International Journal of Zoology Studies
ISSN: 2455-7269; Impact Factor: RJIF 5.14
Received: 09-12-2020; Accepted: 11-01-2021; Published: 28-01-2021
www.zoologyjournals.com
Volume 6; Issue 1; 2021; Page No. 12-16

Organophosphorus insecticides on non-target species in Manipur: A study on toxicity

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Abstract
Biology studies contributes to the knowledge regarding lethal concentrations and safe concentration of a particular pesticide and helps in its application in agriculture and piscicultural operations in such quantities which do not cause mortality of the non-target organisms. This paper attempts to study complete picture regarding pesticides pollution in the lakes and their effect on non-target organisms, the findings may be used in formulating a policy towards rational used of pesticides in the area with a view to minimize its harmful after effects. The time at which the pesticides are added into the water will be noted along with the room and water temperatures. The findings of the present investigation are in agreement with the work of Jha and Singh (1984). The in descending order against adult *Tribolium castaneum* was Quinalphos (0.004197 ppm) > dimethoate (0.006500 ppm) > (0.008622 ppm) and monocrotophos (0.019440 ppm) as LC_{50}. Thus in their study dimethoate is far more toxicity than malathion but in my present study it is found that malathion is far more toxicity than that of dimethoate.

Keywords: *Pantala falvescens*, chlorpyrifos, monochrotophos, toxicity, melathoin

Introduction

Manipur is one of the eight states of the North East India. It is surrounded by hills and the centre is a small oval shaped valley. The state is having an international boundary of about 352 km. long stretch of land with Myanmar in the south-east and 502 km. long border with the adjacent states of Nagaland on the north, Cachar District of Assam on the west and Chin Hills (Myanmar) and Mizoram on the south and the south-west and Surma Tract and upper Chindwin of Myanmar (Burma) on the east. It is an isolated hill-girt state stretching between 92°58´E to 94°45´E longitudes and 23°50´N to 25°42´N latitude. It covers an area of 22,327 sq. km. which forms 0.7 percent of the total land of India. Rahman, *et al* (2012) Manipur is divided into two regions: hills (90 percent of the region equivalent to 20,089 sq.km) and valleys. Hills are mostly occupied by Nagas (18.72%) and Kukis (6.64%) while Meities (65.57%) including Manipuri Muslims reside in the valley. In Manipur, maximum people reside in rural areas about 74.89 percent of the total population. The major occupation of the state is Agriculture. 70 percent of the population depends upon agriculture. The Agriculture covers almost 11 percent of the total geographical area while rest is covered by forest. The State is rich in bio-diversity as most of the part is under forest cover. IWID Report (2012) [10] the valley of Manipur is drained by many rivers which originate in the northern and north eastern hills of the valley. The soil is alluvial type. The bed-rock is tertiary young in age and is very much suitable for paddy cultivation and other vegetables. The vegetations vary from tropical rain forest to coniferous. Under climate and adapted conditions of high temperature, heavy rainfall, dissected topography and thin soil, the vegetation has almost gregarious growth.

Statement

There are a number of shallow lakes including the Loktak Lake in Bishnupur District. For the people living around the lake the Oksoi lake provides water fish cash crops, vegetables, etc, throughout the year. During winter season, the dried up shallow peripheral areas are used for cultivation of the vegetable crops including cabbage, cauliflower, mustard, etc. while these shallow areas are converted in to paddy field. In Manipur, the organophosphorus insecticides, pesticides are used by the farmers in large scale in agriculture and horticulture for the controlling of harmful insects and pests and they produced increase crop yield and quality. But on the other hand (as a result) with the increasing use of insecticides and pesticides, it causes environmental pollution, disturbance in the ecosystem and it leads to extinction of useful non-target species. It also causes many diseases to human beings through food chain system. Therefore, a research work with an objective to develop ways and means of fighting harmful insects, pests and weeds without effecting non-target species and ecosystem is necessary.

