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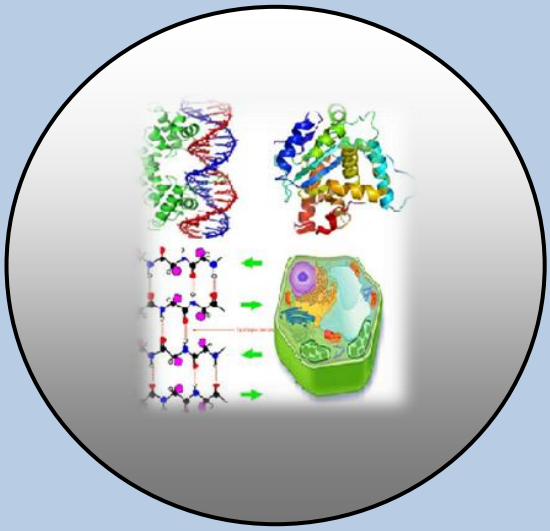

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RESEARCH PAPER
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Toxicity due to Excessive use of Pesticides and its Management

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ABSTRACT

Pesticides continue to be a significant and growing component of modern agricultural system. The relation importance of pesticides has increased despite the availability of alternatives to exclusive chemical pest control such as varietal resistance and integrated pest management (IPM). But the increasing intensive pesticide use has resulted in side effects on the biotic flora and fauna, including man. In this paper, we have discussed the hazards and pesticide management in general.
Keywords: Toxicity, Pesticides, Management and Integrated Pest Management.

INTRODUCTION

The usage of pesticides has been observed during last few years in India. The various forms in. which the pesticides arc used are insecticides, rodenticides, fungicides, herbicides, fumigants etc. Although protective value; of pesticides and the enormous contribution towards crops production can never be ignored, their indiscriminate and promiscuous use posed several contaminants of crops, cereals, various foodstuffs, milk etc. and have become one of the major source of pollutants in the contemporary life. Ideally pesticides toxicity deems to be highly selective to pests, all the pesticides may produce certain adverse effects on being exposed to human. As a result several incidences of mortality/morbidity have been observed in India.

Chemically, these pesticides may be grouped in three major groups' halogenated hydrocarbon and non-halogenated hydrocarbon pesticides, organo-phosphorus pesticides and miscellaneous group dealing herbicides, fungicides, Fumigants etc.

Understanding the various toxicological aspects of pesticide would enable us to bring up more adequate measures for their risk assessment and management.

PESTICIDE TOXICITY

The organochlorine pesticides are widely used as insecticides and aldrin, dieldrin, endrin, endosulphan, heptachlor, toxifen, lindane, chlordione (kepone), DDT etc. These pesticides are CNS stimulant and convulsant. Being hydrocarbons, they may sensitize heart, adrenal medulla, central cardivascular centres to produce ventricular fibrillation. The acute toxic manifestations include vomitting, gastrointestinal upset, dizziness, tremors, convulsion and respiratory failure. Chronic or residual toxicity is of major concern and includes non-specific hepatic damage, hepatic microsomal proliferation, impaired physiological immunological and endocrinal functions, CNS changes etc. The DDT is a potent hepatic microsomal inducer and may increase the toxicity of various compounds. Stray reports of carcinogenicity due to certain chemicals are also present. Another vital group of pesticide consists of organophosphorus compounds which exert their biological effect through inhibition of ChE enzyme (Aldrige et al., 1967). This results in accumulation of Acetylcholine and its toxic manifestations (Gopal et al., 1982). Although relatively quite safer than organochlorine pesticides, these chemicals have much higher acute toxicity. Several accidental and intentional fatal poisoning have been recorded. The important chemicals of this group are malathion, parathion, tetraethylpyrophosphatc (TEP), octamethy pyrolphosphomide, paroxone, etc. The local effects are meiosis, occular pain, conjunctivitis, water discharges from eyes, nose, tightening of chest, wheezing respiration, vomitting, abdominal cramps, diarrhoea, extreme sweating and lacrimation, bradycardia, hypotension, generalised weakness, twitching, convulsion, improper speech, ataxia, hypersensation, laryngospasm, respiratory failure, Coma and death primary due to respiratory incapacitation. These effects are mediated through muscarinic and nicotinitic cholinergic system. In addition, chronic exposure to certain organophosphorus compound like triarylphosphate can produce a peculiar neuropathy characterized by demylination and axonal degeneration. Clinically it is presents in the form of severe polyneuritis which develops several days after exposure to a sufficient single or cumulative amount of toxic compound. Experimental myopathies that result in generalised necrotic lesion and changes in motor and plate are also observed following chronic treatment with organophosphates (Lasowski et al., 1977). Besides, organophosphorus pesticides are known to produce depression. A significant relationship of clinical depression, increase in blood ChE activity and the time-course effect was observed (Gaines et al., 1965, Murphy et al., 1963). Usually depressive symptoms appears when blood ChE activity falls below 50%. However, no direct relationship between the symptoms and the blood ChE levels could be observed (Altnok and Capjub, 2007). The toxicological aspects of carbamate insecticides are similar to organophosphorus pesticides. Certain fumigants usually in gaseous forms contain cyanides which are invariably highly lethal to mankind. The rodenticides like warfarin and red squills are potent anticoagulant and cardiotonic respectively and may be toxic to man (Brown et al., 1967, Kashyap and Gupta, 1971). The use of zinc phosphite, phosphorus, Thallium, certain fungicides are known to produce varying toxicity and carcinogenesis by later in humans.

