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# Ecotoxicological studies of selected agrochemicals on the moulting stages of *Cyphoderus javanus* under laboratory conditions

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**ABSTRACT**

**Indiscriminate use of toxic pesticides in agriculture has raised serious concerns worldwide, which led to a steady destruction of soil biota as well as the overall health of ecosystem. The present study was designed to evaluate the effects of selected agrochemicals such as cyfluthrin (insecticide), fytran (fungicide) and oxadiargyl (herbicide) on the moulting stages of soil springtail *Cyphoderus javnaus*. Laboratory analysis results indicated that the agrochemical treated organisms showed prolonged moulting intervals and need more days than normal to become a complete adult having sexual maturity. On treatment with the sub lethal concentration of oxadiargyl, first moult noticed after12$^{th}$ day, second moult after24 $^{th}$ day, third moult after 36 $^{th}$ day of egg hatching. The effect of herbicide oxadiargyl on Cyphoderus javanus was found to be comparatively higher than that of other two pesticides. The changes noticed in developmental stages, moulting period and egg laying pattern in *Cyphoderus javanus* when exposed to agrochemicals indicated that this soil collembolan is a potential biomarker of ecotoxicology investigations.**

## Introduction

Soil ecosystems are the crucial and basic assets of any kinds of anthropogenic needs and also serves as the essential constituents of agricultural sustainability (Bech *et al*.,2008). In addition to the fundamental aspects of soil biome, inhabiting microarthropods account for huge and ecologically relevant portion of soil biodiversity and they play an inevitable function in degradation by fragmenting and grazing on organic residues present in soil by fungal groups and aids to liberate nutritive elements for plant growth (Abbas and Parwez,2020). Among them, springtails are the most abundant groups and are considered as bioindicators of soil quality because of their rapid reaction to environmental shifts (Florian *et al*.,2019). They also performed a dominant role in paedogenesis, elevating air circulation, void fractions as well as the soil quality improvement by the disintegration of organic litters by complex activities of digestion (Banarjee *et al*., 2009).The enormous agricultural yields currently obtained in many parts of the world are often achieved with the help of excessive fertilizer use (Ju *et al.,* 2009). According to Yanez *et al*. (2002), modern agricultural methods followed by unsustainable practices in many developing nations, have resulted in an enormous quantity of contaminated wastes being dumped into the natural habitats including air, water and land. Deep plowing and monocrop cultivation may result in resource exhaustion and large-scale soil weathering, excessive usage of inorganic pesticides as well as fertilizers have caused adulteration to our riverine ecosystems and soil environment (Baishya,2015). The results of intensive applications of agricultural products on soil inhabiting organisms can be estimated either as fluctuations in the population of organisms or as variations in the metabolic activities of individuals (Bunemann *et al.,*2006). *Cyphoderus javanus* is a tropical terrestrial collembolan present in decaying leaf litter and moist fertile soils. These

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collembolans play an essential link in detritus food chain and has a notable role in decomposition of organic matter. It's role as detritivores and biomarkers of soil ecosystem health makes them as an apt organism for ecotoxicological studies. Recently more researches were carried out focus the impacts of different pesticides on various aspects of life history in soil microarthropods by numerous investigators such as Bini (2019), Vinod (2019), Thomas and Kumar (2020 & 2022), D Lima e Silva *et al.* (2020 & 2022) and Aswin and Kumar (2022). However, toxicity studies on moulting stages of soil arthropods are comparatively very few. Therefore, the present study was mainly designed to study the adverse effects of commonly used some agrochemicals (Cyfluthrin, Fytran and Oxadiargyl) on pre adult moulting interval of common springtail *Cyphoderus javanus.*

## Material and Methods

The live adult specimens of collembola, *Cyphoderus javanus* were collected from soil and leaf litters in various sites (Neyyar, Vithura and Agasthyavanam Biological Park) of Thiruvananthapuram district using soil augar. The obtained *Cyphoderus javanus* were extracted by using modified Tullgren funnel and reared in special plastic containers of 7×3cm size with a combination of Plaster of paris, activated charcoal and distilled water in the ratio 5:1:5 as base (Thomas and Kumar, 2020).

