



BIOLOGICAL RESPONSE OF EARTHWORM *LAMPITO MAURITII* TO MONOCROTOPHOS (ORGANOPHOSPHORUS) INSECTICIDE KEPT IN DIFFERENT SUBSTRATES

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ABSTRACT

The present study has investigated the toxic effect of monocrotophos on the Earthworm *L. mauritii* kept in different substrates by laboratory experiments. The LC₅₀ value and their lower and upper confidence limits for four different substrates such as dry soil (control), cow dung, saw dust, dry coir waste and tea waste mixed with monocrotophos have been worked out in the earthworm, *Lampito mauritii*. It is important to note that the worms exposed to monocrotophos mixed with different substrates experience the behavioral changes noted as initial symptoms. The mortality differences observed between 1 hr – LC₅₀ and 144 hr – LC₅₀ and in the toxicity values of monocrotophos mixed with substrates may be due to difference observed in the feeding activity of the animal in the respective substrate at different periods. The results suggest the substrate tea waste, saw dust and coir waste can be used as good manure to any crop which requires more monocrotophos to *Lampito mauritii*.

Keywords: *Lampito mauritii*, Monocrotophos, Toxicity, Different substrates, Biological response.

INTRODUCTION

Earthworms are common soil organisms in most environments and play an important role in improving structure and fertility of soil ecosystem (Bartlett *et al.*, 2010). They modify soil organic matter both chemically and physically, mix leaf litter with the soil, facilitate the formation and stabilization of soil aggregates and improve soil porosity (Lavelle and Spain, 2001). It has been indicated that earthworms may represent up to 60-80% of the total animal biomass in soil (Ouellet *et al.*, 2008; Jouquet *et al.*, 2010) unlike many other soil organisms that are protected by thick cuticle on the exterior of their bodies, earthworms are particularly susceptible to soil chemicals (Lanno *et al.*, 2004; Nahmani *et al.*, 2007). The bioaccumulation of insecticides in earthworms may not lead to significant effects to the animal itself, but may produce serious damages to high trophic levels (Darling and Thomas, 2005; Hobbelen *et al.*, 2006; Van Gestel *et al.*, 2011). Therefore, earthworms are suitable bio indicators of soil contamination and can be used to provide safety thresholds for insecticide application (Suthar *et al.*, 2008, Lourenco *et al.*, 2011). They are used as bio indicator of soil quality and they serve as model organisms in toxicity testing. Earthworms are characterized by high ability to cumulate a lot of pollutants from soil. It is important to understand the harmful effects that pesticides have on organisms, especially when changing environmental

conditions occur. Earthworms have been studied as a readily available, easily maintainable and cheap test species for assessing chemical pollution. The present study is aimed at to know the impact of different artificial substrates such as coir pith, tea waste, saw dust, and farm yard manure (used as good medium for vermiculture) on the toxicity of monocrotophos to the earthworm, *Lampito mauritii*.

MATERIALS AND METHODS

Collection and Maintenance of Earthworms

L. mauritii were collected from agricultural farm field in Kidarankondan, Thiruvarur, Tamil Nadu, India. They were maintained in the laboratory conditions kept in large trays with a substrate medium, 50% farmyard manure and 50% soil (vol/vol) for two weeks at 28 ± 20 °C with 50 – 60% moisture. Adolescent worms of 10 to 12 cm in length and 2 to 3 mm in width, with pink undifferentiated clitella were used for the present study. The experimental setups were made for this project for *L. mauritii*. The media units, plastic trays (30 x 30 x 30 x 30 x 30 cm) were filled with pre-processed cow dung, saw dust coir pith, tea dust are mixed with soil as in the ratio 1:1 (v/v) and soil as a control keeping the setup in moisture conditions whenever needed add water. The each substrate was added to 1 ml of

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monocrotophos in all trays, ten exotic indigenous earthworms *L. mauritii* were added to the respected medium. The experiments by regular noted, and assess the effect of herbicides on *L. mauritii*.

