THE COMPARATIVE TOXICITIES OF ORGANOPHOSPHORUS AND CARBAMATE PESTICIDES

ABSTRACT

Bioassay studies with organophosphorus and carbamate pesticides were conducted on the survival of the larvicidal fish, *Panchax panchax* var. *blochi* (Arnold). The median tolerance limit (TLm or LC_{50}) was calculated for 48 and 96-hr exposure of fish to various concentrations of the pesticides. Using 96-hr TLm value, the maximum permissible levels of the pesticides were also determined. On the basis of tolerance studies, it is observed that Phosphamidon is the least toxic and Cuman is the most toxic to the fish.

It is well known that pesticides as pollutants will influence the web of life by affecting mostly calcium metabolism and thereby endangering the reproductive potential of animals, particularly in the case of oysters, fish and birds. As reported by Ehrlich and Holdren (1971), the first victims of pesticides are fish and birds. Some earlier studies in India, on the toxicities of pesticides are those of Sreenivasan and Natarajan (1966), Srivastava and Konar (1965), (1966), Sreenivasan and Swaminathan (1967) and Bhatia (1971a & b). It is observed that information available on the effects of pesticides on the animals is still very scant. From this view point, detailed and comparative investigations have been taken up to assess the toxicity of organophosphorus pesticides like Dimecron, Phosphamidon, Nuvan, D.D.V.P., and one carbamate compound, Cuman, on the survival of the larvicidal fish, *Panchax panchax* var. *blochi* (Arnold). This species of fish is stocked widely in ponds of south India for the eradication of mosquitoes. Similarly, a variety of carps was introduced in Tokyo's Kanda river in Japan and elsewhere to control the mosquito menace. The present work undertaken by the author forms a part of the bioassay studies on animals from the aquatic environment in relation to pollution monitoring sponsored by the National Institute of Oceanography.

Glass troughs of the height 35 cm and mouth opening 17 x 24 cm were used for experimental work. Specimens of the larvicidal fish, *Panchax panchax* var. *blochi* were collected from a stream in Goa and acclimatized to laboratory conditions in tap water in two large aquaria for a period of seven days; they ranged in size from 3.5 to 4 cm in length. During acclimatization period the fish were fed daily on fish food. The feeding of fishes was stopped two days before their use in any test and kept without feeding till the end of the experiment. Procedures adopted for conducting bioassay studies with the toxicants are those of Doudoroff *et al.* (1951), Tarzwell (1965) and Sprague (1969). According to them, the fish should not be fed during

the exposure period (96 hr or less) to any toxicant since feeding accelerates respiratory metabolism and increases the metabolic wastes thereby affecting the toxicity of the medium. Salinity of the tap water was 0.084‰, temperature, 29.5°C and pH, 7.85. Ten fishes were used in each experiment. The effects of the pesticides of various concentrations were studied on the survival of the fish for different periods of exposure - 48 and 96 hr. The median tolerance limit or LC_{50} of the different pesticides was calculated by the straight line graphical interpolation method. Also, maximum permissible levels of the pesticides in the water for the fish under investigation were determined using the 96-hr TLm value.

Among the pesticides it is established now that chlorinated hydrocarbon compounds with the exception of BHC are more toxic than herbicides, organophosphorus, and carbamate products. The pesticides, in general, find their access into the rivers, estuaries and then finally into the sea by land drainage systems. For example, the Mississippi river carries about 10,000 kg of pesticides into the Gulf of Mexico annually and about 1900 kg by the San Joaquin river in California per year into San Francisco Bay. Still, no such figures for the amount of pesticides carried by rivers in our country are available even though they are suspected to be carrying sizable amounts. It is absolutely essential that while using pesticides for crops, one has to *select* the least toxic replacing the most toxic one without endangering the environment. The chemical composition of the pesticides used here for determining the toxicity are :

1. Phosphamidon - Dimethyl - (2 - chloro - 2 - diethyl - carbamoyl - 1 - methyl - vinyl) - phosphate. (Active ingredient : Not less than 92% w/w of Phosphamidon).

2. Dimecron - Chemical composition is same as Phosphamidon but not less than 100%w/v. of Phosphamidon.

3. D.D.V.P. - O, O - Dimethyl - 2, 2 - dichlorvinyl phosphate. (Active ingredient : Not less than 92% w/w of D D.V.P.).

4. Nuvan - Similar to. D.D.V.P. but not less than 100% w/v. of D.D.V.P.

5. Cuman - Zinc - N - N - dimethyl-dithiocarbamate.

The results obtained in toxicity experiments on the fish are given in Table 1

On the basis of tolerance studies on the fish tested it can be concluded that the degree of toxicity from low to high of the pesticides is as follows : Phosphamidon, Dimecron, D.D.V.P., Nuvan, and Cuman. Among these pesticides, it is thus found that Phosphamidon is a safe pesticide for the larvicidal fish and Cuman is highly toxic. Elson and Kerswill (1966), working on the toxicity of Phosphamidon to juvenile Atlantic salmon (*Salmo salar* L) have also arrived at similar conclusions. D.D. V.P. has been found to be as toxic as Nuvan. Srivastava and Konar (1966) and Sreenivasan and Swaminathan (1967) found in their studies that D.D.V.P. as a very useful selective fish toxicant. Srivastava and Konar (1965) observed that Phosphamidon also could be utilised for the control of undesirable fish and insects in carp culture. It is seen from the present investigation that Phosphamidon is the safest pesticide. An appli-

TABLE I

Toxicity data for the pesticides

Name of the pesticide	Median tolerance limit 48hr	96hr	Bioassy application factor
Dimecron	37.16 mg/L	23.04 mg/L	0.2304 mg/L
Phosphamidon	48.32 ,,	23.88 ,,	0.2388 ,,
D.D.V.P.	4.21 ,,	3.87 ,,	0.0387 ,,
Nuvan	3.66 ,,	3.42 ,,	0.0342 ,,
Cuman	2.75 ,,	1.94 ,,	0.0194 ,,

cation factor to TLm is widely used in water pollution biology to obtain maximum permissible levels of the toxic substances. In practice as given by Indian Standards Institution, the application factor suggested is 1/100th of the 96hr TLm value for the pesticides. The bioassay application factor of the pesticides for the fish, *Panchax panchax* var. *blochi*, varies from 19.4 to 238.8 µg/L. Thus this aspect of study is important since the present trend in the world is to encourage the use of organophosphorus and carbamate pesticides replacing the persistent and non-biodegradable chlorinated hydrocarbon products, particularly from view point of potential danger to fish.

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