Concept

Organophosphorus (OP) compounds have been widely used for a few decades in agriculture for crop protection and pest control, thousands of these compounds have been screened and over one hundred of them have been marketed for these purposes. OPs constitute a heterogeneous category of chemicals specifically designed for the control of pests, weeds or plant diseases. Their application is still the most effective and accepted means for the protection of plants from pests, and has contributed significantly to enhanced agricultural productivity and crop yields. Subash *et al* (2010) [21] Toxicology is the study of toxic effects of physical and chemical agents – toxicants, on living organism. Pollutant is a wider term that includes toxicants also. A pollutant is an agent in such an amount that produces adverse changes. Pollution of the environment results from the presence of pollutants, in amounts that produces such adverse effects and are generally referred to as toxicants. With varying degrees of pollutions of air, water and soil around, living organisms, knowing or unknowingly absorb significant amount of toxic substances within their bodies, sometimes, ingestion of toxic materials may be intentional or deliberate also and toxic response may or may not appear which depends upon the amounts of material absorbed, chemical properties and behavior of the toxic agents within the living system, but its presence strains the metabolic processes within the body of organisms. The toxic substances and their behavior, effects on living organisms and procedure adopted to reduce or terminate the toxic action come under the purviews of a separate branch of science which we call toxicology. Pesticide are chemicals of varying composition and biological materials that are used by man primarily to reduce or eradicate pest organism which infest and destroy our crop plant and also can devastate human life. Unfortunately the considerable benefits of the use of pesticides are partly offset by some important environmental detriments. An ecologically more pervasive problem is a widespread environment contaminated by persistent pesticides, including the presence of chemical residue in wildlife particularly aquatic life of the disruption of such ecological processes as productivity and nutrient cycling.

Objectives

- To study the toxicity of seven organophosphorus pesticides *viz*. Monocrotophos 36% EC, Endosulphan 16% EC, Chloropyrophos 20% EC, Quinalphos 25% EC, Dimethoate 30% EC and Malathion 50% EC and Dichlorovos 76% EC on the aquatic larvae of dragonflies belonging to the order odonata.
- To study complete picture regarding pesticides pollution in the lakes and their effect on non-target organisms, the findings may be used in formulating a policy towards rational used of pesticides in the area with a view to minimize its harmful after effects.

Research question

- It is said so in Manipur, the organophosphorus insecticides, pesticides are used by the farmers in large scale in agriculture and horticulture, how far it can control harmful or benefit in producing quality crops?
- What are the impacts of increasing use of insecticides and pesticides, in the environmental pollution?

Hypothesis

- Huge amounts of organic pesticides are used widely in agriculture and horticulture for more profit, at the same time production of crops are definitely decreased.
- With the increasing use of insecticides and pesticides it causes nothing to the human beings. So we are required to use plenty amount for the target organisms.