These culture vessels are kept under in a controlled environment with temperature of 28.9± 0.5 ℃ and light dark cycle 12:12 h in a BOD incubator. Moulting studies of *C. javanus* were carried out according to the standard procedures prescribed by Bini and Sanalkumar (2017). For estimating moulting intervals, juveniles arise from egg were cultured separately by transferring a group of ten organisms into new culture vessels with fine moistened camel hair brush. The laboratory cultured individuals of similar age groups were chosen for the investigation and fed with decaying jack leaves soaked with sublethal concentration of agro chemicals as food. Three replicates of *Cyphoderus javanus* and a control were maintained for each agrochemical testing. The number of days needed for each moult and mean number of days for each moult were carefully estimated. One-way ANOVA was conducted to determine the variations in the number of days in the replicates with respect to moulting period of *C. javanus* in normal and agrochemical treated groups (Thomas, 2022).

## Results and Discussion

As shown in Table-1, the collembolan *Cyphoderus javanus* showed four successive moults under normal conditions. The first moult initiated after seven days of egg hatching, second moult after twelve days of hatching, third moult after fifteen days and fourth moult after twenty-three days of hatching and after thirty days of egg hatching, adult started egg deposition. Kaleka *et al.* (2019) cited that the insect larvae undergo moulting processes with number of times and environmental conditions such as humidity, temperature, photoperiod, food quality and quantity affect the number of instars. Butcher *et.al.* (1971) stated that the number of moults and duration needed to attain sexual maturity differs with individuals.

While comparing with control groups, experimental groups showed prolonged moulting period and takes more days to became adult (Table 2). After treatment with insecticide cyfluthrin four moults were obtained, first moult was noticed after ten days of hatching, second moult after sixteen days of hatching, third moult after nineteen days of hatching and four moult after twenty-nine days of hatching and adult laid eggs after thirty-six days of hatching. After exposure with fungicide fytran, first moult was recorded after twelve days of egg hatching and second moult after twenty-two days, third moult after twenty-six days, fourth moult after thirty-five days and after fourty three days adult stage started, having no ability to lay eggs. After treating with herbicide oxiadargyl, only three moults were observed, lacks fourth moult. The first moult was started on twenty third day of hatching, second moult on thirty fifth day and third moult on fifty third days of egg hatching. Similar to fytran treated sets, these experimental groups containing adults was notable to lay eggs. The results of one- way ANOVA indicated that there was no significant variation moulting periods between replicates in control sets and agrochemical treated sets ($P>0.05$) (Table 3).Bini and Sanalkumar (2017) and Aswin and Kumar (2022) have noticed the negative effects of herbicides on soil isopods, showed drastic reduction in fecundity and their

**Table 1: Normal moulting interval of *Cyphoderus javanus* at 28.9±0.5$^0$C**

| Stage | Replicate I (Days) | Replicate II (Days) | Replicate III (Days) | Mean ± SE |
|---|---|---|---|---|
| **Rest** | 5.0 | 6.4 | 7.2 | 6.2±0.44 |
| **1st moult** | 11.9 | 12.4 | 10.9 | 11.7±0.22 |
| **2nd moult** | 13.6 | 14.8 | 15.1 | 14.5±0.21 |
| **3rd moult** | 22.7 | 23.9 | 22.6 | 23.1±0.15 |
| **4th moult** | 30.1 | 28.9 | 28.3 | 29.1±0.17 |
| **Adult** | Eggs laid | | | |

**Table 2: Moulting interval of *Cyphoderus javanus* exposed to different agrochemicals at 28.9±0.5$^0$C**

| Stage | Cyfluthrin | | | | Fytran | | | | Oxadiargyl | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Replicate I (Days) | Replicate II (Days) | Replicate III (Days) | Mean ± SE | Replicate I (Days) | Replicate II (Days) | Replicate III (Days) | Mean ± SE | Replicate I (Days) | Replicate II (Days) | Replicate III (Days) | Mean ± SE |
| **Rest** | 8.1 | 10.5 | 9.2 | 9.3 ±0.39 | 10.1 | 11.0 | 12.1 | 11.1 ±0.30 | 11.8 | 12.7 | 14.1 | 12.8 ±0.34 |
| **1st moult** | 15.2 | 16.4 | 16.5 | 16.0 ±0.18 | 19.6 | 20.8 | 22.2 | 20.9 ±0.75 | 25.4 | 25.2 | 23.8 | 24.8 ±0.17 |
| **2nd moult** | 17.9 | 19.5 | 19.3 | 18.9 ±0.21 | 24.6 | 25.8 | 26.1 | 25.5 ± 0.45 | 36.8 | 37.5 | 35.6 | 36.5 ±0.16 |
| **3rd moult** | 24.8 | 28.1 | 29.2 | 27.3 ±0.43 | 27.8 | 35.0 | 32.4 | 31.7 ±0.61 | 54.3 | 54.1 | 53.4 | 53.9 ±0.06 |
| **4th moult** | 36.1 | 33.2 | 34.4 | 34.5 ±0.25 | 43.9 | 41.5 | 43.1 | 42.8 ±0.19 | - | - | - | - |
| **Adult** | Eggs laid | | | | Eggs not laid | | | | Eggs not laid | | | |

