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# Toxicity of Fenvalerate, Fytran and Altracine to a Curly Wood Louse *Cylisticus convexus*

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**Abstract:** The organisms that live in the soil play an important role in the ecosystem by breaking down organic matter, cycling nutrients, and stabilising the soil structure. Agrochemicals have been used in farming for a very long time to prevent pests and diseases from spreading to crops and lowering agricultural output. However, the majority of them are poisonous to non-target species and may have a deleterious effect on beneficial soil macroinvertebrates. This study evaluated the toxicity of commonly used agrochemicals (fenvalerate, fytran and altracine) on soil isopod, *Cylisticus convexus*. The findings of the trials showed that even at low doses, all of the agrochemicals examined, including fenvalerate, fytran, and altracine, are very hazardous to the test animal. The results of the current study's LC<sub>50</sub> and LC<sub>100</sub> values highlighted the toxicity of these compounds to soil organisms like *Cylisticus*. Additionally, the habitat of soil isopods is threatened by the lingering effects of these agrochemicals in the soil.

**Keywords:** *Cylisticus*, Soil isopod, Agrochemical, Curly wood louse, Toxicity, LC<sub>50</sub>

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## Introduction

Isopods group of organisms play a dominant role to increase soil fertility. Indiscriminate use of pesticides, herbicide and fungicide for agricultural purposes has deleterious effects on the biology of soil arthropods. The chemical treatments that eliminate the group of microorganism undoubtedly create a partial biological vacuum in soil. Many pesticides, fungicide and herbicides can kill more than just their intended targets, namely

necessary microorganism in the soil. Once in the soil, they can kill the microorganism living in the soil that breaks down organic material and aid in plant growth.

Pesticides are the worst enemy of many of the soil organisms. Pesticides widely affect the life of aquatic fauna which are manifested as change in physiology, biochemistry and activity levels of many enzymes. In isopods, digestive gland

epithelial thickness is related to contaminated food (Odendaal and Reinecke, 2004). Drobne *et al.* (2008) reported the occurrence of epithelial thinning as a result of stress and that reduced feeding rate which coincides with reduced epithelial thickness. The action of pesticide may bring external or internal damage to many parts of the organism.

Few studies on toxicity to soil invertebrates were published, including earthworms, springtails and enchytraeids (Wislocki *et al.*, 1989; Sun *et al.*, 2005; Jensen *et al.*, 2007; Kolar *et al.*, 2008). However, its effects on terrestrial isopods are not well known (Kolar *et al.*, 2008). Terrestrial isopods are abundant in different ecosystems and habitats, and have an important ecological role as macro decomposers. These animals have been recognized as useful for the characterisation of chemical toxicity (Hornung *et al.*, 1998; Walker *et al.*, 2001), because they are easy to sample, handle and culture, and large enough to perform a variety of sub-organism studies. A multi-level approach in toxicity testing with terrestrial isopods has previously been successfully used to identify the hazard of different pesticides and nanomaterials (Stanek *et al.*, 2006; Drobne *et al.*, 2009). Due to their important ecological role as decomposers of organic material, terrestrial isopods are widely accepted as test organisms in terrestrial ecotoxicology and ecophysiology (Lapanje *et al.*, 2007).

Pesticide can serve farmers money by preventing crop losses to insect and other pests. Pesticide can be classified by target organism, chemical structure, and physical state. Pesticide can also be classified as inorganic, synthetic, and biological. Like modern insecticides, herbicides were first applied on a large scale basis shortly after World War II.

A preliminary survey in the study area revealed that agrochemicals of common use in the study area are fenvalerate, fytran and altracine. This study evaluated the toxicity of commonly used agrochemicals, fenvalerate, fytran and altracine on soil isopod, *Cylisticus convexus*.

## Materials and Methods

*Cylisticus convexus* were collected from the study area. They were transferred to large culture chambers of Plaster of Paris and activated animal charcoal in the ratio 5:2 as base. They were acclimatized in the laboratory conditions for about 20 days prior to experiment. Decayed leaf bits soaked in water were given as food.

### *Collection and rearing for subculture:*

#### *Preparation of subculture medium:*

Large plastic containers were used as culture bottles; sterile plastic bottles were kept in oven for 24 h at 40°C. Plaster of Paris and activated animal charcoal in the ratio 5:2 mixed in distilled water were kept in this chambers for setting. This was used as a base and these bottles were fixed with water for thorough setting for a period of 24 h.

#### *Collection from soil and extraction:*

Soil samples were collected from Thirunelveli districts of Tamil Nadu and Pathanamthitta districts of Kerala, India and the work was carried out during December, 2019. The soil samples were loaded to series of Berlese funnel for the extraction of organisms. 40 W bulbs were illuminated above each funnel for a period of 24 h to extract the micro arthropod of the soil into a beaker containing thin layer of water. The collected live *Cylisticus convexus* were transferred to culture bottle to acclimatize in the laboratory conditions. Cleaned decayed leaves and wood pieces were given to them as food.

