Health implications from monocrotophos use: a review of the evidence in India

World Health Organization
Regional Office for South-East Asia

Health implications from monocrotophos use: a review of the evidence in India

World Health Organization
Regional Office for South-East Asia

WHO Library Cataloguing-in-Publication data

World Health Organization, Regional Office for South-East Asia.
Health implications from monocrotophos use: a review of the evidence in India.

1. Monocrotophos – adverse effects – toxicity. 2. Pesticides – adverse effects.
3. Hazardous substance. 4. Suicide. 5. India

ISBN 978-92-9022-345-0 (NLM classification: WA 240)

© World Health Organization 2009

All rights reserved.

Requests for publications, or for permission to reproduce or translate WHO publications – whether for sale or for noncommercial distribution – can be obtained from Publishing and Sales, World Health Organization, Regional Office for South-East Asia, Indraprastha Estate, Mahatma Gandhi Marg, New Delhi 110 002, India (fax: +91 11 23370197; e-mail: publications@searo.who.int).

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by the World Health Organization to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall the World Health Organization be liable for damages arising from its use.

This publication does not necessarily represent the decisions or policies of the World Health Organization.

Printed in India

Revision

This document was revised on 24 July 2013, to correct an error on page 7.

Contents

Annexures

Acknowledgements

Lead authors:

- Dr Aruna Dewan, Medical toxicologist; Former Deputy Director, National Institute of Occupational Health Ahmedabad, India.
- Dr T.P. Rajendran, Indian Council of Agricultural Research, New Delhi, India

Reviewers:

- Mr Alexander von Hildebrand, Regional Adviser Environmental Health, Regional Office for South-East Asia of the World Health Organization, New Delhi, India
- Dr V. Ragunathan, Plant Protection Expert, Consultant to the Food and Agriculture Organization, Chennai, India
- Dr Habibullah Saiyed, Medical toxicologist; Former Deputy Director, National Institute of Occupational Health Ahmedabad, India and Consultant to the World Health Organization
- Dr Joanna Tempowski, Scientist, International Programmeme on Chemical Safety, World Health Organization, Geneva, Switzerland
- Mr Harry van der Wulp, Senior Policy Officer, Plant Protection Service, Food and Agriculture Organization, Rome, Italy

Foreword

The World Health Organization (WHO) estimates that globally three million intentional and unintentional pesticide poisoning episodes occur annually and, of these, a minimum of 300 000 die, with 99% of the cases being from low- and middle- income countries (41). These figures, if extrapolated to the South East Asia (SEA) Region where approximately one fourth of humanity lives and assuming an even per capita distribution, would mean 750 000 pesticide poisoning cases and 75 000 deaths annually. The corresponding figures for India would be an estimated 600 000 cases and 60 000 fatal outcomes occurring annually.

According to a WHO estimate, 18% of the pesticide poisonings reported in the SEA Region are work-related, 14% are accidental and 68% are intentional (self-harm or criminal attempts). Between 20% and 55% of self-harm attempts in SEAR countries are carried out by ingestion of pesticides (43). The most vulnerable groups consist of children, women, workers in the informal sector, and poor farmers.

The continuous increase of pesticide suicide rates in India exemplifies this vulnerability. According to the national Crime Records Bureau in India[1], in the five years prior to 2001, there were on average 15 750 reported farmer suicides a year on average. Since 2002, the annual reported average has risen to 17 366 in 2007. That is the equivalent of one suicide every 30 minutes. Gunell et al believe this figure is an under estimate. Detailed studies suggest that India's pesticide suicide rates may be seven times higher, reaching 126 000 cases annually (13).

1 See: http://ncrb.nic.in/ADSI2007/home.htm

Most of the affected farmers are extremely poor. Attracted by discounted loans from pesticides traders and their intermediates[2], extensive borrowing takes place to grow crops, especially cotton. Despite the constant application of pesticides, whitefly, boll weevils and caterpillars have multiplied and cause severe damage to crops.

Several reports have suggested that exposure to agricultural pesticides (mainly chronic exposure to organophosphates) produces depression, and depression is a major risk factor for suicide. Suicide attempts thus may be an effect of exposure to pesticides. (2, 24, 29, 30).

The vast majority of affected farmers are in no position to repay the loans or feed their families[3]. Nearly half of the pesticides used in India go into protecting cotton, the most important commercial crop in the country. However, most of the cotton pests have shown increased resistance to a range of pesticides. According to the Ministry of Agriculture, the crop destruction and losses in the state of Andhra Pradesh went up dramatically despite repeated application of excessive amounts of chemicals – a practice actively encouraged by pesticides traders[4].

Important national efforts and support from WHO to SEA Region countries have been undertaken in the last fifteen years – awareness campaigns and capacity building in the use of a harmonized data collection system, common treatment protocols and guidelines, as well as some laboratory support. Yet, the response capacity to manage poisonings is still far from adequate.

---

2 See: http://www.thaindian.com/newsportal/uncategorized/farmers-suicide-after-loan-default_10041086.html

3 See: http://worldnews.about.com/b/2008/05/11/debts-drive-indias-farmers-to-suicide.htm

4 See: http://www.articlearchives.com/agriculture-forestry/agriculture-crop-production-misc/1510382-1.html

To date SEA countries have a total of only 15 functioning poisons information centres, with capacity to respond to a maximum of 5000 cases per year. Only a small professional pool of experts in toxicology works in the area of case management in the Region. Their commitment is often based on individual choice; doing a lot with little, they have saved hundreds of lives. But the challenges remain tremendous not only in terms of treating, but also in preventing poisonings.

The lack of attention to this issue has many causes. The data on poisoning cases is generally very poor and limited to hospital data. There is no systematic collection of data about poisoning cases occurring at the community level so far. Reporting a case of poisoning may have legal implications as it can be registered as a case of murder or attempted murder when unsuccessful and this risk reduces the willingness of the victim's relatives to report the incident. Furthermore, none of the existing poison centres works 24 hours a day and 7 days a week.

Because of poor data, and, therefore, lack of evidence, there is little awareness about the magnitude of the problem. As a consequence, there is also low political attention given and resources are insufficient to ensure at least one poison information centre in every state / province with the necessary skilled staff. The few engaged toxicologists barely obtain to participate at international meetings or conferences where they could advocate for support.

Strengthening existing national and regional networks, supporting establishment of analytical toxicology facilities and providing capacity building opportunities are important, but identifying funds to do so in a sustained manner remains a main bottleneck. Therefore, poisonings need to be looked at in a more holistic and prevention-oriented manner, beyond case management. Poisonings are the outcome whereas the root causes leading to it need to be identified and addressed.

Monocrotophos is a highly hazardous organophosphate insecticide that is widely used and easily available in India. Monocrotophos has been most frequently associated with both accidental and intentional fatal pesticide poisonings. The report therefore focuses on presenting data on the current practices and health consequences of monocrotophos in particular.

The Food and Agriculture Organization (FAO) and WHO have encouraged countries to phase out highly hazardous pesticides. Leading Asian countries have banned the use of monocrotophos because of unacceptable health risks, but in India, monocrotophos continues to be produced, used and exported. The perception that monocrotophos is cheap and necessary, have prevented the product from being taken off the market. Urgent action is thus needed to reduce the availability of and the demand for highly hazardous pesticides, as recommended by WHO and FAO (42).

It is imperative to consider banning the use of monocrotophos, which is one of the main agents used for suicide attempts in the country. A prohibition on the use of this insecticide would also be in compliance with Article 3.5 and Article 7.5 of the International Code of Conduct on the Distribution and Use of Pesticides[5].

Promoting and implementing schemes based on the principles of integrated pest management (IPM) and integrated vector management (IVM) can drastically reduce reliance on pesticides, including insecticides such as monocrotophos.

The argument that there are no alternatives has been refuted by those countries where its use is no longer permitted, including Australia, Cambodia, China, the European Union, Indonesia, Laos, Philippines, Sri Lanka, Thailand, the United Sates of America and Vietnam.

5 See: http://www.fao.org/docrep/w5715e/w5715e04.htm

The findings of this review, despite the fact that the data do not differentiate between intentional self-poisoning and accidental or occupational poisoning, call for reconsideration of the registration status of monocrotophos in India. This is needed to address the continuing high rates of monocrotophos poisoning in India and to consider aligning with national regulatory measures taken in US, EU and elsewhere in Asia.

This document is based on a literature review and was prepared for the Regional Office of South-East Asia by a group of eminent toxicologists and agronomists. The text was reviewed by WHO and FAO experts.

1. Pesticide use in India and potential impacts on human health

The Indian pesticide industry, with an estimated 79 800 metric tonnes (MT)[6] of production for 2007 – 2008, is ranked second in Asia (behind China) and twelfth globally. In value terms, the size of the Indian pesticide industry was estimated at US$ 1500 million, including exports of US$ 622 million.

The importance of pesticides in India can be understood from the fact that agriculture is a major component of the Indian economy: it contributes 22% of the nation's GDP and is the livelihood of nearly 70% the country's workforce.

Globally, due to consolidation in the agrochemical industry, the top five multinational companies control almost 60% of the market. In India, the industry is very fragmented, with about 30 to 40 large manufacturers and about 400 formulators. The use pattern is skewed towards insecticides, which accounted for 67% of the total pesticide consumption in 2006.

Despite commendable efforts undertaken to regulate pesticide use in the country, India does not yet have a clear-cut system to ensure that pesticides are managed in a sound manner that poses only limited risk to health. Pesticide management and use in India is not yet in line with the standards of conduct provided by the FAO International Code of Conduct on the Distribution and Use of Pesticides.

6 Ministry of Chemicals and Fertilizers, Government of India, 2008

The potential adverse impact on human health from exposure to pesticides is likely to be higher in countries like India due to easy availability of highly hazardous products, and low risk awareness, especially among children and women. The general conditions of use in very hot climates where personal protection gear is not always used, increases the risks to health.

Overexposure to pesticides can occur before spraying– because of easy access for children, lack of adequate labeling and during mixing – during spraying and after spraying operations. Spray operators and bystanders can be affected. Particularly at risk are women at home who are generally in charge of washing the used clothes of the spray operator, and usually do not know about risks from pesticide-contaminated clothes.

Although WHO and FAO recommend puncturing and crushing the containers to prevent their reuse for any purpose[7], the reality is different. Many pesticide containers, because of their sturdiness and look, are often later used to store objects, food grains and water, and sometimes even medicines.