**Table 3: One-way ANOVA showing pre -adult moulting interval of *Cyphoderus javanus* in different treatments**

| Treatments | Between replicates | | |
|---|---|---|---|
| | F value | P-value | F-crit value |
| Control | 0.0038 | 0.9963* | 3.68232 |
| Cyfluthrin | 0.0134 | 0.9867* | 3.68232 |
| Fytran | 0.0201 | 0.9802* | 3.68232 |
| Oxadiargyl | 0.0008 | 0.9992* | 3.68232 |

*** No significant differences in moulting period between the different replicates (P >0.05)**

moulting intervals were prolonged. Haque *et al.* (2011) and Chakravorty *et al.* (2015) pointed that smaller longevity, elevated duration of moulting and early development on *Cyphoderus javanus* subjected to various concentration of pesticides. Liu *et al.* (2018) reported that the appearance or disappearance of highly sensitive and resistant organisms in an extremely polluted soil ecosystem may be act as a potential indicator of ecosystem fitness. Crouau and Moia (2006) studied the susceptibility of growth and fecundity of some chemicals on *Folsomia candida* and discovered adverse effects of these xenobiotics on numerous life history traits of *Folsomia* species. Ijumba *et al.* (2010) suggested that the insect growth regulator insecticides can disrupt the synthesis of chitin and the most influenced insects are not able to produce new cuticle and to undergoes complete moulting into the next phase. Saha and Joy (2014) observed the impact of insect growth regulator pesticides on soil springtail *Cyphoderus javanus* under microsom conditions affected growth rate of *C. javanus,* by decreasing the rate of moulting. Same patterns of results obtained in present study, agrochemicals treated *Cyphoderus javanus* were not able to moult and reproduce properly.

## Conclusion

Soil microarthropods are the victim of collateral destruction resulting from extensive application of pesticides in crop fields which are used to eradicate insect pests. These pesticides cause an intense reduction in the abundance and diversity of soil biota particularly collembolans. The results of the laboratory experiments revealed that the selected pesticides cyfluthrin, oxadiargyl and fytran showed adverse toxic effects on the development of

springtail *Cyphoderus javanus.* The moulting period of *Cyphoderus javanus* showed variations between normal and pesticidal treated experimental sets, which exhibited prolonged moulting interval and requires more days to become adult. This implies that restoration of ecosystem health after the overexposure of agrochemicals is not easy and may need several decades to regain its virgin condition. Therefore, it is highly advisable that these studied pesticides are to be utilized only in permissible amount (<0.05 ppm) suggested by the Department of agriculture, Government of India.

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## Conflict of interest
The authors declare that they have no conflict of interest.

## References
Abbas, M., & Parwez, H. (2020). Seasonal diversity of soil microarthropods in two different vegetable plots of Aligarh-India. *Tropical ecology, 61* (3), 311-316.

Aswin, S.R., & Kumar, M. G.S. (2022). Toxicological studies on the effect of herbicide (altrazine) on the fecundity and moulting of a tropical soil isopod- *Cylisticus convexus. International Journal of Entomology Research,7*(7),6-9.

Baishya, K. (2015). Impact of agrochemicals application on soil quality degradation- a review. *International Journal of science technology and management*,*4*(1),220-228.

Banerjee, S., Sanyal, A.K., & Bhaduri, A.K. (2009). Studies on soil microarthropod population in three different garden plots of 24 parganas, West Bengal-a preliminary report. *Records of zoological survey of India,109*(4), 1-9.

Bech, J.P., Tume, M., Sokolovska, F., Reverter,F., & Sanchez, P.(2008). Paedogeochemical mapping of Cr, Ni, and Cu in soils of the Barcelona Province (Catalonia, Spain): Relationship with soil physico-chemical characteristics. *Journal of Geochemical Exploration, 96,*106-116.

Bini, B (2019). Distribution pattern and association probability of a soil isopod- *Philoscia javanensis* in relation to soil factors. Thesis submitted to University of Kerala. Thiruvananthapuram, Kerala, India.