Review of literature

Different studies are found on the concerns of toxicity and insecticides that base on different states and country but no Ph D and research on the proposed theme is carried out so far as it is directly dealt with the issues of toxicity of the species found in Manipur in general and Bishipur District of Manipur in particular. A number of investigations have been carried out on the toxicity of commonly used pesticides on target as well as non-target organisms. Tanja and Stanislav (2017) [23] discussed the efficacy of the substances was tested individually and in combination with each other. The substances were applied at different concentrations, and bioassays were carried out at four different temperatures (20, 25, 30 and 35°C) and two different relative humidity (RH) levels (55% and 75%). The adult mortality was recorded after the 7th, 14th and 21st days of exposure. The progeny production of individuals exposed to different combinations was also assessed. Finding shows that wood ash can be efficient in controlling granary weevil adults as a single substance or in combination with other substances. Further surveys should focus on the impact of the wood ash dose rates. Due to the high percentage of area covered with forest in some European countries, the main ingredient is present locally, but additional surveys are needed to help improve the practical use of wood ash. Rajanish and Rohit (2014) [19] analysis of variance revealed significant differences among all the treatments under study. Seven insecticides, *viz.*, neem seed kernel powder (NSKP), neem cake, dry neem leaf powder (all at 10 g/kg), neem oil (10 mL/kg), nimbecidine (5 and 10 mL/kg) and deltamethrin (Decis 2.5 WP; 40 mg/kg) were evaluated as seed protectant against *Sitophilus oryzae* L. in stored wheat seed (HUW 234). The finding shows that the deltamethrin (Decis 2.5 WP; 40 mg/kg) was found most effective treatment followed by neem India, at higher and lower doses, nimbecidine at higher and lower dose, neem oil, neem cake, dry neem leaf powder and NSKP treatments. Zahid and Samina (2016) [14] analysed on Mortality effect of pesticides against *Tribolium castaneum, and argued that* Toxicity of pesticides *Acorus calamus* (AC), Eucalyptus oil (EO) was tested against *Tribolium castaneum* by Filter Paper Impregnation method (FPIM) after 24 hours treatment. The LC50 of AC and EO was observed that 24.68 µl/ cm2, 0.6510 µl/cm^2 respectively. The LC50 value of Deltamethrin (DM) was found to be 0.016 6µl/cm^2. *Ileke (2013)* [9] *stated that* powders and extracts from *C. frutescens*, *C. citratus*, *M. oleifera* and *A. occidentale* were very effective in suppressing S. *cerealella*. The insecticidal potential of these plants depended on the format and concentration applied. *Capsicum frutescens* powder and extract were especially quick and effective, reducing oviposition, hatchability and suppressing adult emergence. Sushma *et al* (2012) [22] analysed nine synthetic insecticides *viz.*, dichlorvos, chlorpyriphos, deltamethrin, fenvalerate, cypermethrin, thiomethoxam, bifenthrin, endosulfan and malathion, were evaluated against *Sitophilus oryzae* (L.) on maize under storage condition during the year 2009-10. Based on adult mortality, deltamethrin found superior among the various synthetic insecticides followed by thiomethoxam, cypermethrin and fenvalerate, whereas malathion was least effective followed by dichlorvos and endosulfan. On the basis of half-life and gross persistency, deltamethrin, thiomethoxam, cypermethrin and fenvalerate were more effective, while malathion, endosulfun and dichlorvos were less effective treatments. After 6 months of storage, the per cent germination was almost equal in all the insecticides and the effect of various insecticides on germination was non-significant. Effects of temperature and light exposure on the toxicity of deltamethrin, chlorpyrifos-methyl, and malathion against *Tribolium castaneum* were extensively studied using the residual film method by Mansee and Montasser (2003) [1]. The results revealed that mortality increased proportionally with an increase in temperature, where the optimum temperature for the three tested insecticides was 30°C. Toxicity of the tested insecticides could be arranged in the following descending order: chlorpyrifos-methyl > deltamethrin > malathion. Field bioassay to evaluate contact and residual toxicities of insecticides on Carbid beetles was reported by Floate *et al* (1989). John and Martin (1989) also have reported the toxicity, penetration and metabolism of Acephate on three dipteran fruit flies. In 1988, Knowles, C.O., D.D. Errampalli and G.N. El-Sayed studied on "Comparative toxicities of selected pesticides to Bulb mites (Acari: Acaridae) and two spotted spider mite (Acari Tetranychidre)". Evans, N.J. (1985) [8] studied on the effectiveness of various insecticides on some resistant beetle of stored products in Uganda. Jha and Singh (1984) [12] have studied the toxicity of seven different insecticides against adult Tribolium castaneum, a serious pest of all kinds of stored grain. Ottens *et al* (1984) [17] analysed that field and laboratory cultures of soybean looper larvae, *Pseudoplusia indudens* (Walker), were evaluated for dosage response to selected insecticides. Permethrin, monocrotophos, and fenvalerate were most toxic followed in order of descending toxicity by methomyl, acephate and methyl parathion. Field collected larvae showed higher LD_{50} values than laboratory-reared larvae treated with the same insecticide. In 1976 Champ, B.R. and Dyte, C.E. studied on "Global survey of pesticide susceptibility of stored grain pests". Ahmad & Knowles (1972) [3] reported that except for several organophosphates and carbomates, the bulb mites were not toxic to two spotted spider mites. Dittrich, V, (1962) studied on "A comparative study of toxicological test methods on a population of two spotted spider mite". In 1960, Pradha S. and Swarup P. studied on "Relative toxicity on some insecticides of the larvae of Tribolium castaneum (Hbst.) a pest of milled cereals. In 1925 Abbott W.S. studied on "A method of computing the effectiveness of an insecticide".

Methodology

Collection of Test Animals

The aquatic larvae of fourteen different species dragonflies belonging to the order odonata and suborder Anisoptera will be collected with the help of nets from Okshoi Lake in Bishnupur District, Manipur for use as test animals.

Identification

The identification of odonata larvae will be based on Kumar (1973) and Needham (1954).

Preparation of Stock Solutions

The stock solution will be prepared by mixing 1 ml of insecticide will 1000 ml of water. This stock solution contains 0.001 ml of pesticide per 1 ml. By adding the required quantities of the above solution to 100 ml of water, different concentrations in ppm (parts per million) of the pesticides will be obtained. The solution will be thoroughly mixed and will keep in a clean beaker of 1500 ml capacity with graduated mark on the beaker.

Experimental Procedure

Toxicity experiments will be set up using round plastic bottles of 2000 ml capacity. Water from Okshoi Lake in Bishnupur District will be used in the experiments. The bottles will be marked serially as 1, 2, 3, 4, 5 and control. 10 healthy and active odonate larvae were put in each bottle for 24 hour (1 day) before adding pesticides.

Different quantities of the freshly prepared pesticide stock solution will be added in each bottle except the control.

The final volume in the bottles is 1000 ml and the bottles contain different concentration of pesticides in ppm. The mouth of the bottles will be covered with white thin cloths and fastened using rubber band.