Farmers suffering from pesticide exposure will most probably not be in a position to obtain treatment from medical practitioners. Indeed, beside the fact that the public health services do not reach most remote places, there are only four functioning poison control centres to server India's population of over 1.3 billion. Even in these centres, the availability and quality of antidotes is uncertain.

Having cheap and easily available highly hazardous pesticides at hand increases the incidence of intentional pesticide poisonings (8, 26). Table 1 shows the number of suicides committed in India using pesticides during 1997-2005.

7 See: http://www.who.int/whopes/recommendations/Management_options_empty_pesticide_containers.pdf

Table 1: Farmer suicides and pesticide suicides in India, 1997–2005

	Total Suicides		Farmer's Suicides		Pesticide Suicides	
Year	**Number**	**Suicide rate/ 100 000 population**	**Number %**	**As a % of total suicides**	**Number**	**As a % of total suicides**
1997	95 829 (100)	10.0	13 622 (100)	14.2	18 311 (100)	19.1
1998	104 713 (109)	10.8	16 015 (118)	15.3	19 075 (104)	15.3
1999	110 587 (115)	11.2	16 082 (118)	14.5	20 251 (111)	18.3
2000	108 593 (113)	10.6	16 603 (122)	15.3	21 801 (119)	20.1
2001	108 506 (113)	10.6	16 415 (121)	15.1	21 530 (118)	19.8
2002	110 417 (115)	10.5	17 971 (132)	16.3	21 414 (117)	19.4
2003	110 851 (116)	10.4	17 164 (126)	15.5	23 001 (126)	20.8
2004	113 697 (119)	10.5	18 241 (134)	16.0	23 311 (127)	20.5
2005	113 914 (119)	10.3	17 131 (126)	15.0	22 316 (122)	19.6
Total Suicides 1997-2005	977 107		149 244		191 010	
Annual Compound Growth Rate (ACGR) between 1997 – 2005		2.18		2.91		2.50

Note: Figures in brackets give indices with 1997 as the base.
Source: Various issues of Accidental Deaths and Suicides in India, National Crime Records Bureau (NCRB), Ministry of Home Affiars, Government of India.
Source: http://www.hinduonnet.com/2007/11/12/stories/2007111253911100.htm

According to the National Crime Records Bureau, Ministry of Home Affairs, India, in 2007, 24 126 persons were reported to have committed suicide by consuming pesticides. This figure represents 20% of all suicides recorded in 2007 in the country (10).The number of farmers having reportedly committed suicide by ingesting pesticides totaled 183 000 in the decade 1997-2007. Among the worst-affected States figure the main cotton growing states of Maharashtra, Andhra Pradesh and Madhya Pradesh.

The number of pesticide poisonings appears to be seriously under-recorded: One set of official figures for the years 1997–2001 shows a total of 805 pesticide poisonings (varying between 0 and 573 per year) in the whole state of Andhra Pradesh (Ministry of Agriculture 2001). This is only 13% of the cases recorded at health facilities, which again only reflect part of the problem.

Though it is mandatory to report all cases of pesticide poisoning under the Insecticides Act, the actual data reflect gross under-reporting. This is illustrated in the actual figures recorded by the Ministry of Agriculture (11) as shown in Table 2.

Table 2 reports only 2341 deaths from pesticide poisoning in 2006. This figure stands in contrast with the official figure of 17 060 deaths released by the National Crime Record Bureau –NCRB (10). Further, Table 2 shows no pesticide poisonings recorded from Andhra Pradesh and Gujarat, yet the Poison Information Centre at Ahmedabad, Gujarat has been receiving an average of 340 cases annually since 2000 (5). While it is key to discriminate between intentional and unintentional poisonings -it is possible that the Ministry of Agriculture records unintentional poisonings and the NCRB records intentional ones- it is clear that there is a significant under reporting.

Table 2: Number of officially recorded pesticide poisonings in India, 2005 - 2006, Ministry of Agriculture (11)

Name of the State/UT	Recorded cases 2005-2006	Recorded Deaths 2005-2006
Chattisgarh	2	0
Haryana	439	67
Himachal Pradesh	11	5
Jharkhand	333	66
Kerala	1 181	310
Maharashtra; Manipur; Meghalaya; Mizoram; Nagaland	7 893	1 236
Orissa	28	ND
Pondicherry	1 341	16
Punjab	284	119
Rajasthan	333	331
Uttaranchal	13	ND
Uttar Pradesh	1 259	190
West Bengal	20	1
Andaman & Nicobar; Andhra Pradesh; Arunachal Pradesh; Assam; Bihar; Chandigarh ; Dadra & N. Haveli; Daman & Diu; Delhi; Goa; Gujarat; Jammu& Kashmir ; Karnataka ; Lakshadweep; Madhya Pradesh ; Sikkim Tamil Nadu Tripura	ND	ND
TOTAL	**13 137**	**2 341**

Notes: ND: No data available

The effective number of cases of pesticide poisoning occurring in India annually has been estimated by G. Ravi et al 2007 (35) to be up to 76 000, much higher than the above figure of NCRB. Furthermore, Gunell et al, 2007 (13) calculate that the number of intentional cases alone reaches some 126 000 cases annually.

The very significant under-reporting of pesticide poisonings is a global phenomenon. This is corroborated, for example, by the significant findings of the study conducted in Central America by the PLAGSALUD project[8], a pesticide project oriented towards recording unintentional pesticide poisonings and coordinated by the Pan American Health Organization (PAHO/WHO) in the year 2000. The usage of pesticides per hectare in the countries covered by PLAGSALUD is six times higher than in India. PLAGSALUD estimated 98% underreporting of pesticide poisonings (16, 28).

8 Countries part of the PLAGSALUD Project: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panamá

2. Characteristics of monocrotophos

(see also Annex 1)

Monocrotophos is a systemic insecticide and acaricide belonging to the vinyl phosphate group. It controls pests on a variety of crops, such as cotton, rice, and sugarcane. It is used to control a wide spectrum of chewing, sucking and boring insects (aphids, caterpillars, *Helicoverpa spp*, mites, moths, jassids, budworm, scale and stem borer, as well as locusts).

Monocrotophos is out of patent and therefore has become an easily affordable pesticide. Its low cost and many possible applications have kept up demand in India despite growing evidence of its negative impact on human health.

Monocrotophos is an organophosphorus compound that inhibits cholinesterase. It is highly toxic by all routes of exposure. Monocrotophos can be absorbed following ingestion, inhalation and skin contact. The acute oral lethal dose (LD50) for rats is 14 mg/kg. According to Hayes and Laws (1993), the ingestion of 1200 mg monocrotophos can be fatal to humans (18a).

In the WHO 2004 edition of the Recommended Classification of Pesticides by Hazard and the Guidelines to Classification[9], monocrotophos is classified in the WHO Class Ib. i.e. as a highly hazardous pesticide.

9 See: http://www.inchem.org/documents/pds/pdsother/class.pdf

The FAO/WHO Joint Meeting on Pesticide Management (JMPM), in its second session in October 2008, explicitly noted that risk reduction from highly hazardous pesticides could include a progressive ban of these compounds[10].

WHO and FAO recommend to use alternatives to Class Ia and Class Ib pesticides, and to promote integrated pest management (IPM) and integrated vector management (IVM) systems that rely less on pesticide use[11].

10 See: http://www.fao.org/agriculture/crops/core-themes/theme/pests/pm/code/hhp/en/

11 See: http://www.who.int/ipcs/publications/wha/whares_53_13/en/index.html

3. Symptoms of human poisoning by monocrotophos

Monocrotophos can be absorbed following ingestion, inhalation and skin contact. When inhaled, it affects the respiratory system and may trigger bloody or runny nose, coughing, chest discomfort, difficulty breathing or shortness of breath and wheezing due to constriction or excess fluid in the bronchial tubes. Skin contact with organophosphates may cause localized sweating and involuntary muscle contractions. Eye contact will cause pain, tears, pupil constriction and blurred vision.

Following exposure by any route, other systemic effects may begin within a few minutes or be delayed for up to 12 hours. These may include pallor, nausea, vomiting, diarrhoea, abdominal cramps, headache, dizziness, eye pain, blurred vision, constriction or dilation of the pupils, tears, salivation, sweating and confusion (18).

Severe poisoning will affect the central nervous system, producing lack of coordination, slurred speech, loss of reflexes, weakness, fatigue, involuntary muscle contractions, twitching, tremors of the tongue or eyelids, and eventually paralysis of the body extremities and the respiratory muscles. In severe cases there may also be involuntary defecation or urination, psychosis, irregular heartbeat, unconsciousness, convulsions and coma. Respiratory failure or cardiac arrest may cause death.

Estimation of plasma and cholinesterase levels are useful diagnostic parameters to confirm poisoning by monocrotophos, and other organophosphorus compounds. In severe poisoning with monocrotophos both enzymes are inhibited.

Repeated daily high-level exposure may gradually lead to poisoning. Several studies on occupationally exposed workers have been conducted in countries with a hot climate and where workers usually did not wear protective clothing. In most cases plasma cholinesterase was inhibited. It was extrapolated that absorption of 20 mg of monocrotophos caused inhibition of plasma acetylcholinesterase.

4. Fate in the environment and resistance in insects to monocrotophos

Monocrotophos is one of the most toxic pesticides to birds (see Annex 2); it is highly toxic to bees and extremely toxic to specific wild species. The acute LD50 for birds ranges from 0.9-6.7 mg/kg body weight, and for honey bees 33-84 μg/bee.

It is toxic to shrimps and crabs and moderately toxic for fish. According to FAO, monocrotophos must be labeled as a marine pollutant.

Monocrotophos is not compatible with integrated pest management programmes[12]. There are a number of systemic organophoshorous insecticides that are less harmful than monocrotophos that have long been recommended in various crops to manage the target pests (40).

Almost all polyphagous pests across the world have been reported to have developed resistance to monocrotophos. In the 1980s, *Tetranychus cinnabarinus* (Acari: Tetranychidae) developed resistance to monocrotophos and other organophosphorus pesticides such as Methyl-parathion, Phosphamidon and Dimethoate; resistance to Parathion, for example, increased 466.8 fold (44).