Chemical

Monocrotophos insecticide commercially available, in the trade name of Monostar monocrotophos supplied by Pesticides India Ltd, Mumbai, was used for the present study. It was purchased from local pesticide agency.

Acute toxicity test

For assessing acute toxicity, the preparation of selected test medium of each substrate 1 kg of dry substrate was taken. The test doses are expressed as ml active in gradient monocrotophos /kg dry substrates weight. For assessing the toxicity of each of the selected doses (based on exploratory test) of monocrotophos mixed with different substrates. The mortality rate of earthworm was observed after 1, 3, 6, 12, 24, 36, 48, 72, 96, 120 and 144 hours of exposure. The LC₅₀ value was calculated by Probit analysis method (Finney, 1971) and the number of survivors was also noted at each exposure period. Earthworms were

considered dead if they did not respond to a gentle mechanical stimulus.

RESULTS

The acute toxicity values and their lower and upper confidence limits of the earthworm, *L. mauritii* exposed to five different substrates mixed with monocrotophos (1 ml/kg substrates) have been worked out for different time intervals. The toxic range between 1 hr-LC₅₀ and 144 hrs – LC₅₀ was 8.81 – 0.40, 10.29 – 2.60, 7.46 – 1.75, 7.23 – 1.00 and 10.81 – 1.50 ml (Figure 1-4) active ingredient of monocrotophos kg/dry substrate weight for the earthworm exposed to the substrates 1,2,3,4 and 5 respectively. While the constructing acute toxicity curves for the earthworm LC₅₀ and different time periods, asymptote was reached in all case during 144 hours. Similar trend is also reported in other organophosphates pesticide by a number of previous workers (Bakthavatchalam and Rajaraman, 2003, Bharathi and Subha Rao, 1984) reported 96-h LC₅₀ of carbofuron, phosphamidon, monocrotophos and dichlorvos on *L. mauritii* in artificial soil. (Parnaik and Dash, 1990) exposed earthworms to different concentrations of pesticide monocrotophos.

