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An Assessment on Emphasis of Chlorpyrifos on Human Health and Environment

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ABSTRACT

Among the organophosphate pesticides Chlorpyrifos (CPF) is one of the oldest, wide-spectrum insecticides, used in public health and residential to kill a variety of insects and control the vectors of diseases. Although, the primary toxicity associated with CPF is cholinergic symptoms resulting from acetylcholinesterase inhibition and consequent accumulation of CPF in the body causes toxic effects on the different systems of exposed living beings, such as muscular, nervous, immune, and endocrine alterations. Several studies have reported that CPF has the potential to induce ROS (Reactive Oxygen Species), lipid peroxidation, and enzyme inactivation of cellular membranes through various biochemical processes, and the metabolites produces by the oxidation of CPF show a pattern of induction of chromosome damage and has been related to mutagenicity, carcinogenicity, teratogenicity, and DNA abnormalities. CPF induces toxicity in soil, air as well as water by decreasing their nutrients. In plants, CPF reduces carbon dioxide assimilation ability, and the nitrogen fixation rate also disrupts the chlorophyll biosynthesis pathway. It is also hepatotoxic, genotoxic as well as renal toxic in mammals and shows a large toxic impact on the male reproductive system. This review is based on scientific reports, data, and previous research that had been done in previous years which explain the toxic effect of CPF in a complete environment, in both abiotic and biotic factors, and show the risk to human health due to the use of CPF.

KEYWORDS: Chlorpyrifos (CPF); Organophosphate; toxic effect; human health; environment;

● INTRODUCTION

Since their synthesis and use, insecticides have saved millions of human and animal lives. They played an important role that brought a revolution in the field of agriculture and human health in the control of insect pests of crops and vector-borne diseases. Despite their importance, insecticides also have a negative impact, like toxic residues in food, water, air, and soil, resurgence, the resistance of insect pests, and effect on non-target organisms.

Chlorpyrifos (CPF) is a group of organophosphate insecticides used in a broad spectrum of commercial agriculture applications and consumer products for domestic purposes. It acts on pests by contact, ingestion, and inhalation on the plant surface and inside. After ingress inside the organisms, organophosphate inhibits the Acetylcholinesterase (AchE)

Organophosphate exposure in the long term in basic quantity can cause cancer, diabetes, and many more neurological disorders such as depression, neurodegenerative diseases, and genotoxic effects. However, the effect of the organophosphate mechanism on the pathophysiology of these diseases are yet not known [2].

According to WHO each year more than 2.5 million people worldwide tolerate acute poisoning of pesticides and death the ratio is approx 0.2 million people [41].

According to Bonner et al., (2005), these organophosphates are cancer-causing agents in humans [3]. Zohm and Ward (1998) reported that pesticide exposure is responsible for neuroblastoma, sarcoma, lymphoma, and cancer of the brain and testes [44]. These mutagenic chemicals bring some changes in the DNA and RNA of the organism which affect them and their offspring (Manjula et al., 2009). Pesticides are made up of those chemical compounds which react with cellular biomolecules and form covalent bonds with nucleophilic centers of DNA (Simoniello et al.,2008; Poletta et al.,2009). Changes in DNA can lead to the affect reproductive system, cancer, and various chronic diseases (Meinert et al., 2000).

The toxicological effect of CPF is the most important. Until now, substantial information has been collected based on its mode of action and its short and long-duration exposure effect in both animals and humans [41].

- MATERIAL AND METHODS

Data reported in this issue were collected from various organizations such as WHO, and EPA (Environment Protection Agency) USA by which we can collect the most accurate data and guidance. In addition, the data were extracted from PubMed and Science Direct, and Google Scholar by using many keywords such as Toxicological effect of CPF, Effect of CPF on the environment, CPF. Many scholars have played a crucial role in the study of the effect of CPF and this holograph is based on them.

Result and discussion

- **Effect of chlorpyrifos (CPF) on the environment**

  The use of CPF on plants affects less than 1%of the product archived by the target pest and the rest comes to the soil then it changes through chemical reactions and metabolites come out [19]. According to Jaiswal *et al.*, [15] and Huang *et al*., [13] These organophosphates are very less soluble in water so they are strongly absorbed by the soil. Singh *et al*., [35] concluded that the half-life of 14 days to 365 days but the half-life may vary according to soil type and its content, pH, temperature, and Moisture. Raising soil temperature and low organic compound contents and pH value.