---

12 National Registration Authority for Agricultural and Veterinary Chemicals, Australia, 2000 available at http://www.apvma.gov.au/chemrev/downloads/monocrotophos_env.pdf

White fly resistance has caused plague-like outbreaks on cotton crops. Records over time show that resistance to monocrotophos of the Colorado potato beetle on Long Island, United States of America, appeared more quickly than to almost any other pesticide, within one year of introduction. Cotton bollworms have also been reported to have developed various levels of resistance to the recommended doses of this insecticide on different continents.

5. Overview of international regulation of monocrotophos

Worldwide national authorities have taken regulatory action to ban or severely restrict the use of monocrotophos, based on the risks its high acute toxicity pose to human health, notably via occupational exposure, and on the potential detrimental effects to the environment, and especially birds, bees, and fish and other aquatic organisms.

Monocrotophos use is currently banned or severely restricted in many countries, including all EU members. Its import is illegal in at least 46 countries. In the United States of America, monocrotophos as an active ingredient is no longer contained in any registered product, and, thus, the Office of Pesticide Programmes of the United States Environmental Protection Agency (EPA) has characterized monocrotophos as 'cancelled' in the EPA Pesticide Registration Status implying that no toxicological review for a re-registration eligibility decision will be prepared. China recently completed a gradual phasing out process with a ban on the production and use of monocrotophos.

In Asia, use of monocrotophos is further not permitted in Australia, Cambodia, Indonesia, Lao PDR, Philippines, Sri Lanka and Thailand and Vietnam. Monocrotophos use in India in vegetables was banned in 2006 due to high residue levels.

As an extremely dangerous insecticide, monocrotophos has been included in Annex III of the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and

Pesticides in International Trade[13], an international legally binding convention for the implementation of the Prior Informed Consent (PIC) procedure, which aims to promote shared responsibility and cooperative effort among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment. At least 46 countries notified the secretariat of the Rotterdam Convention that they do not consent to importation of monocrotophos.

13 See: http://www.pic.int/home.php?type=s&id=77

6. Overview of monocrotophos production and use in India

6.1 Production

The total reported national production of monocrotophos in India ranged between 8121 metric tonnes technical in 2003-04 to 5118 metric tonnes technical in 2007-08. The major crops on which it is applied are cotton, rice, pulses, groundnuts, vegetables and fruits. Amongst vegetables, brinjal (aubergine) and tomato receive the highest number of applications. Amongst fruit crops, mango and grapes have the highest share of this insecticide. Among spices, chillies and tea receive a higher number of applications with monocrotophos.

6.2 Use of monocrotophos in India

In India, monocrotophos while mainly applied against cotton pests, it is also used on rice, castor, citrus, olives, rice, maize, sorghum, sugar cane, sugar beet, peanuts, potatoes, soybeans, cabbage, onion and pepper ornamentals and tobacco. Farmers in small-holder cultivation tend to use the same insecticide for all the companion crops. Reported monocrotophos consumption data from 2001 to 2006 is provided in Table 3.

Table 3: Reported state-wise use of monocrotophos, 2001 to 2006

State	Consumption (metric tons)					
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Andhra Pradesh	3 537	3 205	3 095	2 984	2 881	2 779
Bihar	131	119	115	111	107	103
Gujarat	1 101	998	963	929	897	865
Haryana	1 048	950	917	884	854	823
Karnataka	833	755	729	703	679	654
Kerala	131	119	115	111	107	103
Madhya Pradesh	760	689	665	641	619	597
Maharashtra	1 428	1 294	1 250	1 205	1 163	1 122
Punjab	1 622	1 470	1 419	1 369	1 321	1 274
Rajasthan	652	591	571	550	531	512
Tamil Nadu	665	603	582	561	542	522
Uttar Pradesh	182	165	159	154	148	143
West Bengal	215	195	188	181	175	169
ALL INDIA	**16 000**	**14 500**	**14 000**	**13 500**	**13 000**	**11 700**

Source: Ministry of Agriculture, India, 2007.

The highest use of monocrotophos is on cotton in almost all cotton-growing states. The details of the reported use of monocrotophos 2001 2006 are given crop-wise in Table 4.

The price of this insecticide dropped from 280 to 350 Indian Rupees per liter in the early 1980s to INR 230-250 per liter in 2008. Despite a continuous relative fall in terms of total quantities used, a result of new molecules being used against crop pests, monocrotophos is still one of the most popular pesticides in the country, mainly because its low price.

6.3 Regulation in India

A total of 215 pesticides are registered for manufacture and use in India. 12 other pesticides, including monocrotophos, are restricted in use, while 25 others are banned for manufacture, import and use, and 2 more are allowed to be manufactured only for export. 18 other pesticides are refused for registration and 4 more are banned for import, manufacture and use. Finally, (Source: Central Insecticides Board &and Registration Committee, Ministry of Agriculture, 2008).

The use of monocrotophos on vegetables has been banned since 2006 due to reports of high levels of residues in food items. In 2006, an Expert Committee (Annex 3) constituted by the Registration Committee, Ministry of Agriculture, reviewed pesticides that were banned in other countries but still being used in India. Regarding monocrotophos, the committee provided the following preliminary observation on monocrotophos:

"The group considered the information that it is highly hazardous pesticide class (1B) as per WHO recommended Classification of Pesticides by Hazard 2004 and it is included in the Rotterdam Convention on Prior Informed Consent Procedure on hazardous chemicals and pesticides. The group was concerned

Table 4: Reported crop-wise monocrotophos use in India 2001 2006

Year	Total (metric tons)	Cotton	Rice	Wheat	PULSES			OILSEEDS			Beverages		Sugar cane	Other
					Red Gram	Bengal gram	Other pulses	Ground Nut	Soya-bean	Mustard	Tea	Coffee		
2001	16 000	8050	1958	188	385	154	77	252	220	75	226	10	11	60
2002	14 500	7295	1774	188	349	140	70	228	199	68	205	9	10	54
2003	14 000	7044	1713	188	337	135	61	221	193	66	198	9	10	53
2004	13 500	6792	1652	188	325	130	55	213	186	63	191	8	9	51
2005	13 000	6541	1591	188	313	125	50	205	179	61	184	8	9	49
2006	11 700	5887	1432	188	282	113	45	184	161	55	165	7	8	44

Year	Chilies	SPICES		FRUITS							Flowers	NARCOTICS		Other
		Cumin	Carda-mom	Apple	Banana	Grapes	Mango	Citrus	Pome-granate	Other		Opium	Tobacco	
2001	648	10	80	3	16	116	300	65	15	23	1	2	0	114
2002	587	9	73	3	15	105	272	59	14	21	1	2	0	103
2003	567	8	70	3	0	102	263	57	13	20	1	2	0	100
2004	547	7	68	3	0	98	253	55	13	19	1	2	0	96
2005	527	7	61	2	0	94	244	53	12	19	1	2	0	93
2006	474	6	55	2	0	85	219	48	11	17	1	1	0	83

Source: Ministry of Agriculture, India, 2007 with the recent reports of endocrine disruption and the International information of poisoning cases. The group noted that the government has issued the notification regarding the ban on the use in vegetables which is difficult to implement considering the use of this pesticide on other crops in the past. Further in view of certain reports/ observations there was an apprehension among the members that there are chances of misuse of the pesticide in terms of application technology. It was also noted that better alternatives are available. In view of above it was decided that the basic manufacturers/Pesticide Associations may be asked to present their views on the above concerns."

However, after the pesticide industry presented its views, the committee decided not to take any further action in terms of restricting or banning the use of monocrotophos in the country beyond the already announced ban of use on vegetables[14]. It requires an efficient mechanism to enforce the partial ban on monocrotophos use to avoid the application of this insecticide intended for use on cotton and other crops on vegetables.

14 Minutes of the 248th Meeting of the Registration Committee held on 06.10.2004, New Delhi http://cibrc.nic.in/248rc.doc

7. Reports on acute monocrotophos poisoning and deaths in India

7.1 WHO study on pesticide poisoning data in India, 2000.

A WHO sponsored study carried out in India showed data collected from July 1999 to June 2000 from hospitals in Andhra Pradesh, Haryana, Punjab and Karnataka and one Poison Information Centre in Ahmedabad, Gujarat. A total of 1531 cases of pesticide poisoning were recorded during this one-year period. The poison Information Centre, Ahmedabad reported 206 cases. In Haryana, information was collected from five hospitals. Two were located in Faridabad and one each in Rohtak, Sirsa and Ballabgarh. There were 673 cases in these five hospitals. In Karnataka, two hospitals located in Gulbarga reported 389 cases. Two hospitals in Punjab (Bhatinda and Faridkot) reported 61 cases. Out of the 1531 cases, 609 were due to organophosphorus pesticides. Monocrotophos was involved in 86 cases, the largest number of poisonings due to an insecticide.

7.2 Burdwan, West Bengal

In a paper presented in 2001 at the Annual Conference of the Association of Physicians of India, Kundu (22) reported 108 cases of organophosphorus poisoning admitted to Burdwan Medical College, West Bengal. Of these, 50% of the patients had moderate and 29.6% had severe poisoning. The authors reported a mortality of 31% due to monocrotophos and dimethoate.

7.3 Tamluk, West Bengal

A report published in 2002 in the Journal of Indian Paediatrics by Bhattacharyya et al, (3) describes accidental paediatric poisonings due to pesticides from Tamluk, an subdivision of West Bengal, India. This area has a predominant rural population engaged in rice and betel leaf cultivation year-round. During the winter months, due to fog and clouds, insect pests and fungal diseases are more common. Farmers tend to buy a large quantity of insecticides and fungicides and store them in their houses well in advance. This has led to frequent poisoning of children during this period. Out of 140 pesticide poisoning cases amongst children and admitted during 2000, 38 cases (76%) were due to insecticides and fungicides. All cases were accidental and nearly 50% of them were referred to hospital as respiratory tract infection, bronchopneumonia, seizure disorder and acute gastroenteritis by primary physicians. 19 cases were due to organophosphates, including monocrotophos.

7.4 Warangal, Andhra Pradesh

An extensive retrospective hospital-based study was carried out by Srinivas Rao (38) in 2004-2005 on all cases of pesticide poisoning in the Warangal district of Andhra Pradesh, India, admitted during 1997-2002 to the Mahatma Gandhi Memorial (MGM) District Government Hospital. MGM Hospital is a 550-bed teaching hospital located in the city and district of Warangal. Total inpatient admissions to the hospital on an average were about 300 per day.

