CHLORPYRIFOS
A CANDIDATE POP

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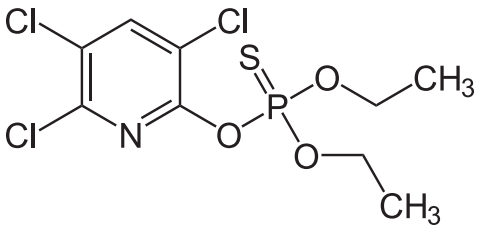
INTRODUCTION

Chlorpyrifos ($C_9H_{11}Cl_3NO_3PS$) is a synthetic chlorinated organophosphate pesticide. The pesticide is found to be effective against different kinds of pests, including termites, stem borers, aphids, jassids, whiteflies, plant hoppers etc., and is used to protect a wide range of crops.[1] Chloyrifos has now been classified as **moderately hazardous to humans** (**Class II**) by the World Health Organization (WHO) based on the review of human toxicity studies.[2] Several countries have taken note of this and restricted the use of the pesticide.

CHLORPYRIFOS AS A CANDIDATE POP IN STOCKHOLM CONVENTION

Since chlorpyrifos is effective and cost-competitive, it is used extensively and has often been chosen as a replacement for persistent organochlorinated compounds, which are now being phased out.[2] In June 2021, the EU submitted a **proposal for listing Chlorpyrifos as a Persistent Organic Pollutant (POP)** in Annex A to the Stockholm Convention. This initiated the process to eliminate the production and use of this pesticide. However, due to a lack of consensus on the long-range environment transport (LRET) of the pesticide, the **Persistent Organic Pollutants Review Committee (POPRC)** of the Convention in its 18th meeting (September 2022) decided to defer its decision to consider the draft risk profile for chlorpyrifos.

Chlorpyrifos structure



June 2021

European Union submitted a proposal to list Chlorpyrifos in Annex A to the Stockholm Convention.

January 2022

POPRC agreed that Chlorpyrifos fulfil the screening criteria in Annex D to the Convention and decided to establish an intersessional working group to review the proposal further and to prepare a draft risk profile in accordance with Annex E to the Convention

April 2022

Draft risk profile prepared

September 2022

At POPRC-18 in September 2022, the consideration of the draft risk profile for chlorpyrifos due to a lack of consensus on the adverse effects resulting from long-range environmental transport

EXPOSURE TO CHLORPYRIFOS[3]

Direct inhalation or dermal absorption | Residues on crops | Breast milk | Bovine milk | Drinking water

HEALTH EFFECTS

Major effect of organophosphate pesticides is the inhibition of an enzyme (acetyl cholinesterase) which controls the transmission of nerve impulses.[4]

Initial Symptoms	Signs of Progression	Severe Toxicity
Tearing of the eyes, runny nose, increased saliva and sweat production, nausea, dizziness and headache	Muscle twitching, weakness or tremors, lack of coordination, vomiting, abdominal cramps, diarrhoea, and pupil constriction with blurred or darkened vision	Increased heart rate, unconscious-ness, loss of control of the urine or bowels, convulsions, respiratory depression, and paralysis

Source: Webpage of national pesticide information center[2]

According to the Agency for Toxic Substances and Disease Registry, pregnant women may be more sensitive to chlorpyrifos toxicity. In addition to the immediate effects of exposure, chlorpyrifos is also linked to a number of serious longer term health impacts such as adverse effects on neurodevelopment, reduced birth size, endocrine disruption, lung and prostate cancer.[3]

Human toxicity studies on chlorpyrifos conducted globally have been summarized in the table given in **Annexure-I**

ECOLOGICAL EFFECTS[5, 6]

- Moderately to very highly toxic to birds, honeybees, fish, and aquatic organisms
- Even a single application of chlorpyrifos can pose a risk to small mammals (US EPA)
- As chlorpyrifos is a persistent chemical, it accumulates in the tissues of aquatic organisms and has a half-life in soil ranging from 60 days to one year depending on climate and soil type
- Concentrations greater than recommended levels exert detrimental effect on the soil microbial population and their biological activity