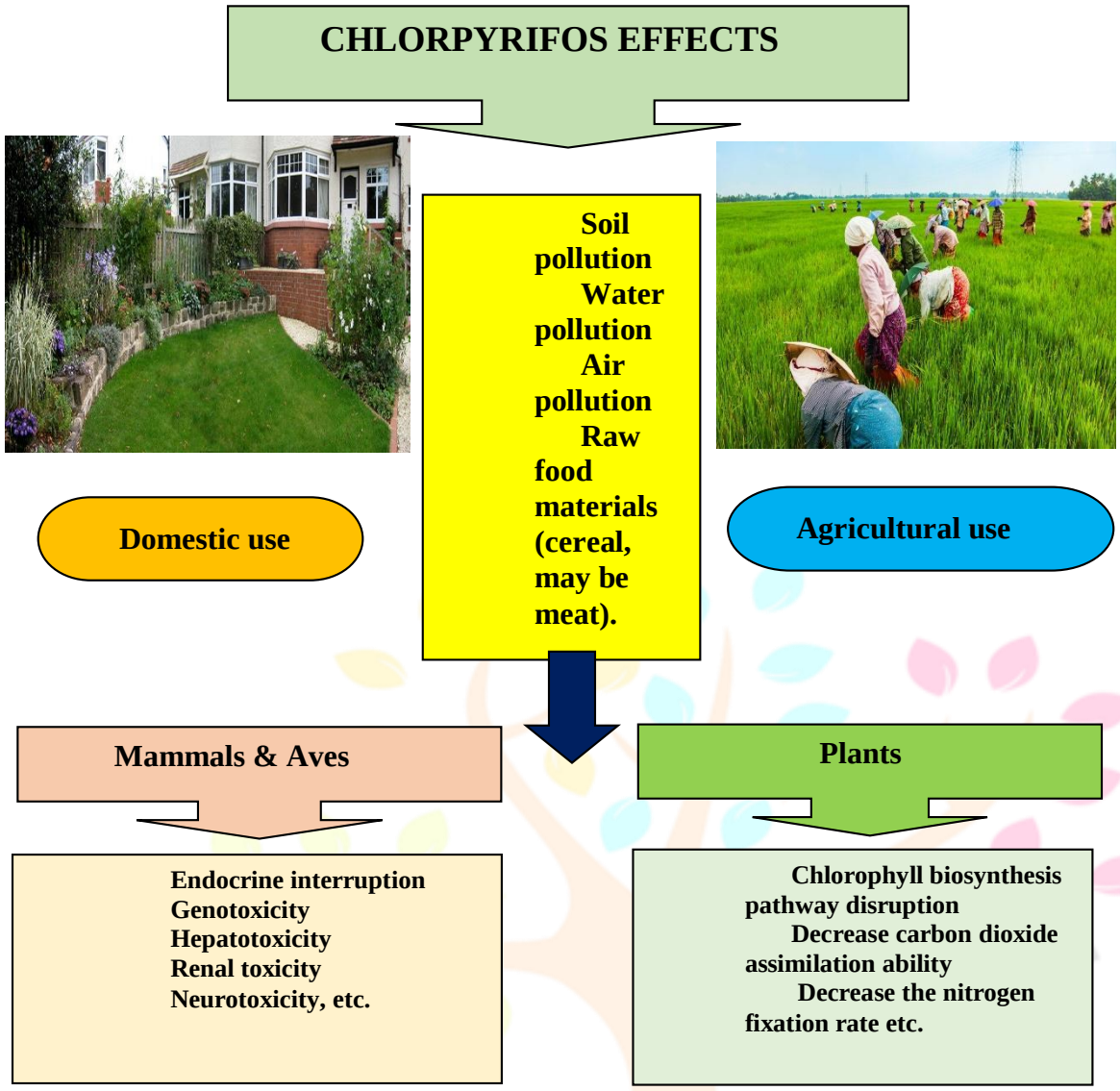

FIGURE – 1. Presence of Chlorpyrifos in the environment.

Based on literature information microbiota, soil nutrients recycling including nitrogen fixation affected by these pesticides induces ROS peroxidation also CPF inhibits the gene expression which is responsible for nitrogen fixation.[19].

Riah *et al*., [28] concluded that soil enzymes such as phosphatase and beta-galactosidase are actively affected by CPF. Chlorpyrifos-oxons are the metabolites of CPF which are more toxic than the original compounds for soil nutrients and microbiota.