From 1997 to 2002, 7005 patients were admitted to the hospital with pesticide poisoning and 1594 (22.6%) of them died. In 2002 alone, 1015 cases of poisoning were recorded; 653 patients were reported, or presumed from clinical signs, to have ingested OP pesticides.

The most commonly consumed organophosphates were monocrotophos (257 patients), chlorpyrifos (114 patients), and quinalphos (78 patients). The most commonly consumed organochlorines were endosulfan (139 patients) and Endrin (74 patients). The other commonly ingested pesticide was cypermethrin (58 patients). Carbamates were uncommon, with only six identified admissions; 144 patients consumed an unknown pesticide but were treated for OP poisoning because of the clinical signs at presentation; in 83 cases, no clinical diagnosis was made. Two-thirds of the patients were less than 30 years old, 57% were male and 96% had intentionally poisoned themselves.

The overall mortality ratio was 22% for organophosphates and other pesticides. However, there were marked differences between individual agents within classes. Methyl parathion and monocrotophos had a high case fatality rate. The case fatality rate for methyl parathion was highest (3 out of 5). There were 257 monocrotophos poisonings with 91 deaths during the year 2002 amounting to a case fatality rate of 35% (see Table 5).

To assess the magnitude of the problem at state level, the data from Warangal district is extrapolated to all 23 districts of Andhra Pradesh. The toll of annual deaths from pesticide poisoning may exceed 5000 and deaths from monocrotophos poisoning may be close to 2000, or 40% of the total deaths. It may be noted that the nature of the pesticide was identified only in 168 cases (75%) out of the 225 fatalities. A subsequent analysis of the data based only on the identified compounds shows that monocrotophos alone was responsible for more than half of the fatal outcomes.(Figure 1).

Srinivas Rao also notes that Class I pesticides and endosulfan have been banned for use in Sri Lanka. In 2002, Eddleston (7) reported that, although the effect of these bans is not yet clear, mortality from pesticide poisoning in some Sri Lankan hospitals is now below 15% -significantly lower that the 22% reported before

Table 5: Case fatality due to different pesticides reported from MGM hospital, Warangal, 2002

Pesticide	Cases	Deaths	Case Fatality Rate (%)
Organophosphorus compounds			
Methyl parathion	5	3	60.00
Monocrotophos	257	91	35.41
Acephate	14	4	28.57
Malathion	5	1	20.00
Phorate	21	4	19.05
Triazophos	6	1	16.67
Quinalphos	78	9	11.54
Chlorpyrifos	113	7	6.19
Unknown anticholinesterase	144	48	33.33
Organochlorine compounds			
Endosulfan	138	39	28.26
Endrin	74	4	5.41
Other compounds			
Indoxicarb	7	1	14.29
Cypermethrin	58	4	6.90
Spinosad	4	0	0.00
Imadocloprid	8	0	0.00
Unknown pesticides	83	9	10.84
Total	1015	225	

Source: Srinivas Rao et al, 2005 (38) the ban The positive impact of the ban was supported in 2003 by Konradsen (21) and in 2003 by Roberts (37).These authors suggested that targeted restrictions of the most commonly fatal pesticides, particularly monocrotophos and endosulfan, may bring down the number of deaths.

7.5 Warangal and Mahabubnagar, Andhra Pradesh

In 2005, Mancini published a report on a season-long assessment conducted in 2003 of acute pesticide poisoning among farmers engaged in cotton growing in three villages of Andhra Pradesh (25).

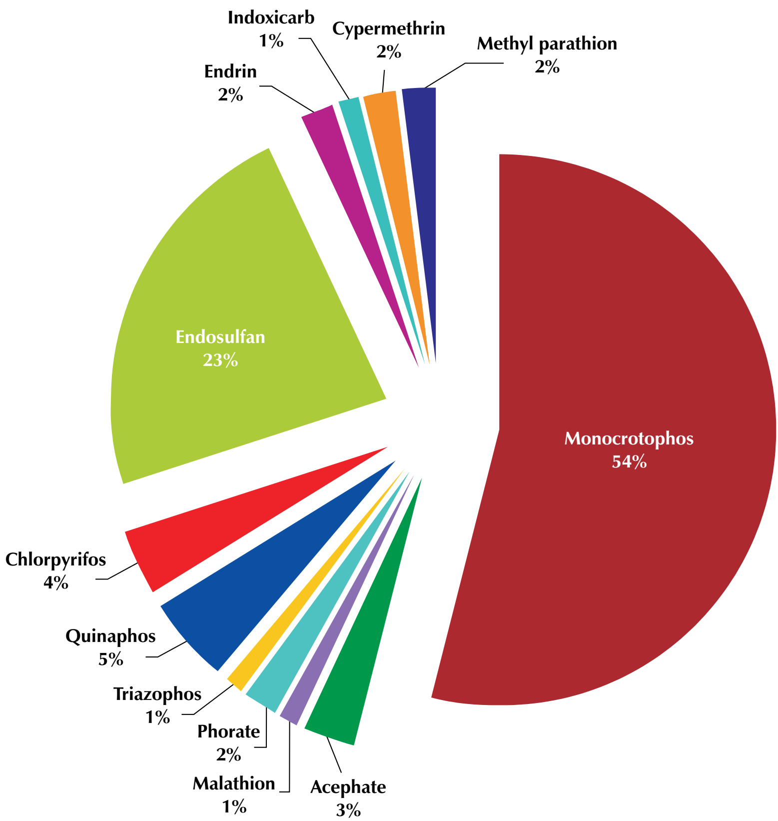
Organophosphate insecticides were used in 47% of the spraying events. Monocrotophos was one of the common insecticides used. Of 323 reported spraying events, 83.6% were associated with signs and symptoms of mild to severe human poisoning, and 10% of the pesticide application sessions were associated with three or more neurotoxic /systemic signs and symptoms typical of poisoning by organophosphates.

7.6 Manipal, Karnataka

Vikram (39) in 2005 reported on a two-year study on the spectrum of poisonings in Manipal; 153 cases admitted to Kasturba Hospital Manipal between January 2001 and December 2002 were organophoshorous poisonings. The most common reason for poisoning was attempted self harm (98.7%). The most common age group involved was 21 30 years (36.6%) and 75.1% were males. Out of 153 cases, methyl parathion was the most common compound consumed (58 cases).

Monocrotophos poisoning was found in 11 cases. Mortality was 26.2%, and 30% of the victims died within 24 hours. Agriculture was the most common occupation of the victims.

Figure 1: Proportion of identified pesticides responsible for all deaths reported at MGM hospital, Warangal, 1997 2001.



Source: data from Srinivas Rao 2005

7.7 Chennai, Tamil Nadu

During the six-month period from January to June 2007, 1027 poisoning cases were treated at the Poison Control, Training and Research Centre (PCTRC), Government General Hospital, Chennai. Of these, 187 were due to organophosphates. Among these there were 38 cases of monocrotophos poisoning (20% of all OPs). The majority of the monocrotophos poisoning patients were between 30 and 40 years old and males outnumbered females 4:1. Hospital stays varied from 4 to 25 days and average stay was 14 days. Out of the 38 monocrotophos-related cases 32 (84%) had evidence of severe poisoning as they developed progressive muscular weakness, depressed deep tendon reflexes, and respiratory distress needing mechanical ventilator support. Six (15%) patients died in spite of continued care (34).

The above report shows that monocrotophos caused severe poisoning in the vast majority of cases. Mortality was lower than in the District hospital, Warangal, probably due to better treatment facilities at a tertiary care centre in a metropolitan city.

7.8 Thanjavur, Tamil Nadu

The relationship between extent of pesticide use and signs and symptoms of illnesses due to exposure was assessed by Chitra (4) in a cross-sectional survey carried out in 2005, that included 631 farmers (537 men and 94 women) in Kalyanapuram panchayat, Thanjavur district of the State of Tamil Nadu. Responses to questionnaires showed that 433 farmers (68.6%) sprayed pesticides themselves and were thus directly exposed.

The major crops in this area are rice, betel leaf, sugar cane, cotton and vegetables. Of the 631 farmers, 207 (32.8%) were working on betel leaf plantations; 143 (22.6%) on paddy fields, and the rest were involved in cultivation of other agricultural products such as brinjal, bananas, and sugar cane. Of the self-spraying farmers 196 (45.9%) used monocrotophos.

The farmers in this study did not take necessary personal protective measures while handling and spraying pesticides; 382 (88%) reported that they took no precaution while handling and spraying pesticides, and 244 (56.4%) made "cocktails" of different kinds of pesticides before spraying. These farmers experienced a variety of signs and symptoms related to pesticide exposure. They reported excessive sweating (36.5%), burning/stinging/itching of eyes (35.7%), dry/sore throat (25.5%), and excessive salivation (14.1%); and all such symptoms are more prevalent among farmers spraying pesticides. Among men, excessive sweating and eye and throat problems were significantly associated with exposure to pesticides.

7.9 Ahmedabad, Gujarat

Data from cases reported to the Poison Information Centre (PIC) at National Institute of Occupational Health, Ahmedabad, Gujarat, from January 2000 to December 2006 was analysed for pesticide poisonings by Dewan and Patel (5) in 2007. The majority of cases reported to the PIC were from hospitals in and around Ahmedabad.

During this period, 2395 poisoning cases were reported to the Centre. Pesticides were responsible for 68.3% (1636 cases) of all poisoning cases; 1006 cases (42%) were due to agricultural pesticides and 630 cases (26.3%) were due to household pesticides. Among the agricultural pesticides, 824 cases were organophosphates (OP) poisonings. The identity of the compound could not be ascertained in close to 50% of the cases. But, among those identified, the most common OPs were chlorpyriphos, dimethoate, monocrotophos and phorate (see table 6).

Table 6: Number of poisoning cases by cause for the four most common organophosphate pesticides reported at the PIC Ahmedabad in 2000 2006

OP compound	Number of Cases	Self-harm poisoning (% age)	Accidental poisoning (% age)	Occupational poisoning (% age)
Chlorpyriphos	120	116 (96.7)	3 (2.5)	1 (0.8)
Dimethoate	82	68 (84.0)	7 (8.5)	7 (8.5)
Monocrotophos	59	44 (74.6)	4 (6.8)	11 (18.6)
Phorate	57	34 (59.6)	3 (5.3)	20 (35.1)

Source: Dewan and Patel, 2007

As seen in the above table, though self-harm ingestion remains the commonest reason for poisoning with all the four commonly encountered organophosphate pesticides, occupational poisoning was also an important cause with phorate and monocrotophos. The majority of accidental or occupational poisonings were due to monocrotophos and affected mainly farmers or farm labourers.