GLOBAL REGULATIONS

- In 2010, South Africa banned the use of chlorpyrifos for residential use; however, it is still allowed to be used for agriculture
- Since April 2016, it is illegal to sell, distribute or use stocks of products containing chlorpyrifos in UK.[7]
- By February 2020, EU Member States had revoked all authorizations of plant protection products that include Chlorpyrifos and Chlorpyrifos-methyl.[8] Both substances were already banned in Germany and seven other EU-countries before the EU regulation.
- In Aug 2021, the US EPA banned the use of chlorpyrifos on food to prevent the use of chlorpyrifos on all foods and protect human health, particularly which of children and farmworkers.[9] The indoor use of chlorpyrifos was banned way back in 1996.
- From June 2023, in Argentina, the National Agrifood Health and Quality Service (Senasa) has prohibited the use of phytosanitary products formulated based on Chlorpyrifos ethyl and Chlorpyrifos methyl

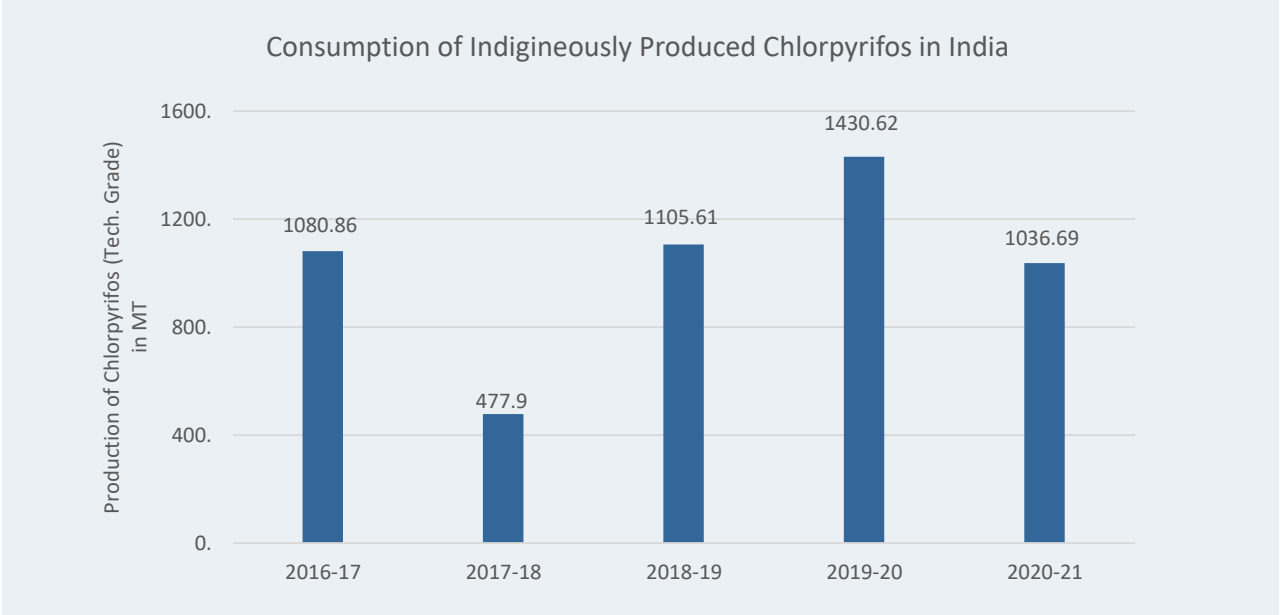
REGULATIONS IN ASIAN COUNTRIES

- In 2004, in Sri Lanka, the residential use of chlorpyrifos in was banned. All other uses were banned in 2013.
- In 2011, chlorpyrifos was used in over 20 crops in China (Chen, 2011), including the staple crops, rice and wheat (Lili Yu, 2020). Since then, China has deregistered chlorpyrifos for use on vegetables from December 2014, and banned the use of chlorpyrifos on vegetables from December, 2016.[10]
- In February 2019, the Vietnam's Ministry of Agriculture and Rural Development decided to remove plant protection products containing chlorpyrifos-ethyl.[11]
- Since 2019, Indonesia has banned chlorpyrifos in all the crops
- Effective June 2020, Thailand imposed a ban on the insecticides chlorpyrifos and chlorpyrifos-methyl.[12]
- Chlorpyrifos is still widely used in Bangladesh and Nepal.

SCENARIO IN INDIA

In India, chlorpyrifos has been registered under the Insecticide Act of 1968 since 1977. The Government of India has recommended the agricultural use of chlorpyrifos for rice, beans, gram, sugarcane, cotton, groundnut, mustard, brinjal, cabbage, onion, apple, ber, citrus and tobacco. It has also been recommended for some crops in combination with cypermethrin and alphacypermethrin (both synthetic pyrethroids) depending on the type of pests.

- Chlorpyrifos is the most consumed pesticide in India