1. Risk Assessment

Experimental study in animals-Toxicological aspects of pesticides are studies through experimental studies in animals to unravel the possible adverse effects in mammals including humans.

(a) Acute Toxicity Study

Lethality of the pesticides including acute ID_{50} are determined using oral, dermal or pulmonary route. Atleast 5 animals, not older than young adults of either sex and of two different species preferably one rodent and other mammal are used. The lethality of the pesticides is estimated by use of a series of three or more dose levels which increases in geometric progression. For the purpose of this study, a precise LD_{50} value is not required.

The duration of exposure may be either short, for example, a single injection of intubation or continuous such as in the food or water. The total duration of exposure should not exceed 24 hrs. An observation of I4 days duration is made on each animal following treatment. Daily observations are made regarding signs of toxic effect. Weight, organ function, absorption and excretion are recorded at the beginning of the study and later at weekly intervals. Pathological studies are done after necropsy using histopathological procedures.

(b) Subacute Toxicity

The aim is to study and predict the toxic effect which may occur in the animals during the chronic administration of pesticides.

The Two healthy species rat/dog/monkeys are selected since they have been sensitive to pesticides and have metabolic patterns resembling humans.

There dose levels are tested. The highest being the one that produces clinical sign of toxicity, pathological lesions and mortality. The remaining dose level is tested and should be fraction thereof e.g. 1/2, 1/4 etc. or 2.5x ED_{60} and relation to proposed clinical dose. These are administered daily.

Daily observations are made for clinical signs of toxicity such as changes in appearance and behaviour, rate of body weight gain, urine and blood analysis including hematology. Body weigh are recorded weekly whereas haematogram and blood chemistry are done monthly.

At the end of treatment period, all animals are sacrificed and necrotised. Pathological studies of various organs are done.

2. Teratology

The studies are conducted in three different species viz. rats, rabbits and monkeys. The test pesticide is administered from day 6 through day 15 of pregnancy for rat, day 6 through day 18 for rabbit and day 15 through 45 postgestational period for monkey. Foetuses are delivered by caesarean section 1 or 2 days prior to parturition. Following observations are made:

(a) Number of implantation in each horn.
(b) Number of corpora lutea in each ovary.
(c) Number of dead foetuses.
(d) Number of resorption : early/late.
(e) Number of foetuses (live or dead).
(f) Weight of each foetus.
(g) Any external anomaly in the foetus.

1/3 of foetuses are selected randomly and fixed in 10% alcohol for further dissection or alternatively slicing method of Wilson to discover visceral anomalies 2/3 of the foetuses are cleaned in 1% KOH and stained with Alizarin red for bon staining to detect skeleton anomoly.

Further it is crucially important to study the toxic aspects of various biotransformation products of parent's pesticide.

Certain specific toxic studies should also be conducted to detect neurotoxicity and carcinogenicity of new pesticide as a mean of safety evaluation.

(a) Evaluation of Pesticide Residues

The pesticide residues are progressively increased in crops, cereals, vegetables, soil, water, air etc. The analysis of pesticide residues is immensely needed to monitor food stuff for pesticides; Development of accurate, cheap and quick methods has been the basic objective for residue analysis. Bioassay method is still extensively used in India since it does not require any specific equipment. The chemical assay is conducted using various technology viz, calo. imetric method, thin layer chromatography (TLC), Gas liquid chromatography (GLC). There is need to use multiple methodologies so as to confirm the identity of these pesticides. Recently the use of infra-red, ultraviolet and more advanced mass spectroscopy has further facilitated precisely the identification of the pesticides. The pesticide residue analysis has many complexities starting from the point of sampling to the point of estimating the residues. In the light of the present knowledge of the parent chemical pesticides and their metabolites, the chemical estimations by using GLC, TLC or other assay techniques do not seem to throw light on the potential hazards. Since, the residues are present almost invariably in multiple combinations, a version of the concept of Permissible limits, tolerance and analysis of the residue is warranted. The interaction of the multiple compounds in presence of different types of substrates do results in various degrees of toxicological syndromes. The analysis of residue should be directed more towards the measurement of their potential effect on the cell, tissue or the organism as a whole. A bioassay coupled with the chemical assays, such as TLC or GLC related methods, done concurrently would offer more reliable index to potential toxicity. In the field of pest control, selective manipulation of the populations of hosts and parasites with and integrated application of biological, chemical, physical and ecological methods are required.