Severity of poisoning cases was decided on the basis of the clinical picture described by the patient's relatives who brought blood samples of the patients to the PIC for cholinesterase estimations. Cases on ventilator support that had more than 90% inhibition of RBC cholinesterase were categorized as severe. Mild and moderate poisonings were combined. Among the four organophosphate pesticides, the highest percentage of severe poisoning was in the monocrotophos cases (Table 6).

It was also observed that severe monocrotophos poisoning caused almost 100% inhibition of RBC cholinesterase. Recovery of RBC cholinesterase was very slow. It was not possible to determine a case fatality rate for all cases, but complete recovery was expected in all mild and moderate monocrotophos poisoning cases and 28 out of 40 cases of severe monocrotophos poisoning. This assumption was based on the improving clinical picture and rising cholinesterase levels when serial estimations were carried out.

Among the remaining 12 severe cases, there was a definite record of death in one case, whereas in 11 cases patients were released although they were severely ill, were on ventilator support and their RBC cholinesterase levels were nil when done for the first time. Death was the likely outcome. They never reported back for estimations of cholinesterase. Thus mortality of around 20% is predicted for cases of monocrotophos poisoning referred to Poison Information Centre, Ahmedabad.

The severity of poisoning with above mentioned compounds is shown in table 7.

Table 7: Severity of poisoning with different organophosphates reported at the PIC Ahmedabad in 2006

Compound	WHO hazard category	Number of cases	Mild to moderate poisoning (%)	Severe poisoning (%)
Chlorpyriphos	II	120	98 (82)	21 (18)
Dimethoate	II	82	41 (50)	41 (50)
Monocrotophos	Ib	59	19 (32)	40 (68)
Phorate	Ia	57	47 (83)	10 (18)

7.10 Jamnagar, Gujarat

A study published by Gupta and Vaghela (12) in 2005 reported 132 cases of poisoning out of 826 post-mortem examinations carried out by the Department of Forensic Medicine at MP Shah Medical College, Jamnagar, Gujarat, India, from 18 August 2003 to 17 August 2004. During this period, 71 poisoning cases were due to insecticides and monocrotophos was responsible for the highest number of cases (20 out of 71) among deaths due to insecticide poisoning.

7.11 Linkages between exposure to pesticides and suicide attempts among farmers

According to the National Crime Records Bureau (NCRB) of India, suicide was responsible for 113 914 deaths in India in 2005, with almost 90% of suicides occurring in rural India. An agrarian crisis has been attributed to the increased cost of cultivation, stemming for example from higher input prices and higher cost of labour, higher requirement for cash and falling prices of agricultural produce. This has been compounded by the collapse of soil health due to excessive use of agrochemicals and falling water tables due to irrational, wasteful use of water resulting from free electricity and free water. The distress experienced by the farmer is a combination of indebtedness, water woes, labour shortages and social evils.

Suicides by consumption of pesticides have received a lot of attention recently both from the scientific community as well as the media due to the social, political and economic issues associated with it. Concerns about suicides by swallowing pesticides, especially by debt-ridden farmers, have now been raised at the highest national level (19) as well as internationally, by various agencies.

The Tata Institute of Social Sciences (TISS) carried out a survey on causes of farmer suicides in Maharashtra and submitted its report to Mumbai High Court in March, 2005. TISS found that suicides of farmers are widespread and most occurred in the districts of Yavatmal and Amravati. In Maharashtra 70% of farmers grew cotton as their primary cash crop.

Acute pesticide poisoning was found to be the leading cause of unnatural deaths and the third most common cause of emergency hospitalizations in Maharashtra by Batra (1). Poisoning caused about 30% of all deaths requiring a medico-legal procedure in the region over the five-year period of five years 1997 to 2001 Organophosphate insecticides were responsible for 23% of hospital admissions and 43.4% of the total deaths. The exact nature of the OP compounds was not reported in this study.

Because there is no specific mention of monocrotophos in most reports, there is urgent need to establish the importance of monocrotophos pesticide-related poisonings and deaths due to the fact that it is one of the most commonly used insecticides and that it is highly toxic.

8. Reports on acute monocrotophos poisoning and deaths in other countries

8.1 Sri Lanka

Because self-harm and pesticide poisoning in Sri Lanka, the Srilankan President set up a special commission in the mid-1990s to advise on ways to reduce the country's alarming high rate of suicide. In 1995, self-harm was the main cause of death nationally in the 15–24 and 25–49 year age groups. Pesticide poisoning was the sixth commonest cause of hospital death in Sri Lanka, with 1571 deaths and 15 730 cases reported annually.

An earlier study conducted by Karalliede and Senanayake (20) in 1988 had analysed the records of 92 cases of acute organophosphorus poisonings. Of the patients, 91% were under 30 years of age and 86% were males. The most common agents were dimethoate, methamidophos, malathion, monocrotophos and fenthion. The overall mortality rate was 18%.

8.2 Anuradhapura, Sri Lanka

Roberts (2003) reported on the influence of pesticide regulation on acute poisoning deaths in Sri Lanka. Anuradhapura General Hospital is a secondary referral centre for more than 900 000 people living in the North Central Province of Sri Lanka; most of this population is rural farmers. In 1991-1992, 72% of pesticide-induced deaths in Anuradhapura General Hospital were caused by organophosphates and Carbamates- in particular, the WHO class I pesticides monocrotophos and methamidophos.

Consequently, monocrotophos, methamidophos, and endosulfan were banned in 1998. Manuweera G (26) confirmed in 2008 that these bans were followed by a large reduction in both fatal poisonings and suicide in Sri Lanka.

8.3 Indonesia

A study carried out in 1994 by Hirschhorn (17) on observations of 906 spray operations of 214 farmers commonly used monocrotophos and other OPs, researchers found a significant increase from two to fifty-fold in the symptoms of pesticide toxicity during the spraying period. Of these spray operations, 21% brought on three or more neuro- behavioural and intestinal signs of poisoning.

8.4 Luzon, Philippines

An epidemiological study conducted from 1972 to 1984 in a rice-growing district of central Luzon showed an increase in mortality by 27% in the population exposed to pesticide spraying. These years were a period of high pesticide use. Among the four most commonly used pesticides was monocrotophos (23, 9).

8.5 Egypt

In a cotton growing region of Egypt, the health status of 114 farmers who sprayed pesticides on cotton in the village of Tanan, Kalubia Governorate was compared with a control group from the same village. The farmers sprayed a range of pesticides, predominantly OPs, including monocrotophos. Among the exposed group, 61% showed symptoms of chronic pesticide poisoning in the form of blurred vision (experienced by 16.6%), dizziness (14%), parasthesia (12%), numbness (16.6%), headache (16.6%), asthenia (weakness) (9.5%), arthralgia (joint pain) (12%) and low back pain (16.6%) (6).

8.6 Brazil

In the state of Parana, monocrotophos caused 107 out of 412 reported incidents of poisoning analysed in 1990 by the Toxicology Centre and Health Clinics that also noted 1650 incidents involving monocrotophos between 1982 and 1991 (36).

In Mato Grosso do Sul, Brazil a study was carried out by Recena in 2006 to characterize the poisonings from acute exposure to agricultural pesticides used from 1992 to 2002, which were reported to the Integrated Centre of Toxicological Vigilance of the State Health Department. A total of 1355 poisoning cases were reported during the period of the study. One hundred seventy-six poisonings lead to death, with a case fatality rate (CFR) three times higher than the average Brazilian CFR. The insecticide Dimethoate was associated with the highest CFR (30.8%) followed by monocrotophos with 22.2%.

8.7 Central America

A study was conducted in Central American countries within the framework of the PLAGSALUD project, a pesticide project coordinated by the Pan American Health Organization (PAHO) in 2000 (15). PLAGSALUD and the ministries of health from Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panamá prepared the list of the 12 pesticides that most frequently caused acute pesticide poisonings: aldicarb, aluminum phosphide, carbofuran, chlorpyriphos, endosulfan, etoprophos, methamidophos, methomyl, methylparathion, monocrotophos, paraquat, and terbufos.

The PAHO study found that 76% were work-related poisonings, followed by accidental poisonings and by suicides. Preliminary analysis of the study indicated 98% underreporting of pesticide poisonings and a regional estimate of 400 000 poisonings per year (1.9% of the general population). It was estimated that annually, 4.9% of those who use or are otherwise exposed to pesticides may suffer a symptomatic episode of pesticide poisoning (16).

9. Restricting and banning the use of monocrotophos

A number of examples world wide have shown that restricting the availability of highly toxic or locally popular pesticides can be effective in reducing total death rates from self-harm. Many restrictive measures were implemented 20 to 30 years ago. Piola (32, 33) showed that a national ban on the organophosphate parathion reduced the number of deaths reported to their poison centre in Rosario, Argentina. Between 1977 and 1985 and between 1990 to 1994, a total of 21 lethal pesticide-poisoning cases were reported to the centre, including 15 adult cases of self-poisoning and 4 accidental cases in children, 17 of which were due to parathion.

Due to the high number of deaths occurring nationally with this pesticide, it was banned throughout in Argentina in 1994. The last death from parathion in Rosario was reported in 1995. There was subsequently a marked fall in the number of all deaths due to poisoning: from 16 cases in the first half of the decade to 4 cases in the second (33).

In 1981, parathion was also banned in Jordan after studies showed that it was responsible for more than 90% of deaths from pesticides in the country. The total number of poisoning deaths undergoing autopsy in Amman, Jordan, fell from 58 cases in 1978 and 49 cases in 1980 to 28 cases in 1982 and 10 cases in 1984.

Generally, occupational exposure to pesticides will lead to milder signs and symptoms than poisoning due to self-harm ingestion. However, as argued by McConnell and Hruska (27), a restriction of availability of pesticides might have prevented the epidemic of occupational poisoning cases seen in north western Nicaragua during 1987 as a result of the use of the Class I pesticides carbofuran and methamidophos.