- Consumption of technical grade chlorpyrifos was more than 1036 metric tonnes in 2020-21
- Total production of chlorpyrifos formulations in India in 2021 was reported to be 24,000 tonnes, of which 11,000 tonnes was used domestically, 12,000 tonnes was exported and remaining 1,000 were stockpiles (PMFAI 2022)



Source: PPQS website

In 2013, Anupam Verma Committee was set up to review 66 pesticides that had been banned, restricted, or withdrawn in other countries, but which were still in use in India. Out of the pesticides under review, chlorpyrifos residues were most abundantly found, in fruit and vegetable samples analysed between 2011 and 2014. In its report, submitted in 2015, the committee recommended phasing out of 6 pesticides, and a review of 27 others, including chlorpyrifos. Based on the review, a draft order banning 27 pesticides, including chlorpyrifos was issued but has not been notified till now.

Source of Import and list of Indigenous Manufactures of Chlorpyrifos (PPQS website)

Active Ingredient	Approved Sources For Import	Local Manufacturers
Chlorpyrifos Technical 94% min.	1. Dow AgroSciences LLC, USA 2. Dow AgroSciences UC, UK 3. Mekhteshim Chemical Works, Israel 4. FMC Corporation, USA S. Cheminova Denmark	1. De-NOCIL Crop Protection Ltd., Mumbai 2. Excel Crop Care Ltd. Ltd. Mumbai 3. Gharda Chemicals Ltd. Mumbai 4. Montari Industries Ltd., Delhi S. Siris India ltd., Hyderabad. 6. Vantech Industries Ltd., Hyderabad. 7. GSP Crop Science ltd., Ahmedabad 8. Sabero Organics Gujrat limited, 9. India Pesticide ltd, Lucknow 10. Punjab Chemicals and Crop Protection ltd, Chandigarh 11. Rotam India Limited, Mumbaj 12. Heranba Industries Limited 13. GSP Crop Science Ltd., Ahmedabad 14. Insecticides India Ltd., 15. Shivalik Rasayan Ltd., New Delhi 16. Bonagri Life Science Ltd, Hubli. 17. Coromandel International Ltd. 18. Hyderabad Chemical Products Pvt. Ltd. 19. Cheminova Inida Ltd. Gujarat 20. Netmatrix Ltd. Hyderabad 21. Megmani Organics ltd., Ahmedabad 22. Bharat Rasayan Ltd., Delhi 23. Gujarat Insecticides ltd. Ankleshwar 24. Sudarshan Chemic.al Industries Ltd., Pune 25. Bhagiratha Chemicals & Industries ltd. 26. HPM Chemicals & Fertilizers Ltd., 27. Jubilent Life Sciences Ltd., UP 28. Best Crop Science UP, Gaj raula, UP

PHASING OUT CHLORPYRIFOS

Many countries have acknowledged the health and environmental impacts of chlorpyrifos and have phased out its use in agriculture.