(b) Evaluation of Pesticide Residue in Humans

There is a great need to develop sophisticated in-vivo methods of quantifying the pesticide residue in humans. Certain methods have been quite promising is this area (4). The inhibition of blood choline esterase is considered a reliable index of absorption and severity of exposure of organ phosphorous pesticides. This is the most valuable parameter which can be employed in the assessment, diagnosis, treatment and prevention of organophsphorus pesticides. The greatest practical value lies in understanding routine to these chemicals. More than 25% fall in the ChE activity from the pre-exposure value considered significant for organophosphate pesticides. Currently the ChE in R.B.C. is considered a more reliable index than that of whole blood assay.

3. Precise Determination of Acceptable Daily Intake

It is the daily dose of a pesticide which, during an entire life time, appears to be without appreciable risk on the basis of all the known tests. Certainly is achieved here that injury will not result even after a life time exposure. It is expressed as mg/kg/day.

4. Precise Determination of Permissible Level

The permissible concentration of a residue in food when first offered consumption is calculated from the acceptable daily intake, the food factor and the average weight of consumer. The permissible level is expressed in ppm of the fresh weight of the food.

5. Precise Determination of Tolerances

It is the permitted concentration of residue actually remaining when food is first offered for consumption following good agricultural practice and the permissible level. The tolerance is also expressed as ppm. It is never greater than the permissible level for the food in question and usually smaller. The known pesticide, therefore, can be added to food in a quantity which does not exceed the permissible limit of same.

Frequent inter-laboratory exercises and comparative evaluation of the various index, values should be conducted to ensure more protective measures.

6. Chronic toxicity of the pesticides should also be done in light of dietary deficiency, dietary habits and climatic conditions.

Dietary habits may altogether alter the amount of pesticide consumption. Similarly malnutrition may potentially exacerbate the toxicity of pesticide. Temperature plays a vital role in the rate of absorption of pesticide residue.

MANAGEMENT

1. Primary prevention i.e. restricting or minimizing the exposure of pesticides should be our prime objective.
2. The use of less persistent and safer pesticides should be recommended. Organophosphate pesticides should be preferred to organochlorine pesticides. Malathion, parathion and others should be made easily available. The uses of food grains protectants already approved by WHO/FAO and Codex Aimentariens Commission should only be promoted.
3. Injudicious, uncontrolled use of pesticides should be restricted.
4. The Observance of Required Waiting Period
   This should always be considered depending on the dissipation of pesticides on agricultural commodities. The studies should further be directed in our condition to determine the period during which pesticides deposits will get dissipated to a level below the tolerance level as established by Codex Aimentariens Commission and Joint Pesticides Committee of the WHO and FAO.
5. The home processing of agriculture products should be emphasized particularly for those vegetables and fruits which are intensively treated with pesticides. Proper cooking also reduces the pesticides residues considerably.
6. Regular and period analysis of portable water and edibles for pesticides, residue particularly for DDT should be carried out. This will ensure lower levels of pesticides in raw water and to improve the water treatment procedure for eliminating the pesticides.

7. For the occupationally exposed people and pesticide applicator, the contaminated air could pose serious hazards and therefore, adequate precautions and safety equipments should be devised, Adequate precautions are essential for the workers in the pest manufacturing/formulating plants and people concerned with the storage, transportation and sale of pesticides.
8. A common pattern should be evolved which could provide formulations for the use of pesticide, Firstly, there should be collaboration between manufacturer, researcher and the Govt. department. Second requirement is the guidance to former for their proper use. Thirdly provision of punitive action should be coined against illegitimate and uncontrolled use of pesticides. These aspects further require qualifying farmers, to establish sensitive analytical procedure for pesticide residue, toxicological between agricultural, health and nature conservation personals to agree on the conditions for the use of pesticides.
9. Pesticide Act and prevention of food Adulteration act should be reconsidered according to recent advancement. The tolerance of pesticide residues laid down in India in the rules made under the Prevention of Food Adulteration Actare arbitrary. We may consider the question of accepting the tolerances recommended by the Join pesticides Committee of the FAO/WHO to being with, but should develop the rational to arrive at such tolerances, i.e. permissible contamination levels. Permissibility of the residue in foodstuffs should be considered while using any pesticide as protectant.
10. Adequate measures should be developed for processing the removal of pesticide residue. The detoxification of effluents of manufacturing and formulating plant should be adequately carried out.
11. Prompt detection and early treatment of pesticide toxicity i.e. secondary prevention would minimise the lethality Physicial should have through awareness of industrial toxicology. The emergence of cholinesterase reactivators have totally revolutionised the treatment of organosphosphorus pesticides. Further pesticides may also potentially interact with drugs and may distort, decrease of increase their effect. Certain drugs are contraindicated in pesticide poisoning and should be avoided e.g. use of CNS stimulant in organochlorine and cholinergic against in organophosphate poisoning. A proper guidelines for the use of antidotes and their availability should be ensured.
12. Lastly, an active consideration towards maximum Allowable Concentration (MAC). Threshold Limit Value (TLV), Short Term Exposed Limit (STEL), Bilogical Threshold Limit Values are immensely needed in all the pesticide manufacturing factories. All the same it is crucially essential that toxicologist should keep these factors in mind while carrying out their predictive responsibilities, safety evaluation and in the process of diagnosis and treatment of a given pesticide.

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