An increased use of pesticides in the Philippines during the 1970s coincided with a 27% increase in mortality from non-traumatic causes among economically active men. The incidence in men between the age of 15 and 34 of stroke—a condition rare in this age group, but which could be confused with some types of acute pesticide poisoning—also rose during this period but then fell by more than 60% in the two years following a ban on Endrin (23).

A study conducted in China by Phillips (31) published in 2002 concluded that a major component of preventive efforts to reduce acute poisoning in rural areas would be restricting the ready availability of pesticides. The authors pointed out that the ready availability of potent pesticides in homes of most residents makes this the preferred method of self-harm. This study also supports the suggestion of Eddleston (7) that not all people who die following acts of self-harm actually wish to die. Furthermore, the often impulsive behaviour linked with the ingestion of pesticides and the influence of alcohol makes it important to restrict pesticide availability in the homes.

As mentioned earlier, some authors (2, 24, 29, 30) have advanced the theory that chronic exposure to organophosphate pesticides, because of their ability to affect the nervous system and produce depression, is a major risk factor for suicide. Some suicide attempts may therefore be an *effect* of exposure to pesticides. London (24) suggested that organophosphate pesticides are not only agents for suicide but may be part of the causal pathway. Indeed, animal studies link OP exposure to serotonin disturbances in the central nervous system, which are implicated in depression and suicide in humans.

Epidemiological studies conclude that acute and chronic OP exposure is associated with affective disorders. Considering organophosphates solely as agents for suicide rather than causal factors shifts responsibility for prevention to the individual, reduces corporate responsibility and limits policy options available for control (24).

Since the late 1980s, the Sri Lankan government has taken an active role in determining which pesticides can be used. By the mid-1990s, all WHO Class I pesticides were banned for use in the country. As a result, the number of deaths due to methamidophos and monocrotophos fell dramatically, as documented for one district hospital (38). Unfortunately, another highly toxic (although WHO Class II) compound, the organochlorine endosulfan, then replaced the WHO Class I OPs in agricultural practice. The number of self-poisoning deaths rose as endosulfan became more popular. endosulfan was therefore banned in 1998 and deaths fell from 50 to 3 in the same district hospital over the next 3 years (37). Since Sri Lanka shifted to less toxic pesticides, the number of deaths from pesticide poisoning has been reduced significantly and no obvious adverse effect on agricultural output was reported (26).

More recently in 2007, Gunnell published a report of their study whether Sri Lanka's regulatory controls on the import and sale of pesticides particularly toxic to humans were responsible for the reduction in the incidence of suicide. Their investigation showed that restrictions on the import and sales of WHO Class I pesticides in 1995 and endosulfan in 1998 coincided with reductions in suicide in both men and women of all ages; 19 769 fewer suicides occurred in 1996 to 2005 as compared with 1986 to 1995. Trends in unemployment, alcohol misuse, divorce, pesticide use and the conflict situation did not appear to be associated with these declines. On the basis of their data, the authors concluded that in countries where pesticides are commonly used in acts of self-poisoning, import controls on the most toxic pesticides may have a favourable impact on suicide. (13)

Conditions in India are similar to Sri Lanka insofar as pesticides remain the most common cause of acute poisoning. Due to poor surveillance and reporting of pesticide poisoning, the exact figures in India are not available. However, the available reports from India (1,3,4,5,12,20,22,25,34,35,38,39) show that monocrotophos continues to cause severe poisoning with high case fatality rate despite its use on vegetables having been officially banned.

10. Conclusions

(1) Monocrotophos is a highly hazardous pesticide that is used in large quantities in India, especially in cotton growing areas.

(2) Ample evidence is available showing that organophosphates, including monocrotophos, continue to be a major agent of self-poisoning, with high case fatality rates.

(3) The easy availability in the market and high toxicity of monocrotophos makes it a preferred product for those attempting self-harm by consuming insecticides.

(4) A review of the hospital-based studies on pesticides poisoning in India shows that monocrotophos poisoning has been reported from all parts of India and that it has higher case fatality rates than other pesticides.

(5) There is a gross underreporting of poisoning cases in India. Taking into account the estimation of specific studies carried out by national and international experts specialized in this area, and considering that approximately 20% of poisoning cases are due to pesticides, the number of unintentional and intentional poisoning cases in India would be close to 76 000/year. However, official sources reported fewer than 20 000 cases in 2007.

(6) Monocrotophos is also harmful to the environment. It is highly toxic to birds and it was implicated in a large number of bird death incidents affecting a wide variety of avian species.

(7) Although a restriction on the use of monocrotophos on vegetable crops has been imposed on health grounds, there are doubts about whether this restriction can be enforced.

(8) Other countries have banned monocrotophos on the grounds of its risks to public health and negative environmental impacts. Monocrotophos use is not permitted in the United States of America, and the European Union. Other countries in Asia no longer permit its use: Australia, Cambodia China, Indonesia, Lao PDR, Philippines, Sri Lanka Thailand, Vietnam.

(9) Countries that have banned highly hazardous pesticides such as monocrotophos have been able to demonstrate an overall reduction in deaths due to pesticides.

(10) There are adequate substitutes for monocrotophos.

(11) Taking the above mentioned facts into consideration, it can be concluded that the overall health impact in India if monocrotophos were banned would be positive.

(12) It would be suitable if the following steps are initiated to protect human health and the environment:

- Consider banning the use of highly hazardous pesticides, including monocrotophos, as recommended by WHO and FAO;

- Implement Article 3.5 of the International Code of Conduct on the Distribution and Use of Pesticides[15] which stipulates:" Pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small-scale users in tropical climates. Preference should be given to pesticides that require inexpensive personal protective and application equipment and to procedures appropriate to the conditions under which the pesticides are to be handled and used."

- Consider Article 7.5 of the International Code of Conduct on the Distribution and Use of Pesticides which stipulates: "Prohibition of the importation, sale and purchase of highly toxic and hazardous products, such as those included in WHO Classes Ia and Ib, may be desirable if other control measures or good marketing practices are insufficient to ensure that the product can be handled with acceptable risk to the user."

- Implement measures leading to reduced reliance on pesticides in general and in particular through integrated pest management (IPM) and integrated vector management (IVM) programmes, which also result in significant health and environmental benefits.

15 See: http://www.fao.org/docrep/w5715e/w5715e04.htm

References

1. Batra YK, Keoliya AN, Jadhav GU. Poisoning: an unnatural cause of morbidity and mortality in rural India. *J Assoc Physicians India*. 2000; 51, 955–959.

2. Beseler, C; Stallones, L, Hoppin, J, Alavanja, Mi, Blair A, Keefe, T, Kamel, F. Depression and pesticide exposures in female spouses of licensed pesticide applicators in the agricultural health study cohort. *Journal of Occupational & Environmental Medicine*. 2006 October; 48(10):1005-1013.

3. Bhattacharyya S, Lahiri M, Chattopadhyay T. Seasonal pattern of pediatric poisoning in an agricultural belt of W. Bengal. *Indian Pediatrics*. 2002; 39: 102-104. (http://indianpediatrics.net/jan2002/jan-102-104.htm - accessed 02 February 2009).

4. Chitra G A, Muraleedharan VR, Swaminathan T, Veeraraghavan D. Use of pesticides and its impact on health of farmers in South India. *Int J Occup Environ Health*. 2006; 12: 228–233.

5. Dewan A, Patel AB. Monocrotophos poisoning (2000-2006) from cases reported to Poison Information Centre. Ahmedabad: 2007. (Unpublished).

6. Dinham, B. *The pesticide hazard: a global health and environmental audit*. London: Zed Books, 1993. pp 87-88.

7. Eddleston, M. Patterns and problems of deliberate self-poisoning in the developed world. *Q. J. Med.* 2000; 93: 715–731.

8. Eddleston M, Karalliedde L, Buckley N, Fernando R, Hutchinson G, Isbister G, Konradsen F, Murray D, Piola JC, Senanayake N, Sheriff R, Singh S, Siwach SB, Smit L. Pesticide poisoning in the developing world – a minimum pesticides list. *Lancet*. 2002 Oct 12; 360(9340):1163-7.

9. Forget, G., Goodman, T. de Villiers, A. *Impact of pesticide use on health in developing countries: proceedings of a symposium 1990*. Ottawa: IDRC, 1993.

10. Government of India, Ministry of Home Affairs. *Accidental deaths and suicides in India 2007*. New Delhi: National Crime Records Bureau, 2008. (http://ncrb.nic.in/ADSI2007/home.htm - accessed 02 February 2009).

11. Government of India, Ministry of Agriculture. Division of Medical Toxicology and Risk Assessment, Central Insecticides laboratory.

Directorate of Plant Protection, Quarantine & Storage, Report on Establishment of Harmonized Pesticide Poisoning Database in India: internal report.

12. Gupta BD, Vaghela PC. Profile of fatal poisoning in and around Jamnagar. *JIAFM*. 2005; 27(3): 145-148.

13. Gunnell D, Eddleston M, Phillips MR, Konradsen F. The global distribution of fatal pesticide self-poisoning: systematic review. BMC Public Health. 2007; 7:357. (http://www.biomedcentral.com/1471-2458/7/357 - accessed 02 February 2009).

14. Hart DE, Rojas LA, Rosario JA, Recalde H, Roman GC. Childhood Guillain-Barre syndrome in Paraguay, 1990 to 1991. *Ann Neurol*, 1994 Dec; 36(6):859-63.

15. Hayes WJ, Laws ER, ed. *Handbook of pesticide toxicology*. New York: Academic Press, Inc. 1991.

16. Henao S, Arbelaez MP. Epidemiological situation of acute pesticide poisoning in the Central American Isthmus, 1992-2000. Pan American Health Organization (PAHO) PLAGSALUD. *Epidemiol Bull. 2002; 23: 5-9. (*http://www.paho.org/English/sha/be_v23n3-cover.htm - accessed 02 February 2009).

17. Hirschhorn N. Study of the occupational health of Indonesian farmers who spray pesticides, the Indonesian National IPM Programme. Jakarta: FAO, 1993. UTF/INS/067/INS. (In Dinham, 1993, pp 59-60). Op. cit 6)

18. International Programmeme on Chemical Safety. Monocrotophos: health and safety guide. Geneva: IPCS/World Health Organization, 1993. (http://www.inchem.org/documents/hsg/hsg/hsg80_e.htm#PartNumber:5 accessed 05 February 2009)

18a. Hayes, WJ, Laws ER (ed.). Handbook of Pesticide Toxicology. New York, Academic Press, 1991.