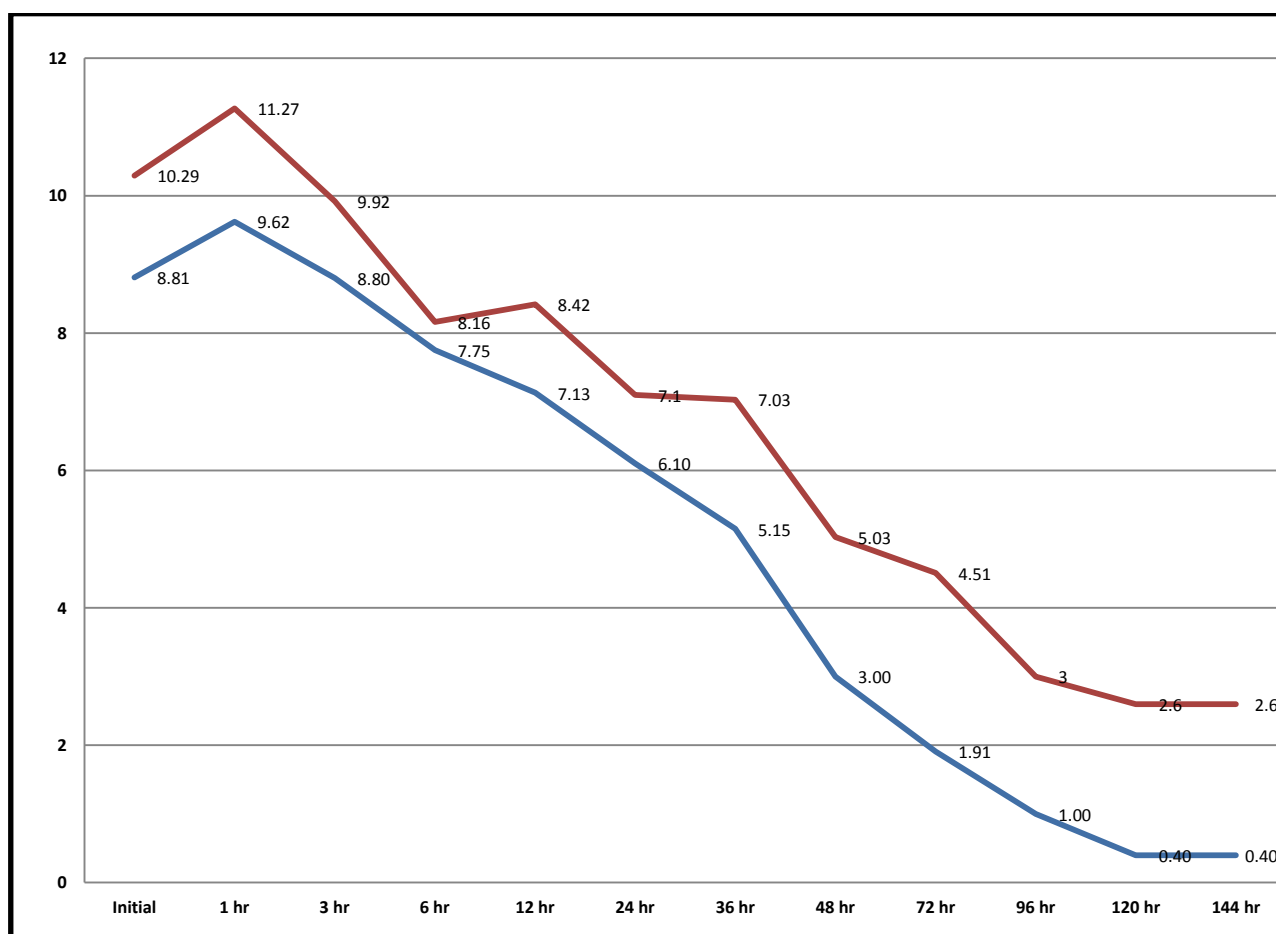


Figure 1. Comparative toxic impact of monocrotophos (ml/kg) concentration on *Lampito mauritii* in control and cow dung.

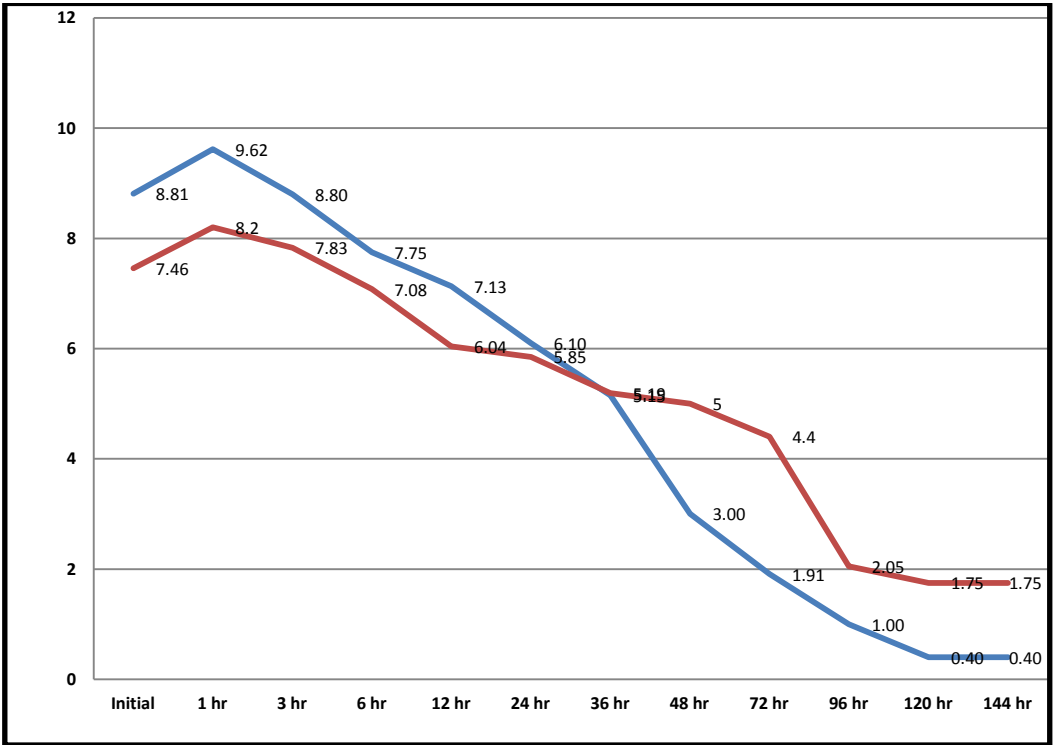


Figure 2. Comparative toxic impact of monocrotophos (ml/kg) concentration on *Lampito mauritii* in control and coir pith.