In many Asian countries including **Sri Lanka, Vietnam, Indonesia and Thailand** which have more or less similar agricultural pattern as India, have completely phased out chlorpyrifos. Notably, **Sri Lanka has banned the pesticide use since 2007**. This clearly indicates the availability of effective alternatives, which can suitably replace chlorpyrifos

In 2019, a cross-sector work group was formed in California, USA to identify, evaluate and recommend safer, more sustainable pest management alternatives to chlorpyrifos, as

Crop	Common Name of Pest	Registered for use in India*	Recommended by CIBRC**
Apple	Aphid	• Spirotetramat • Imidacloprid • Acetamiprid • Azadirachtin	No alternative insecticide recommended
Cabbage	Cabbage Aphid	• Acetamiprid • Flonicamid • Spirotetramat • Imidacloprid • Pymetrozine	• Acetamiprid
Cotton	Aphid	• Acetamiprid • Flonicamid • Flupyradifurone • Imidacloprid • Thiamethoxam • Pymetrozine	• Acetamiprid • Flonicamid • Imidacloprid • Thiamethoxam
	Bollworm	• Indoxacarb • Spinosad	• Indoxacarb • Spinosad
	Whitefly	• Buprofezin • Pyriproxyfen • Acetamiprid • Flupyradifurone • Dinotefuran • Clothianidin • Bifenthrin • Fenpropathrin	• Buprofezin • Pyriproxyfen • Dinotefuran • Clothianidin • Bifenthrin • Fenpropathrin
	Cut worm	• Indoxacarb	No alternative insecticide recommended

** List of pesticides recommended by the US work group and registered in India*

*** List of pesticides recommended by the US work group, registered in India and recommended for specific pest/crop combination though not specifically as alternatives to chlorpyrifos*

a part of efforts to ban chlorpyrifos in the state.[13] Many of these suggested alternatives are registered for use in India, and recommended for the pest-crop combination, as shown in Table below. However, these pesticides have not been explicitly recommended as alternatives to chlorpyrifos in India.

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ANNEXURE

Country and Year	Study	Toxic Effects observed
Italy, 2020[14]	Integrating biokinetics and in vitro studies to evaluate developmental neurotoxicity induced by chlorpyrifos in human iPSC-derived neural stem cells undergoing differentiation towards neuronal and glial cells	Repeated treatment with chlorpyrifos at low concentrations decreased the number of neurons and branch points in a concentration-dependent manner, and ultimately impacted neuronal network formation, leading to a decrease in electrical activity and neuronal network functionality
Taiwan, 2020[15]	Outcome of patients with chlorpyrifos intoxication	All patients developed acute cholinergic crisis such as emesis, respiratory failure, tachycardia, kidney injury, and seizure. 70% of patients were given a 'poor' prognosis
China, 2019[16]	Chlorpyrifos Induces Metabolic Disruption by Altering Levels of Reproductive Hormones	Chlorpyrifos causes metabolic disruption and changes Reproductive Hormone levels
Argentina, 2017[17]	Impact of chlorpyrifos on human villous trophoblasts and chorionic villi	Placental ex vivo exposure to chlorpyrifos produces tissue alterations and suggest that human placenta is a potential target of chlorpyrifos toxicity
USA, 2014[18]	Neurodevelopmental Disorders and Prenatal Residential Proximity to Agricultural Pesticides	Linkage of neurodevelopmental disorders, like autism spectrum disorder (ASD) and developmental delays with gestational exposure to chlorpyrifos
India, 2013[19]	Chlorpyrifos toxicity causing delayed myeloneuropathy (case study)	On ingesting 50ml of chlorpyrifos 50%EC formulation, man needed mechanical ventilation for 2 weeks and needed support to walk up to 6 months
USA, 2012[20]	Brain anomalies in children exposed prenatally to a common organophosphate pesticide	Changes in brain morphology

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