Guo *et al*., [10] reported that the mobility of antibiotic-resistance genes of the rhizosphere can be affected by the presence of CPF. Sanchez-Hrenandez *et al.,* [30,] studied the impact of L. terrestris in organophosphate-containing soil and concluded that L. terrestris has a positive impact on the soil by improving soil enzyme activity.

Organophosphate spread into the soil which percolates into the water resources through the soil. Rainfall and flood are the main source through which pesticides reach the water source and cause water pollution.[32] Its solubility depends on its hydrophobicity and capability of making bonds with an organic compound present in the environment.[5] It hydrolyzed well in high pH solution but remain stable in low pH and neutral solutions. But still in spite of CPF shows its presence in natural water resources in various parts of the world. [22, 36]

Humans and animals both depend on plants which provide nutrients but the CPF shows negative effects on it. A high concentration of CPF decreases the root and shoot length of the plant, decreases the carbon dioxide assimilation ability of plants, nitrogen metabolites of leguminous plants, etc (fig 1).[17]

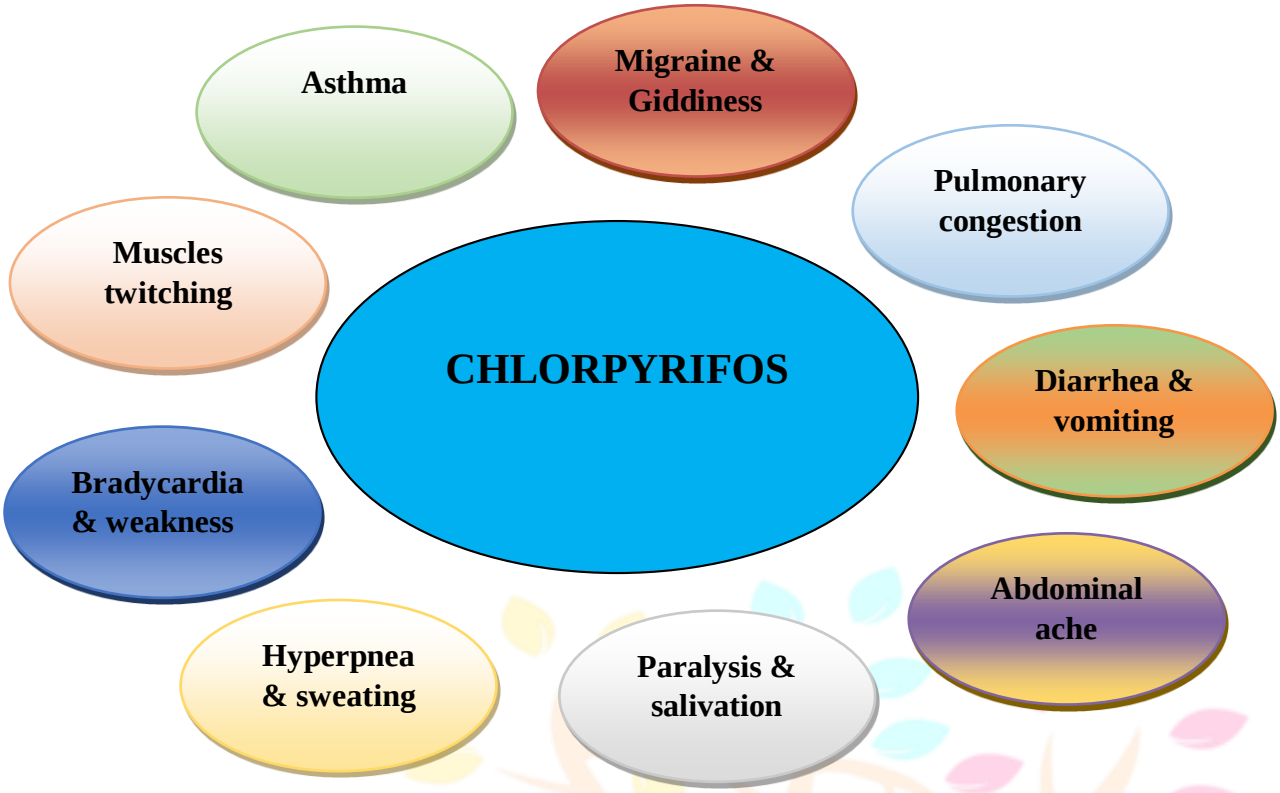

FIG.2 – EFFECT OF CHLORPYRIFOS ON MAMMALS.

In accordance with acute systemic toxicity. In case of any organism evaluation of any kind of adverse effect occurs due to administration of any substance orally or dermal exposure or by inhalation for single or multiple times use will be found out.