The time at which the pesticides are added into the water will be noted along with the room and water temperatures. The larvae will be observed continuously for their response to the chemical. Whenever a larva dies, it will immediately be removed. The total number of larvae died within a period of 24 hours (1 day) will be noted for observation of LC_{50}. Larvae which is ceased to exhibit any movement will be counted as dead.

Result and Discussion

Experiment 1: Toxicity of Monocrotophos 36% on aquatic larvae of *Pantala flavescens* (Fig. 1)

Fig 1: Test for Monocrotophos

Experimental details

Test animal: Pantala flavescens

Water temperature: 18^0C

Room temperature: 16^0C

Weather: Sunny

Time: 11.30 a.m.

pH of water: 7

Observation

1 ml. of Monocrotophos 36% (trade name Monovip) was mixed with 1000 ml of water as stock solution. The six bottles were marked as 1, 2, 3, 4, 5 and control. 1000 ml of water was added in each bottle. 10 healthy larvae were put in each bottle for 24 hours and different quantities of the stock solution i.e. 1 ppm, 5 ppm, 1 ppm, 1.5 ppm & 2 ppm respectively was added in the bottle except the control bottle (Table 1).

On the next day, it was found that no larva was dead in the bottles except that they appear very weak. A second experiment was set up using higher concentrations of the pesticide i.e. 10 ppm, 20 ppm, 30 ppm, 40 ppm, 50 ppm & control (Table 2). LC_{50} (24 hour) was determined as 30 ppm, while LC_{100} was 50 ppm and above. However, a concentration of even 20 ppm result to 40% mortality, and 10 ppm was determined as the LC_0, the concentration at which no mortality of test animals occurs.

Table 1: Toxicity of Monocrotophos 36% EC on aquatic larve of Pantala flavescens

Bottle No.	Volume of water (ml)	Concn. of pesticide (ppm)	No of live animals		Mortality %	LC_{50}
			Before Expt.	After Expt.		
1.	1000	1.0	10	10	0	
2.	1000	2.0	10	10	0	
3.	1000	3.0	10	10	0	
4.	1000	4.0	10	10	0	
5.	1000	5.0	10	10	0	
Control	1000	0.0	10	10	0	

Table 2: Toxicity of Monocrotophos 36% EC on aquatic Larvae of Pantala flavescens

Bottle No.	Volume of water (ml)	Concn. Of pesticide (ppm)	No of live animals		Mortality %	LC_{50}
			Before Expt.	After Expt.		
1.	1000	10.0	10	10	0	
2.	1000	20.0	10	6	40	
3.	1000	30.0	10	5	50	30 ppm
4.	1000	40.0	10	1	90	
5.	1000	50.0	10	0	100	
Control	1000	00.0	10	10	0	

Experimental conclusions

LC_0 = 10 ppm;
$LC5_0$ = 30 ppm;
LC_{100} = 50 ppm.

Conclusion

Biology studies contributes to the knowledge regarding lethal concentrations and safe concentration of a particular pesticide and helps in its application in agriculture and piscicultural operations in such quantities which do not cause mortality of the non-target organisms.

The date presented in different tables have shown that LC_{50} of the seven insecticides on *Pantala falvescens* varies from a minimum value of 0.6 ppm to a maximum value of 30 ppm. The LC_{50} value in case of Chlorpyrifos was lowest (0.6 ppm) and that of monochrotophos was comparatively the toxic pesticide that can be lethal to aquatic larvae of dragonflies at a low concentration. The toxicity of the seven pesticides was in the decreasing order as follows: chlorpyrifos > quinolphos > endosulphan > dichlorvos > malathion > dimethoate > monochrotophos.

The toxicity in descending order on *Pantala flavescens* was chlorpyrifos (0.6 ppm) > quinalphos (1.00 ppm) > endosulphan (1.50 ppm) > dichlorvos (5.40 ppm) > malathion (6.00 ppm) > dimethoate (7.00 ppm) and monochrotophos (30.00 ppm) as LC_{50}.

However, the toxicity of insecticides measured as the value of LC_{100} in descending order on *Pantala flavescens* was chlorpyrifos (1.00 ppm) > quinalphos (2.1 ppm) > endosulphan (2.5 ppm) > dichlorvos (8.00 ppm) > malathion (above 8.00 ppm) > dimethoate (8.00 ppm above) monochrotophos (50.00 ppm).

The findings of the present investigation are in agreement with the work of Jha and Singh (1984) [12]. The toxicity in descending order against adult *Tribolium castaneum* was Quinalphos (0.004197 ppm) > dimethoate (0.006500 ppm) > melathoin (0.008622 ppm) and monocrotophos (0.019440 ppm) as LC_{50}. Thus in their study dimethoate is far more toxicity than malathion but in my present study it is found that malathion is far more toxicity than that of dimethoate.

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