19. Joshi Sharad: Statistics may not tell the real tale, The Hindu Business Line; Wednesday, May 31, 2006 (http://www.blonnet.com/2006/05/31/stories/2006053102091100.htm - accessed 08 February 2009)

20. Karalliedde L, Senanayake N. Acute organophosphorus insecticide poisoning in Sri Lanka. *Forensic Sci Int*. 1988 Jan; 36(1-2): 97-100.

21. Konradsen F, van der Hoek W, Cole DC, et al. Reducing acute poisoning in developing countries - options for restricting the availability of pesticides. *Toxicology* 2003; 192: 249–261.

22. Kundu AK, Mukhopadhyay JD, Saha AK, Das S. *Predictors of mortality in organophosphorus (OP) compound poisoning- hospital based study from suburban West Bengal*. Paper presented during APICON, 2001, JAPI, January, 2001 India.

23. Loevinsohn ME. Insecticide use and increased mortality in rural central Luzon, Philippines. *Lancet*. 1987 Jun 13;1(8546):1359-62.

24. London L, Flisher AJ, Wesseling C, Mergler D, Kromhout,D. Suicide and exposure to organophosphate insecticides: Cause or effect?' *American Journal of Industrial Medicine*. 2006;47(4): 308 - 21

25. Mancini F, van Bruggen, Ariena HC, Jiggins Janice LS, Ambatipudi AC, Murphy H. Helen. Acute Pesticide Poisoning among Female and Male Cotton Growers in India. *Int J Occup Environ Health*. 2005; 11:221–232. (http://library.wur.nl/file/wurpubs/LUWPUBRD_00341230_A502_001.pdf - accessed 02 February 2009).

26. Gamini M, Eddleston M, Egodage S, Buckley NA. Do targeted bans of insecticides to prevent deaths from self-poisoning result in reduced agricultural output? *Environ Health Perspect*. 2008 April; 116(4): 492–5. (http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2291009 - accessed 02 February 2009).

27. McConnell R, Hruska AJ. An epidemic of pesticide poisoning in Nicaragua: implications for prevention in developing countries. *Am. J. Public Health*. 1993; 83: 1559–62.

28. Murray D, Wesseling C, Keifer M, Corriols M, Henao S. Pesticide illness surveillance in the developing world: putting the data to work. *Int J Occup Environ Health*. 2002; 8: 243-8.

29. Parron T, Hernandez AF, Villanueva E. Increased risk of suicide with exposure to pesticides in an intensive agricultural area: a 12-year retrospective study. *Forensic Sci Int*. 1996; 79: 53-63.

30. Passos Carlos José Sousa, Exposition humaine aux pesticides : un facteur de risque pour le suicide au Brésil? (Human exposure to pesticides: a risk factor for suicide attempts in Brazil?) *VertigO – La revue en sciences de l'environnement*, 2006 ;Vol7 no1, (http://www.vertigo.uqam.ca/vol7no1/art3vol7no1/vertigovol7no1_passos.pdf - accessed 02 February 2009).

31. Phillips MR, Li X, Zhang Y. Suicide rates in China, 1995–99. *Lancet. 2002;* 359: 835–40.

32. Piola JC, Prada DB. Influencia de medidas regulatorias en la morbilidad y mortalidad por Talio y Parathion en Rosario, Argentina. *Acta Toxicol. Argent*. 1999; 7(2): 41–43.

33. Piola, J.C., Prada, D.B., Evangelista, M., Cagna, B., 2001. Intoxicaciones con evolucion letal atendidas en Rosario, 1990–1999. *Rev. Med. Rosario*. 2003; 67: 19–24.

34. Rajendiran C. (2007) Personal Communication, Poison Control Centre, Government General Hospital, Chennai.

35. Ravi G. Rajendiran C, Thirumalaikolundusubramanian P. Babu N. *Poison Control, Training and Research Centre, Institute of Internal Medicine, Government General Hospital, Madras Medical College, Chennai, India*. Presented at 6th Annual congress of Asia Pacific Association of Medical Toxicology, Bangkok, Thailand 2-14 December 2007.

36. Recena MC, Pires DX, Caldas ED. Acute poisoning with pesticides in the state of Mato Grosso do Sul, Brazil. *Sci. Total Environ*. 2006 Mar 15; 357(1-3): 88-95.

37. Roberts DM, Karunarathna A, Buckley NA, Manuweera G, Sheriff MH, Eddleston M. Influence of pesticide regulation on acute poisoning deaths in Sri Lanka. *Bull World Health Organ*. 2003(11): 81:789–798.

38. Srinivas Rao. Venkateswarlu, V Surender T, Eddleston M, Buckley NA. Pesticide poisoning in south India: opportunities for prevention and improved medical management. *Tropical Medicine and International Health*. 2005 June; 10(6): 581–588. (http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1762001 – accessed 04 February 2009).

39. Vikram, A, Saralaya K M and ,Singh B 2005 Spectrum of Organophoshorous Poisoning in Manipal. *Medico-Legal Update*. 2005 April-June; 5(2): (2005-04 - 2005-06). (http://www.indmedica.com/journals.php?journalid=9&issueid=68&articleid=868&action=article – accessed 04 February 2009).

40. Vorley WT, Dittrich V. 1994. Integrated pest management and resistance management systems. Review of Environmental Contamination and Toxicology, ISSN 0179-5953.139: 179-193 (http://www.fao.org/agris/search/display.do?f=./1996/v2225/US9615183.xml;US9615183 - accessed 08 February 2009)

41. World Health Organization. Mental Health and Substance Abuse Facts and Figures Suicide Prevention: Emerging from Darkness. New Delhi, India, 2006 (http://www.searo.who.int/en/Section1174/Section1199/Section1567/Section1824_8078.htm - accessed 08 February 2009)

42. World Health Organization. The WHO recommended classification of pesticides by hazard and guidelines to classification. Geneva: WHO, 2004. (http://www.inchem.org/documents/pds/pdsother/class.pdf - accessed 04 February 2009).

43. World Health Organization. Pesticide Poisoning Database in SEAR Countries. Report of a Regional Workshop. New Delhi, India, 2001 (http://whqlibdoc.who.int/searo/2001/SEA_EH_534.pdf - accessed 04 February 2009)

44. Wu KM, Liu XC, Qin XQ, Lou GQ. Investigation of carmine spider mite (Tetranychus cinnabarinus) resistance to insecticides. *Acta Agricultura Boreali-Sinica*. 1990; 5: 117-23.

Further reading

I. Cherian MA, Roshini C, Visalakshi J, Jeyaseelan L, Cherian AM. Biochemical and clinical profile after organophosphorus poisoning — a placebo-controlled trial using pralidoxime. *J Assoc Phys India*. 2005 May; 53: 427-431.

II. Chugh SN, Dushyant, Ram S, Arora B, Malhotra KC. Incidence and outcome of aluminium phosphide poisoning in a hospital study. *Indian J Med Res*. 1991; 94: 232–35.

III. Eddleston M, Sheriff MHR, Hawton K. Deliberate self-harm in Sri Lanka: an overlooked tragedy in the developing world. *BMJ*. 1998; 317:133–35.

IV. Gautami S, Sudershan RV, Bhat RV, et al. Chemical poisoning in three Telengana districts of Andhra Pradesh. *Forensic Sci Int*. 2001;122:167–71.

V. Gunnell D, Eddleston M. Suicide by intentional ingestion of pesticides: a continuing tragedy in developing countries. *Int J Epidemiol*. 2003; 32: 902-9.

VI. Hettiarachchi J, Kodithuwakku GCS. Pattern of poisoning in rural Sri Lanka. *Int. J. Epidemiol*. 1989; 18, 418–422.

VII. Konradsen F, 2007. Acute pesticide poisoning - a global public health problem. *Danish Medical Bulletin*. 2007 Feb; 54(1): 58-9.

VIII. Kranthi KR, Jadhav DR, Wanjari RR, Ali SS, Russell D.Carbamate and organophosphate resistance in cotton pests in India, 1995 to 1999. *Bulletin of Entomological Research*. 2001; 91: 37-46.

IX. Lester D, Abe K. The effect of controls on sedatives and hypnotics and their use for suicide. *Clin. Toxicol*. 1989; 27, 299–303.

X. Mani A, Thomas MS, Abraham AP. Type II paralysis or intermediate syndrome following organophosphate poisoning. *JAPI*. 1992; 40: 542–4.

XI. Oliver RG, Hetzel BS. Rise and fall of suicide rates in Australia: relation to sedative availability. *Med. J. Aust*. 1972; II: 919–23.

XII. Pain DJ, Gargi R, Cunningham AA, Jones A, Prakash V. Mortality of globally threatened Sarus cranes Grus antigon from monocrotophos poisoning in India. *Science of the Total Environment*. 2004; 326: 55-61.

XIII. Pawar KS, Bhoite RR, Pillay CP, Chavan SC, Malshikare DS, Garad SG. Continuous pralidoxime infusion versus repeated bolus injection to treat organophosphorus pesticide poisoning: a randomised controlled trial. *Lancet*. 2006; 368: 2136-41.

XIV. Peiris JB, Fernando R, De Abrew K. Respiratory failure from severe organophosphate toxicity due to absorption through the skin. *Forensic Sci Int*. 1988; 36: 251-3.

XV. Proudfoot AT, Park J, Changing patterns of drugs used for self-poisoning. *BMJ*. 1978; 14, 90–93.

XVI. Rupa DS, Lakshman Rao PV, Reddy PP, Reddi OS. *In vitro* effect of monocrotophos on human lymphocytes. *Bull. Environ. Contam. Toxicol*. 1988; 41: 737-741

XVII. Rupa DS, Reddy PP, Reddi OS. Frequencies of chromosomal aberrations in smokers exposed to pesticides in cotton fields. *Mutat. Res*. 1989; 222(1): 37–41.

XVIII. Rupa DS, Reddy PP, Reddi OS. Reproductive performance in population exposed to pesticides in cotton fields in India. *Environ Res*. 1991; 55: 123-8.

XIX. Schulze-Rosario, Loosli R. *Reviews of Environmental Contamination and Toxicology*. 1994; 139.

XX. Senanayake N, Karalliede L. Neurotoxic effects of organophosphorus insecticides: an intermediate syndrome. *N Engl J Med* 1987; 316: 761-3.