#### *Preparation of Stock Solution of Agrochemicals:*

1000 ppm stock solution of fenvalerate, fytran and altracine was prepared by dissolving required quantity of chemicals in 1 L of distilled water (APHA, 2005). From this stock solution different concentration of pesticide, fungicide and herbicide were prepared for bioassay.

#### *Bioassay:*

Various concentration like 1,3,5,7,9 and 11 ppm fenvalerate, fytran and altracine were prepared from stock solution. A group of 150 mature

isopods in three replicates and a control were tested for each concentration of these agro chemicals. Leaves were dosed with pesticide as described by Stanek *et al.* (2006). The food (Decaying leaves) was soaked in respective concentration of pesticides for a period of 24 h and was given to experimental animals and leaves soaked in distilled water was given to control animals. The mortality was recorded at 48, 72 and 96 h interval and the percentage mortality at different hours were calculated.

#### **Toxicity Analysis:**

From the data of bioassay, lethal concentration - 100 (LC<sub>100</sub>) lethal concentration - 50 (LC<sub>50</sub>) and safe level concentration were calculated. LC<sub>50</sub> value was calculated by Probit analysis (Finney, 1980) and safe concentration was determined by the method suggested by Hart *et al.* (1945).

#### **Determination of Lethal Concentrations (LC<sub>100</sub>, LC<sub>50</sub>) and Safe Level:**

Lethal concentration-100 (LC<sub>100</sub>) and Lethal Concentration-50 (LC<sub>50</sub>) was calculated using Probit analysis by Finney (1980). Sub-lethal concentration was calculated following the method described by Loomis and Sternberg (1968). One third (1/3) of the LC<sub>50</sub> was taken as sub-lethal concentration.

## **Results and Discussion**

#### **Mortality:**

##### **Fenvalerate:**

Percentage mortality of *Cylisticus convexus* at different hours following fenvalerate exposure is given in Table 1. The increase in mortality was gradual as the concentration of the pesticide increases. 14.8, 22.8, 30.6, 37.9, 72.6 and 80.8% mortality was recorded for 1, 3, 5, 7, 9 and 11 ppm concentration of fenvalerate, respectively at 48 h. 14.8, 30.6, 38, 49.8, 78.7 and 90% mortality was recorded for 1, 3, 5, 7, 9 and 11 ppm concentration of fenvalerate at 72 h, respectively. 16.8, 40.8, 56.8, 64.3, 94.9 and 100% mortality was recorded for 1, 3, 5, 7, 9, and 11 ppm concentration of fenvalerate at 96 h, respectively.

##### **Fytran:**

There was a gradual increase in the mortality as the fungicide concentration increases. 17.7% mortality was observed for 1 ppm concentration of fungicide at 48 h. 100% mortality was observed for 11 ppm fytran at 96 h. 75.9, 86.8 and 100% was the mortality rate when *Cylisticus* were exposed to 11 ppm fungicide at 48, 72 and 96 h, respectively (Table 2).

##### **Altracine:**

The increase in mortality was gradual as the concentration of the herbicide increases. 27.8, 31.8, 37.6, 44.8, 66.9 and 74.8% mortality was recorded for 1,3,5,7,9 and 11 ppm concentrations of altracine, respectively at 48 h. 32.8, 44.9, 48.6, 56.8, 82.8 and 94.8% mortality was recorded for 1,3,5,7,9 and 11 ppm concentrations of altracine at 72 h, respectively. 40.6, 42.6, 56.5, 86.9, 96.2 and 100% mortality was recorded for 1, 3, 5, 7, 9 and 11 ppm concentrations of altracine at 96 h, respectively (Table 3).

#### **Lethal concentration 100 (LC<sub>100</sub>) and lethal concentration 50 (LC<sub>50</sub>):**

##### **Fenvalerate:**

Lethal concentration 100 of Fenvalerate was found to be 21.386 ppm (48 h) and 19.924 ppm (72 h) and 17.459 ppm (96 h). The LC<sub>50</sub> values were calculated to be 13.116 ppm (48 h), 11.949 ppm (72 h) and 10.224 ppm (96 h). The LC<sub>100</sub> values of fenvalerate is quite high for *Cylisticus convexus* (Table 4).

##### **Fytran:**

The LC<sub>100</sub> value of fytran was 8.424 (48 h), 7.156 (72 h) and 5.906 (96 h). The LC<sub>50</sub> value was found to be 4.079(48 h), 3.156 (72 h), and 2.581(96 h) (Table 4).