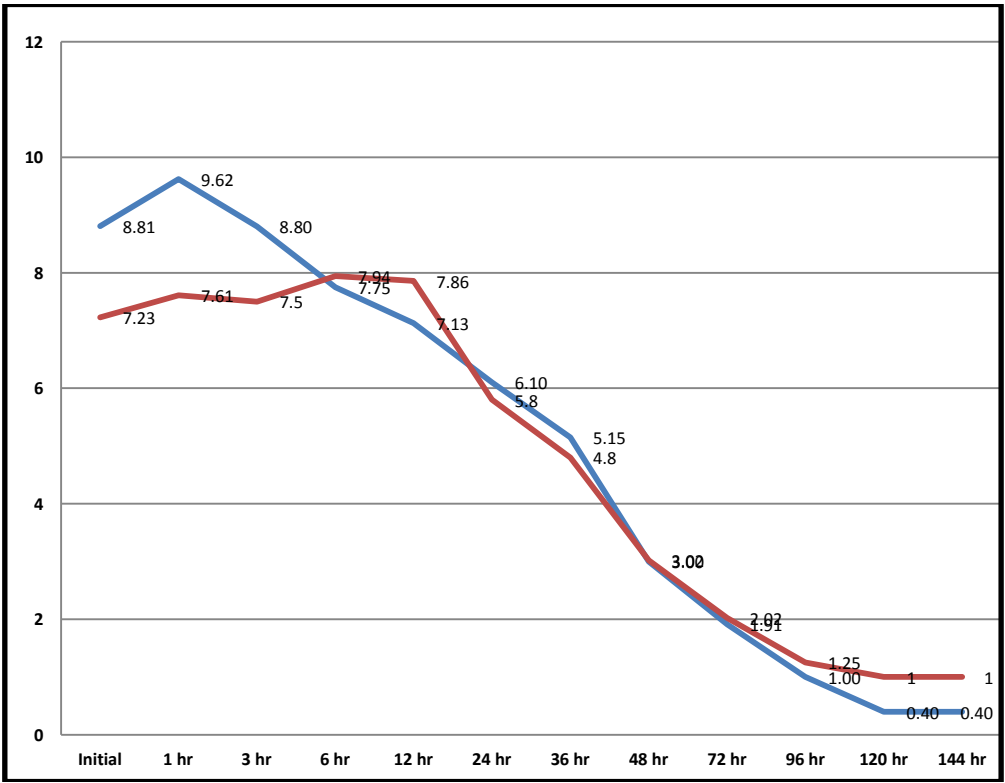


Figure 3. Comparative toxic impact of monocrotophos (ml/kg) concentration on *Lampito mauritii* in control and saw dust.

