CONCLUSION AND RECOMMENDATIONS

Conclusion

Endosulfan is mutagenic to bacterial test systems only in the absence of exogenous metabolic activation system. The mutagenicity was strong in case of *Salmonella* strain TA 102. Nonetheless, mutagenicity should be tested in sensitive strain like *Eschrichia coli* WP_2 uvrA with or without plasmids, since these strains are similar to *Salmonella* strains TA 102 in terms of sensitivity to mutate, for further confirmation.

Endosulfan was found to induce toxicity and clastogenicity in mammalian cells. The mutagenicity of Endosulfan is equivocal for mammalian cells. On one side it gives clear increase in clastogenic response and induces various chromosomal aberrations while on the other side somatic cell mutagenicity was not found in single trial of short term exposure. An experimental design including long term exposure with repeat experiments is required to detect mammalian cell mutagenicity as short term exposure may lead to death of the mutant cell (during 7 days expression period, CHO HGPRT assay) or expression period should be reduced to select mutant cells for expression. Therefore, confirmation on mutagenicity should be taken only after performing more sensitive test like mouse lymphoma assay (MLA).

Endosulfan is extremely toxic which leads to mortality on acute dosing and becomes clastogenic when applied repetitively both *in vitro* and *in vivo* tests.

Systemic exposure is all neurogenic type and clearly detected by increase in cholinesterase levels in serum. The hazards of Endosulfan is clearly due to targeting to the nervous system as is detected by the symptoms observed after exposure (all pertaining to nervous system) therefore, it is extremely toxic to the living system.

Endosulfan induces abnormality in sperm head and tail morphology. The anueniginecity of Endosulfan is very clearly detected by repetitive 28 days micronucleus test. This may be because Endosulfan takes time to get absorbed in to the mammalian system. The menace of Endosulfan induced malformations in human being could be related to its anuegenicity and gamete abnormality However, further carefully designed study on reproductive and developmental toxicity needs to be undertaken in order to consolidate the current notion.

Recommendations

The indications are that Endosulfan poses serious risks to human health, especially under conditions of use in developing countries. Indeed, the chemical has been implicated in scores of cases of accidental death across the globe and long-term exposure has been linked to a range of serious disorders among villagers of southern India.

This pesticide kills indiscriminately, affecting not only pests, but also a range of other harmless or beneficial insects, with similar ramifications for species further up the food chain. Endosulfan's ability to harm is reflected in its mutagenic, aneugenic and systemic toxicity. This document presents ample evidence that Endosulfan might pose considerable risk to humans and the environment. In light of this the following recommendations are made:

Endosulfan is a highly dangerous, outdated chemical, the safe use of which cannot be guaranteed by many poor countries where it is still used. Governments should ban Endosulfan use, and Designated National Authorities in countries that are signatories of the Rotterdam Convention (India is party since 2005) should propose the chemical for inclusion in the Convention's Prior Informed Consent procedure. Endosulfan is already referred Chemical Review Committee (CRC 2) to be included in Annexure III. However, the decision is still pending.

Endosulfan is a persistent chemical that has been demonstrated to bioaccumulate in exposed organisms. As such, it should be included on the list of Persistent Organic Pollutants targeted for global elimination by the Stockholm Convention to further promote better practice. The World Health Organization should upgrade Endosulfan from Class II (Moderately Hazardous) to Class Ib (Highly Hazardous), in line with the USA's EPA classification. Such a move would assist many countries, which has banned all Class Ia and Ib chemicals, to promote safer agrochemical practices.

Safe alternatives to Endosulfan must be researched, identified and widely promoted. Pesticides Action Network Asia-Pacific lists a number of alternatives to Endosulfan use in different agricultural contexts. These include use of botanical pesticides (neem extracts) and parasitic wasps in rice production, and the use of baculoviruses, natural enemies and pheromone traps to control cotton pests (Source: Environmental Justice Foundation Ltd. www.ejfoundation.org).

Ultimately, the action most ably protecting human and environmental health would be the withdrawal from sale of Endosulfan. This requires the agrochemical industry to rapidly phase out production of Endosulfan and to dispose of all stockpiles safely.