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Ill-effects of fytran on survival and reproduction of a tropical soil spring tail - *Cyphoderus javanus* Borner

Bhavya L.R.[1]* and Sanal Kumar M.G.[2]

P.G. & Research Department of Zoology, N.S.S. College, Pandalam-689 501, Kerala, India

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ABSTRACT

Soil collembolans are regarded as ecosystem engineers determining the soil fertility, biological structure and environmental stability. The tiny predominant tropical detritivore soil collembolan *Cyphoderus javanus*, was selected as a tool for assessing the potential adverse effects of the fungicide fytran on various life history parameters under laboratory conditions. Findings of the present study revealed that fecundity rates, incubation time, survival success, juvenile hatching and longevity were observed to be declined significantly with fungicidal amount elevation. Anthropogenic interventions in modern agriculture practices paved the way for the emergence of toxic pesticides, that can reduce the surplus population of soil fauna including collembolans and also have the potential to affect the resistance and resilience of the ecosystem.

Key words : *Fecundity, Fytran, Lethal concentration, Longevity, Springtails*

Introduction

Soil is a living dynamic entity and is an abode of huge numbers of living organisms that engaged in crucial processes in environment (Sheikh *et al.*, 2017) such as litter break down, organic matter translocation, nutrient recycling, soil maturation, void formation and water regulation (Menta *et al.,* 2020). Soil microarthropods are considered as an important treasure of biodiversity and are widely used as bioindicators of anthropogenic disturbance (Paoletti and Bressan, 1996). Among various groups of soil microarthropods, soil spring tails are highly vulnerable to soil pollution (Fountain and Hopkin, 2005) and their enormous number throughout the organic matter rich top layers of soil indicated their significant role in many phases of decomposition (Hagvar, 1982). Collembolans are known as ideal test organisms for eco-toxicological studies (Nursita *et al*., 2005) and have been utilized in numerous experiments to evaluate the impact of environmental contaminants such as pesticides, fumigants, heavy metals, acid rain and chemicals on soil fauna (Sorensen and Holmstrup, 2005). Elevated quantity of agrochemical residues in agricultural soils imply a major challenge to soil dwelling animals which may negatively affects the processes like atrophy of organic residues, nutrient assimilation and maintenance of soil health (Lavelle *et al.,* 2016)

Cyphoderus javanus is a commonly seen soil collembolan in Western Ghats of Kerala and are considered highly suitable biomarker for bioassay studies because of their abundance in uncontaminated soils, easy breeding and greater sensitivity to physical and chemical stresses (Saha and Joy, 2014). Several previous investigations related to various aspects of toxicology include Endwebler *et al*. (2006), Chakravorthy *et al*. (2015), Carniel *et al.* (2019), Thomas (2022), Aswin and Kumar (2022). Although, information is scanty on toxic effects of agrochemicals

([1]Research Scholar, [2]Professor and Head)

on survival and reproduction of these non- target organisms in tropical soils. It is therefore of importance to study the effect of fungicides on key biological processes of *Cyphoderus javanus.*

Materials and Methods

Collection and rearing of *Cyphoderus javanus*

The live adult organisms of *Cyphoderus javanus* were collected from soil and leaf litters of different sites of Thiruvananthapuram district by soil augar and transferred to the laboratory in a labelled polythene bag. The trapped *C. javanus* were extracted by using modified Tullgren funnel and maintained in polythene jars of 7×3cms size and decaying jack leaves with baker's yeast were provided as food. For experimental studies, freshly laid eggs were reared in a separate smaller culture jars of 5x 3cms with perforated plastic lids, containing a mixture of plaster of paris, animal charcoal and distilled water in 5:1:5 ratio (Snider *et al.,* 1969).

Bioassay Studies

1000 ppm stock solution of Fytran 50% WDP was prepared by dissolving adequate amount of chemical in one liter of distilled water. From this stock solution, six concentrations (in ppm) and a control were prepared. Five replicates of *C. javanus* were examined for each concentration of fytran. Decaying leaves washed in water and soaked in fytran for 24 hours were given as food for experimental group. A control was also maintained and mortality was recorded at every 12,24,48,72 and 96 hours.

Fecundity Studies: A pair of sub adult female and males were introduced in each culture jar and its fecundity was recorded in each oviposition by carefully removing eggs from the culture jar using a fine brush. Number of eggs in each oviposition was recorded carefully. Five replicates were maintained for the agrochemical study and individuals were fed with jack leaves soaked in sublethal concentration of fytran. Number of eggs laid in each oviposition was counted and removed using a fine brush.

Data Analysis: Lethal concentrations (LC 100 and LC 50) were estimated using Probit analysis of Finney (1964). Safe concentrations and sublethal concentrations were calculated by the method of Hart (1945). For understanding the differences between number of eggs in different replicates and also in different oviposition for control and experimental groups, two-way ANOVA was used.