XXI. Singh S, Wig N, Chaudhary D, Sood NK, Sharma BK. Changing pattern of acute poisoning in adults: experience of a large North-west Indian hospital. *J. Assoc. Phys. India*. 1997; 45, 194–7.

XXII. Singh S, Chaudhry D, Behera D, Gupta D, Jindal SK. Aggressive atropinisation and continuous pralidoxime (2-PAM) infusion in patients with severe organophosphate poisoning: experience of a northwest Indian hospital. *Hum. exp. toxicol*. 2001; 20(1): 15-18.

XXIII. Singh S, Ranjit A, Parthasarathy S, Sharma N, Bambery P. Organophosphate induced delayed neuropathy: Report of two cases. *Neurology India*. 2004 Oct-Nov; 52(4): 525-526.

XXIV. Tomlin, Clive. 1994. *The pesticide manual: a world compendium*. 10th ed. Surrey: British Crop Protection Council, 1994.

XXV. Wananukul W, Kiateboonsri S, Thithapandha A. The intermediate syndrome as critical sequelae of organophosphate poisoning: the first report of two cases in Thailand. *J Med Assoc Tha.i* 2005; 88(9): 1308-13.

XXVI. Wesseling C, McConnell R, Partanen T, Hogstedt C. Agricultural pesticide use in developing countries: health effects and research needs. *Int J Health Services*. 1997; 27: 273–308.

Annex 1: Chemical and Physical Properties and Identification

Common Name: Monocrotophos

Chemical Name: Phosphoric Acid, Dimethyl 1-Methyl-3-(Methylamino)-3-Oxo-1-Propenyl Ester, (E)-

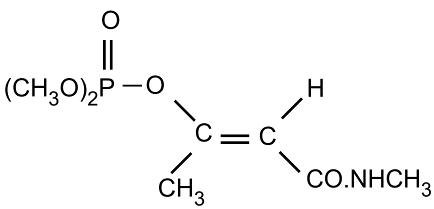
Synonyms: phosphoric acid, dimethyl [1-methyl-3-(methylamino)-3-oxo-1-propenyl] ester; (*E*)-phosphoric acid dimethyl ester, ester with 3-hydroxy-*N*-methylcrotonamide; 3-(dimethoxyphosphinyloxy)-*N*-methyl-*cis*-crotonamide; dimethyl 2-methylcarbamoyl-1-methylvinyl phosphate,

IUPAC name: Dimethyl (E)1-methyl-2-methylcarbamoyl) vinylphosphate; 3-(dimethoxyphosphinyl-oxy)- *N*-methylisocrotonamide

CAS chemical name: (E)-dimethyl-1-methyl-3-(methylamino)-3-oxo-1-propenyl phosphate (9Cl); dimethyl phosphate ester with(E)-3-hydroxy- *N*-methylcrotonamide 8 Cl)

Trade names: Nuvacron(R), Azodrin(R), Biloborn, Nuvacron, Monocron, Phoskill

Chemical structure:



Molecular formula: $C_7H_{14}NO_5P$

Physical Data

Molecular weight: 223.2
Vapor Pressure: 7 x 10 -6 mm Hg at 68º F (20º C)
Flash Point: 200º F (93º C)
Water Solubility: Soluble
Boiling point: At 0.07 Pa: 125oC
Melting point: 54-55oC
Vapour pressure: 3 x 10-4 Pa
Solubility in water: miscible Log Poctanol/water: -0.22

The pure compound consists of colourless hygroscopic crystals. The commercial product is a reddish-brown to dark brown clear viscous liquid with a mild ester odour, which eventually forms a semisolid to solid mass through crystallization (commercial product). The compound is unstable in low molecular weight alcohols and glycols. It is stable in ketones and higher molecular weight alcohols and glycols and when stored in glass and polyethylene containers. It is relatively stable at acidic and neutral pH values, but it is hydrolysed in alkaline solutions.

Source: IPCS, WHO (18)

Annex 2: Cases of Avian Toxicity due to monocrotophos

(**Source:** American Bird Conservancy , http://www.abcbirds.org/)

Israel, 1979.

In an attempt to control voles in alfalfa fields, farmers sprayed with monocrotophos at twice to three times the recommended rate. Massive bird kills were observed over a four-year period (1975-1979). Raptors were particularly hard-hit. In 1976, authorities recovered 219 individual raptors of 13 species dead or paralysed. Spotted, Lesser Spotted, and Imperial Eagle, Long-legged and Common Buzzard, Black Kite, Marsh, Hen, and Pallid Harriers, Kestrel, Short-eared, Long-eared, and Barn Owl. In 1977 the deaths continued at similar rates with four more species: White-tailed Sea Eagle, Merlin, Sparrowhawk, and Eagle Owl.

Argentina,1996.

Researchers described at least 14 different incidents of hawk kills in the Pampas region of Argentina, thought to comprise the "core" wintering site for Swainson's hawks. The different kills ranged in number of birds killed from just a few to over 3000 at one site. One scientist estimated that up to 20000 Swainson's hawks were killed that year, alone.

Texas, USA, 1985.

Forty five Franklin's gulls were found dead in a sugarcane field that had been aerially sprayed with monocrotophos. The gulls were feeding on emerging cicada larva. Brain Acetylcholinesterase (AchE) in the gulls was inhibited between 86 and 98%.

Arizona, USA, 1967.

U.S. Fish and Wildlife Service officials searched four miles of cotton field edge that had been treated with monocrotophos the previous day. A total of 96 dead or severely affected birds were found. Species included Gambel's Quail, Mourning Doves, Vesper, Chipping and unidentified sparrows, Orange-crowned Warblers, Western Tanager, Spotted Sandpiper, and Northern Harrier; 36 of 40 carcasses tested for brain AchE activity showed severe inhibition compared to controls.

New Mexico, USA, 1987.

In a study where cornfields were sprayed with monocrotophos and compared with a nearby control plot, 26 bird carcasses were found only in the non-crop strips of edge habitat in the sprayed fields. Search efforts were begun two days after spraying; details of the search methods and frequency are unavailable. Species include: Northern Bobwhite, Killdeer, Mourning Dove, Horned Lark, Mockingbird, Chipping and House Sparrow. Scavengers removed 90% of placed carcasses, indicating that the true kill rate was actually much higher. Brain AchE tests were performed with an average AchE depression of 84% of all birds tested compared to control birds.

Germany, 1970.

A field study to test avian toxicity of monocrotophos when used in corn found 30 dead birds in one test plot, and 44 dead or paralyzed birds in another. The test plots were treated with different concentrations of monocrotophos and were quite small (1 hectare) so the numbers of dead birds found were significant. Species included Ring-necked Pheasant, Blackbird, Song Thrush, Great Tit, Sedge Warbler, shrikes, Yellowhammer, Corn Bunting, Chaffinch, Greenfinch, as well as House and Tree Sparrows.

After reviewing the avian toxicity of monocrotophos, National Registration Authority for Agricultural and Veterinary Chemicals, Australia (2000) concluded that the weight of evidence indicates use of monocrotophos poses a high hazard to birds, and it is difficult to defend its continued use.

Annex 3: Registration Committee, Ministry of Agriculture, Expert Committee Report on monocrotophos, 2006

Expert group constituted to review pesticides which are banned in other countries but are being used in India

The following members attended the THE THIRD MEETING:-

- Dr C. D. Mayee, Chairman , ASRB New Delhi – CHAIRMAN
- Dr P.S. Chandurkar, Plant Protection Adviser to the Govt. of India
- Dr B.S. Parmar, Joint. Director (Research), IARI, Pusa, New Delhi.
- Dr R.A.Tripathi, Prof.& Head, Dept. of Entomology, CS Azad Uni. Of Agri.& Tech, Kanpur
- Dr Y.S. Ahlawat, Division of Plant Pathology, IARI, New Delhi-12
- Dr L.S. Barar, Prof.& Head, Deptt. of Agronomy, PAU, Ludhiana
- Dr O.P. Dubey, former ADG(OP), Indian Council of Agricultural research Krishi Bhavan New Delhi
- Dr S. K. Handa, WHO Consultant Room No 526 , Wing A, Representative from PFA Div. Min. Of Health & Family Welfare, New Delhi
- Dr (Mrs) Chanda Chaudhary, Addl. Director HSM Division, Min. of Environment& Forests, CGO Complex, Lodi Road , New Delhi

- Dr T.S.Thind, Professor Plant Pathology, Deptt. of Plant Pathology, PAU, Ludhiana-141004 (Punjab)
- Dr Keshav Kranti, CICR, Post Bag No.2, Nagpur-440010 (MS)
- Dr NT. Yaduraju, Principal Scientist, Div. of Agronomy, IARI New Delhi
- Dr K.K. Sharma, Project Coordinator, AICRP on Pesticide Residue, LBS Building, IARI, New Delhi-110012
- Dr A.K. Majumdar, Director (IH), Central Labour Institute, Sion, Mumbai-22

The preliminary observation of the committee is given below.

"**Monocrotophos**

The group considered the information that it is highly hazardous pesticide class (1B) as per WHO recommended Classification of Pesticides by Hazard 2004 and it is included in the Rotterdam Convention on Prior Informed Consent Procedure on hazardous chemicals and pesticides. The group was concerned with the recent reports of endocrine disruption and the International information of poisoning cases .The group noted that the government has issued the notification regarding the ban on the use of (monocrotophos on) vegetables which is difficult to implement considering the use of this pesticide on other crops in the past. Further in view of certain reports/ observations there was an apprehension among the members that there are chances of misuse of the pesticide in terms of application technology. It was also noted that better alternatives are available.

In view of above it was decided that the basic manufacturers/ Pesticide Associations may be asked to present their views on the above concerns."

The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) have encouraged countries to phase out highly hazardous pesticides. Leading Asian countries have banned the use of monocrotophos because of unacceptable health risks. In India, however, monocrotophos continues to be produced, used and exported. This publication is designed to provide health policy-makers with technical information needed for urgent action to reduce the availability of and the demand for highly hazardous pesticides, as recommended by WHO and FAO.

World Health Organization
Regional Office for South-East Asia

World Health House
Indraprastha Estate,
Mahatma Gandhi Marg,
New Delhi-110002, India

ISBN 978-92-9022-345-0

9 789290 223450