According to previous research concluded, due to the presence of CPF many kinds of diseases such as bradycardia syndrome, weakness, diarrhea, paralysis, etc occur. [8]

At the initial stage, symptoms are very simple like headache, body aches, and vomiting but later become chronic which leads to death.

Report accordance with Yadav *et al*., (2000) organophosphates are responsible for mutagenic, teratogenic, carcinogenic, and chromosomal aberration (CA) and many adverse effects such as neurotoxic, hepatotoxic, renal toxic, and reproductive effects.

- **Genotoxic effect of chlorpyrifos**

The Renewal Assessment Report (RAR) explains the CPF effect on gene mutation, CA, and haphazard DNA synthesis. Abdelaziz *et al.*,[1] performed a comet assay and found CPF is responsible for CB, and DNA damage. In additional Cui *et al*.,[4] reported CPF can haphazard DNA synthesis.

According to EFSA[7] CPF induces oxidative stress in many tissue and type of tissues which destroy or damage vital components of human beings such as protein, lipid, DNA, etc. Ojha *et al*.,[24] concluded that after 24hr exposure of CPF shows substantial damage in the tissue of brain, liver, and kidney.

Lu *et al*.,[20] suggested that CPF restricts the topoisomerase II which causes DNA damage. Hernandez and Manendez [12] considered a connection between CPF and newborn leukemia. Serpa et al.,[32] affirm that CPF has genotoxic potential they observe that due to its genotoxic potential causes Chromosomal Aberration, alteration in leukocyte concentration, apoptosis, and micronuclei [9].

- **Endocrine Disruption/ Reproductive Toxicity of CPF.**

Many organophosphates including CPF are highly toxic insecticide which has the ability to induce the phosphorylation of proteins and inhibit the acetylcholinesterase enzyme. At the time of pregnancy exposure of CPF can export to the fetus through the placenta, which shows a major effect on infant health and growth [38]

and also causes congenital disease, and neurological deficiency. Maternal exposure causes acute lymphoblastic, leukemia, breast cancer, and chromosomal aberration [37, 43].

Current studies concluded that CPF is responsible for thyroid, and adrenal gland disruption [16, 36] in mammals. Salazar-Arrendonda *et al*.,[29] experimented on mice and indicate CPF affects spermatogenesis which shows poor sperm quality so concluded that CPF has the ability to disrupt the endocrine gland. Heikal *et al*.,[11] concluded due to disturbance in mitochondrial function no. of ATP reduces which shows decrement in sperm mobility and abnormal sperm physiology.

- **Neurotoxicity Due to CPF.**

We can say directly or indirectly CPF is present in the environment and many studies concluded that CPF is neurotoxic which depends on the duration and quantity of exposure [26]. The researcher said CPF is brain development sensitive [33].CPF shows a negative impact on toddlers' behavior by creating difficulties in learning and memorizing. It is degenerative for both the peripheral nervous system and the central nervous system. Current studies explain CPF may induce the development of autism, Parkinson's disease, and other brain-related diseases.

Derivatives of CPF and CPF itself have an ability to inhibit Acetylcholinesterase due to which accumulation of acetylcholine, and breakdown of neurotransmitters take place. After that increment is shown in chloregenic synapses activity in neurons and neuromuscular junction, so this accumulation leads to neurotoxicity [39].

• CONCLUSION

CPF is considered a soil, water as well as air pollutant. It contaminates the entire environment including microbiota, and soil enzymes, and restricts N_2 – fixation. The exploitation of CPF shows the deficiency of soil enzymes, decreases the root and shoot length of the plant, decreases the carbon dioxide assimilation ability of plants, and nitrogen metabolites of leguminous plants, which affect so badly to the agriculture [17]. It creates pollution in soil, air & water pollution by various ways.

CPF is mutagenic, carcinogenic, and teratogenic. Its effect is shown in the genes of the organism and is responsible for major changes. It is responsible for CB, DNA damage, alteration in leukocyte concentration, apoptosis, and micronuclei [9], major effects on infant health and growth[38] also cause congenital disease and neurological deficiency. CPF may cause acute lymphoblastic, leukemia, breast cancer, and chromosomal aberration [37, 42]. shows a decrement in sperm mobility and abnormal sperm physiology. autism, Parkinson's disease, and other brain-related diseases are also responsible for hepatotoxicity and renal toxicity. So the application of microorganisms and herbal extracts for the removal of CPF and its toxicity from surroundings has become the aim of researchers for the purpose to create an eco-friendly environment.[18]

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