##### **Altracine:**

The LC<sub>100</sub> value of altracine was 4.712 ppm (48 h), 3.765 ppm (72 h) and 3.233 ppm (96 h). The LC<sub>50</sub> values were calculated to be 2.377 ppm (48 h) 1.865 (72 h) and 1.568 (96 h), respectively (Table 4).

Table 1: Percentage mortality of *Cylisticus* exposed to different concentration of fenvalerate

Concentration (ppm)	Mortality (%)			Control Mortality %
	48 h	72 h	96 h	
1	14.8	14.8	16.8	0
3	22.8	30.6	40.8	0
5	30.6	38	56.8	0
7	37.9	49.8	64.3	0
9	72.6	78.7	94.9	0
11	80.8	90	100	0

Table 2: Percentage mortality of *Cylisticus* exposed to different concentration of fytran

Concentration (ppm)	Mortality (%)			Control Mortality (%)
	48 h	72 h	96 h	
1	17.7	26.9	32.8	0
3	23.9	37.9	39.6	0
5	42.8	43.6	52.9	0
7	46.8	54.8	64.8	0
9	52.9	75.8	92.8	0
11	75.9	86.8	100	0

Table 3: Percentage mortality of *Cylisticus* exposed to different concentration of altracine

Concentration (ppm)	Mortality (%)			Control Mortality (%)
	48 h	72 h	96 h	
1	27.8	32.8	40.6	0
3	31.8	44.9	42.6	0
5	37.6	48.6	56.5	0
7	44.8	56.8	86.9	0
9	66.9	82.8	96.2	0
11	74.8	94.8	100	0

Table 4: LC<sub>100</sub> and LC<sub>50</sub> (in ppm) of different agrochemicals at different hours

Chemicals	LC <sub>100</sub>			LC <sub>50</sub>		
	48 h	72 h	96 h	48 h	72 h	96 h
Fenvalerate	21.386	19.924	17.459	13.116	11.949	10.224
Fytran	8.424	7.156	5.906	4.079	3.156	2.581
Altracine	4.712	3.765	3.233	2.377	1.865	1.568

Table 5: Safe concentration and sublethal concentration of agrochemicals tested

Chemicals	Sublethal Concentration (ppm)	Safe Concentration (ppm)
Fenvalerate	2.5561	2.5457
Fytran	0.64525	0.4634
Altracine	0.3920	0.2897

### **Safe concentration and sublethal concentration:**

The safe level concentration of fenvalerate was found to be 2.5457 ppm; for fytran it was found to be 0.4634 ppm and for atracine it was found to be 0.2897 ppm. The sublethal concentration was found to be 2.556 ppm for fenvalerate; 0.645 ppm for fytran and 0.392 for atracine (Table 5).

Indiscriminate use of insecticides, pesticides and other toxic agrochemicals has led to the contamination of soil as well as water resources and subsequent loss of population of many useful terrestrial and aquatic organisms. There are reports of reduction in number of earthworms, collembolans, mites and other organisms in soil consequent to the regular application of these toxic agrochemicals (Pall and Chatterjee, 1986; Andrew and Sanil, 1991). Another important consequence of the use of agrochemicals is the bioaccumulation of these toxins by the soil invertebrates (Sun *et al.*, 2005; Diao *et al.*, 2007) and thereby affecting their physiology (Drobne *et al.*, 2008).

The percentage mortality of *Cylisticus* increased with the increasing concentration of all the agrochemicals tested and with increasing time of exposure. 11 ppm concentration at 96 h of all these pesticides tested showed 90-100 per cent mortality of the organism. But at low concentrations of 1-3 ppm and the same exposure time of 96 h, the mortality was 40-60 per cent only. This means that these agrochemicals and its residual remains in the habitat of *Cylisticus* have a long term impact in the sustenance of the species.

The LC<sub>50</sub> value of fenvalerate (10.224) is the highest as compared with other agrochemicals tested followed by Fytran (2.581) and Altracine (1.568) at 96 h. Also the LC<sub>100</sub> values showed a similar trend being the highest is fenvalerate (17.459) followed by Fytran (5.906) and Altracine (3.233). The results showed that fenvalerate is highly toxic to *Cylisticus* even at low concentration and atracine is the least toxic out of the tested agrochemicals. The Probit analysis results revealed that fenvalerate is safe even upto 2.5457

ppm but the other chemicals tested are safe at less than 0.4 ppm only.

The present study of the toxicity of different commonly used agrochemicals on soil isopod is in conformity with the earlier research works in this field. The isopod seems to be highly prone to the action of the agrochemicals studied and indiscriminate use of these pesticides will drastically decrease the population density and diversity of soil isopods and thereby reduces the soil fertility.

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