Bini, B., & Sanalkumar M. G. (2017). Effect of Herbicide (Glyphosate) upon the fecundity and moulting of a terrestrial isopod (*Philoscia javanensis*) under lab condition. *International Journal of pure and applied researches, 4*(1),27-33.

Bunemann, E. K., Schwenke, B., & Van Zwieten, L. (2006). Impact of agricultural inputs on soil organisms—a review. *Australian Journal of Soil Research, 44,* 379–406.

Butcher, J.W., Snider, R., & Snider, R.J. (1971). Bioecology of edaphic collembola and acarina. *Annual Review of Entomology, 16,* 249-288.

Chakravorty, P.P., Haque, A., Sanayal, S., & Dasgupta, R. (2015). Effect of herbicides on *Cyphoderus javanus* Hexapoda: Collembola) under laboratory conditions. *Journal of Entomology and Zoology Studies*, *3* (1), 220-223.

Crouau ,Y., & Moia, C.(2006). The relative sensitivity of growth and reproduction in the springtail., *Folsomia candida*, exposed to xenobiotics in the laboratory, an indicator of soil toxicity. *Journal of Ecoloxicology and Environmental Safety, 64*,115–121.

De Lima e Silva, C., De Rooji, W., Verweji, R.A. and Van Gestel, C.A.M. (2020). Toxicity in neonicotinoids to *Folosomia candida* and *Eisenia andrei*. *Environmental Toxicology and Chemistry,* 39(3),548-555.

De Lima e Silva, C., Van Haren, C., Mianardi, G., De Rooji, W., Ligtelijn, M., Van Straleen, N.M. and Van Gestel, C.A.M. (2022). Bringing ecology into toxicology: life cycle of two neonicotinoids to four different species of springtails in LUFA 2.2 natural soil. *Chemosphere*, 263.

Florian,N., Ladányi,M., Ittzes, A., Kroel-Dulay, G., Onodi, G., & Mucsi, M. (2019). Effects of single and repeated drought on soil microarthropods in a semi-arid ecosystem depend more on timing and duration than drought severity. *PLoS ONE,14*(7).

Haque, A., Das, G.R., & Chakravorty, P.P. (2011). Effects of herbicides on *Xenylla welchi* (Hexapoda: Collembola) under laboratory conditions. *Bulletin of environmental contamination and toxicology, 85*,583.

Ijumba, J.N., Mtana, R.R., & Suya, T.B. (2010). Bio-efficacy of novaluron, a chitin synthesis inhibitor against larval stages of *Culex quinquefasciatus* and *Anopheles gambiae* Sensulato*. European journal of scientific research, 47*(3), 484-493.

Ju, X.T., Xing, G.X., Chen, X.P., Zhang, S.L., Zhang, L.J., & Liu, X.J. (2009). Reducing environmental risk by improving N management in intensive Chinese agricultural systems. *Proceedings of the National Academy of Sciences of the United States of America, 106*,3041–3046.

Kaleka, A., Kaur, N., & Bali, G. (2019). Larval Development and Molting. Edible insects. 2020 Edition. Heimo Mikkola, Intech Open.

Liu, M., Xu, J., Krogh, P.H., Song, J., Wu, L.H., Luo, Y., & Ke, X. (2018). Assessment of toxicity of heavy metal-contaminated soils toward collembola in the paddy fields supported by laboratory tests. *Environmental Science and Pollution Research, 25*,16969–16978.

Saha, I., & Joy, V.C. (2014). Potential ill effects of IGR pesticides on life-history parameters in ecologically important soil collembolan *Cyphoderus javanus* Borner. *International journal of science, environment and technology ,3* (2),365 – 373.

Thomas N., & Kumar M.G.S. (2020). Effect of feed on life history of *Bilobella branuera* (Dhervang-1981) - (Collembola: Neanuridae). *Journal of Xidian University,14*(12),485-492.

Thomas, N.2022. *Some aspects on the ecology and reproductive biology of a soil collembolan-Bilobella braunerae*. Thesis submitted to University of Kerala, Thiruvananthapuram.

Vinod P. (2019). *Some aspects on the ecology and reproductive biology of a soil collembola- Crytophygys thermophilus.*Thesis submitted to University of Kerala. Thiruvananthapuram, Kerala, India.

Yanez, L., Ortiz, D., Calderon, J., Batres, L., Carrizales, L., Mejja, J., Martinez, L., Garcia-Nieto, E., & Diaz-Barriga, F. (2002). Overview of human health and chemical mixtures: Problems facing developing countries. *Environmental Health Perspectives, 110*,901–909.