral blood erythrocytes in the i.p. route only

Poisoning data

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

Acephate was responsible for 4 deaths and 14 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:

Acephate and its metabolite methamidophos do not bioaccumulate but is acutely toxic to honey bees in the immediate post-application period (U.S. EPA, 2006)

Acephate is non-persistent in soil (US ARS Pesticide database)

The mobility of acephate in soil is faster than that of methamidophos, and may lead to the contamination of groundwater much more easily than methamidophos under normal conditions (Yen. J.H et al, 2000)

Studies indicated declining population of resident avian species after Acephate treatment (USEPA, 1985)

Ecotoxicity

Mammals- Moderate acute toxicity

Birds- Moderate acute toxicity

Earthworms- Low acute toxicity

Honeybees- Moderate acute toxicity

Fish - Low acute toxicity

Aquatic invertebrates-Moderate 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.

REFERENCES

1. Joshi, A. K. R. J.; Rajini, P. S. Reversible hyperglycemia in rats following acute exposure to acephate, an organophosphorus insecticide: Role of gluconeogenesis. Toxicology 2009, 257, 40-45.

2. Liu, X., Zhang, Q., Li, S., Mi, P., Chen, D., Zhao, X., & Feng, X. (2018). Developmental toxicity and neurotoxicity of synthetic organic insecticides in zebrafish (Danio rerio): A comparative study of deltamethrin, acephate, and thiamethoxam. Chemosphere, 199, 16-25.

3. Reregistration Elegibility Decision (RED) Acephate; EPA 738-R-01-013; U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Office of Pesticide Programs, U.S. Government Printing Office: Washington, DC, 2006; pp 1-87

4. Singh AK. Acute effects of acephate and methamidophos and interleukin-1 on corticotropin-releasing factor (CRF) synthesis in and release from the hypothalamus in vitro. Comp. Biochem. Physiol. C Toxicol. Pharmacol. 2002;132:9–24

5. Spassova, D.; White, T.; Singh, A. K. Acute effects of acephate and methamidophos on acetylcholinesterase activity, endocrine system and amino acid concentrations in rats. Comp. Biochem. Physiol. Part C 2000, 126, 79-89.

6. Yen, J. H., Lin, K. H., & Wang, Y. S. (2000). Potential of the insecticides acephate and methamidophos to contaminate groundwater. Ecotoxicology and Environmental Safety, 45(1), 79-86.

7. U.S. EPA. 1987. "Guidance for the Reregistration of pesticide Products Containing Acephate as the Active Ingredient." Office of Pesticide Programs. Washington, D.C

8. G.B. Jena, S.P. Bhunya, Mutagenicity of an organophosphate insecticide acephate—an in vivo study in chicks, Mutagenesis, Volume 9, Issue 4, July 1994, Pages 319–324

9. Sinha, S. N., Rao, M. V. V., & Vasudev, K. (2012). Distribution of pesticides in different commonly used vegetables from Hyderabad, India. Food Research International, 45(1), 161-169.

Web references

BeyondPesticides- https://www.beyondpesticides.org/assets/media/documents/pesticides/factsheets/Acephate.pdf

Acephate (beyondpesticides.org)

JMPR- https://apps.who.int/pesticide-residues-jmpr-database/Document/142

ACEPHATE (Addendum) - DocsLib

PPDB- Acephate (herts.ac.uk)Acephate Technical Fact Sheet (orst.edu)