Results and Discussion

The extensive utilization of fungicide fytran showed that applied quantity of this agrochemical has drastic impact on the population of soil collembolans, particularly *Cyphoderus javanus* during the present study. The lethal concentration 100 of fungicide fytran treated *Cyphoderus javanus* were calculated as 31.7 ppm at 12 hours, 26.0 ppm at 24 hours, 19.86 ppm at 48 hours, 17.31 ppm at 72 hours and 14.32 ppm at 96 hours. LC 50 values of fytran treated *Cyphoderus javanus* were computed as 16.08, 12.5, 10.02, 8.2, 6.5 ppm at 12, 24, 48, 72 and 96 hours intervals respectively. The safe level concentration and its sublethal concentration of fytran was found to be 1.31 ppm and 1.63 ppm. Laboratory analysis results indicated that morality rate of this springtail *Cyphoderus javanus* was observed to be higher with concentration rise. High percentage mortality was noticed at 96 hours and lowest during 12 hours (Table 1). No mortality was observed in control sets. This agrees with the results of Staempfli (2007) and Carniel *et al.* (2019) and observed that the fungicide mancozeb and herbicide dinoseb reduced the survival, growth and reproduction of collembolans. Sublethal concentrations of pesticides chlorpyrifos prolonged the development periods of 4th instar and pupae of Asian lady beetle, *Harmonia axyridis* and significantly negatively affected feeding ability, adult longevity, female fecundity, population growth and demographic patterns (Rasheed *et al.,* 2020).

Table 1. Concentration mortality (%) of fytran on *Cyphoderus javanus*

Concentration	Time (in hours)				
(ppm)	12	24	48	72	96
2	7.6	13.7	17.4	25.6	30.5
6	15.4	24.7	27.3	34.4	39.6
8	25.2	33.2	39.4	47.2	55.3
10	27.7	38.3	43.4	50.5	69.2
12	36.6	47.2	54.2	70.8	87.6
14	45.1	58.1	75.2	86.8	100

Examining the effects of fytran on life-history traits on collembolan *Cyphoderus javanus* proved that the number of eggs laid by females, number of juveniles hatched, number of exuvium deposition, rate

Table 2. Life history parameters of *C. javanus* with sublethal concentration of fytran

Treatment	Fecundity (Mean± SD)	Number of juveniles (Mean± SD)	Number of exuvia (Mean± SD)	Longevity (Mean± SD)	Hatching success (%)
Control	70.97± 0.58	65.09±0.55	5.09±0.17	106±1.03	91.7
Test	41.89 ±0.66	30.84±0.18	1.38±0.05	45 ±1.50	73.6

of hatching success and longevity were found to be decreased with increasing concentration of fungicide (Table 2). Similar results were reported by Sahana *et al.* (2014), rate of fecundity and moulting was found to be high in control than in lead and cadmium treated groups. The two-way ANOVA results revealed that there is no significant variation in the number of eggs laid in each replicate during different oviposition (P 0.633; P>0.05) and showed significant variation between number of eggs laid during different ovipositions (P 2.09×10^{-6}; P<0.05).

According to Alves *et al.* (2014), imidacloprid and fipronil were the most toxic seed dressing pesticides which reduces significantly the reproduction of collembolan *Folsomia candida*. Zhang *et al*. (2016) reported that after heat stress, the females of *Neoseiulus barkeri* had a markedly extended pre-oviposition period, shortened oviposition period, reduced fecundity and longevity. Soil springtail communities are sensitive to pesticides and other chemicals in modern agriculture, and their paucity in species may indicate negative impacts on non-target organisms (Wiktelius *et al.*, 1999; Ponge *et al.*, 2004). Large scale use of pesticides has caused many environmental problems like pesticides poisoning, insecticide resistance, resurgence of pests, effects on non-target organisms including its death (Mittal *et al.*, 2014). Laboratory and field study of Sahana and Joy (2014) showed negligible lethal effect of fly ash on *Cyphoderusj avanus*, but major life history parameters namely survival success, fecundity and moulting were significantly inhibited by fly ash treatments. Mohammed *et al.* (1992) pointed out that the pesticides had a significant influence on survival rates, body weights and rates of oxygen consumption in *Hemilepistus reaumuri.*

Conclusion

Observing the impacts of fungicide fytran on survival, growth and fecundity of common detritivore collembolan *Cyphoderus javanus,* it is clear that intensive use of pesticides in modern agriculture has detrimental effect on soil integrity and soil fertility. The results of current study revealed that there was a profound reduction in fecundity, longevity, incubation, hatching and exuvium deposition in test organisms. Survival ability of fytran treated organisms were observed to be very low and negligible mortality were noticed in control sets. The negative influences of this copper containing fungicide on non - target organisms like *Cyphoderus javanus* would cause environmental imbalances and disturbances in biological food chain, hence the overuse of this fungicide should be reduced.

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Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

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