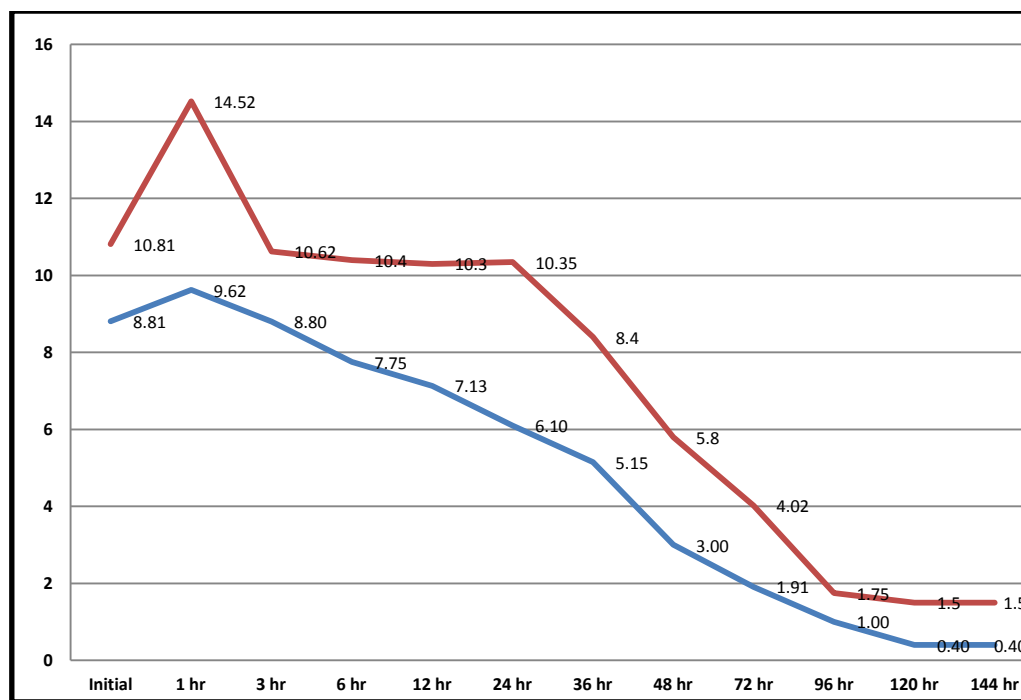


Figure 4. Comparative toxic impact of monocrotophos (ml/kg) concentration on *Lampito mauritii* in control and tea waste.

DISCUSSION

Acute toxicity of earthworm is an efficient tool in assessing ecological risks of contaminated soils (Lukkari *et al.*, 2005; Hemibach, 1985) and the end point is mortality (Karnak and Hamelink, 1982; Dean-Ross, 1983; Ellis *et al.*, 2007). In this present experiment, Monochrotophose showed no mortality at the recommended agricultural dose. The toxic range between 1 hr – LC₅₀ and 120 hr – LC₅₀ for the earthworm kept in substrate 1 (control) was found to be 9.62 – 0.40 ml active ingredient of monocrotophos /kg dry substrate weight. The worms kept in substrate 2, (Cow Dung), the same toxic range was found to be 11.27 – 2.60 ml active ingredient of monocrotophos /kg dry substrate weight. In the case of substrates 3 (Cair Pith) the similar toxic ranges was found to be 8.20 – 1.75 ml active ingredient of monocrotophos / kg dry substrate weight. The worms kept in substrate 4 (Saw Dust) and 5 (Tea Dust Waste) the respective toxic range was found to be 7.61 – 1.00 and 14.52 – 1.50 ml active ingredient of monocrotophos/kg dry substrate weight. In all the cases, asymptote was reached in the acute toxicity curve during 144 hours at the concentrations 0.40, 2.60, 1.75, 1.00 and 1.50 ml active ingredient of monocrotophos/kg dry substrate weight due to the attainment of equilibrium in the insecticide medium.

It is important note that the worms exposed to monocrotophos mixed with different substrates experience the following as initial symptoms: swelling in the segments of clitellum and posterior region, oozing out of the mucous substances from the body surface, deep constriction at certain parts of the body, rolling of body surface, colour change and fragmentations of body segments due to

autotomy. Marginal weight gain at 1 hr revealed was by swelling of body surface. But in subsequent hours of exposure the worms showed remarkable reduction in their body weights as revealed by oozing of mucous substances from the body surface.

CONCLUSION

From the results, it is inferred that even the concentration now used as non-lethal, would cause drastic change in the body weight as revealed by low uptake of substrate and hence the concentration cannot be considered as safe for the worm. Out of four substrates (except control) used, the substrates 5, 3 and 2 able to reduce the toxicity of monocrotophos to *L. mauritii* better than once viz.

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REFERENCES

- Bakthavachalam, R. and Rajaraman, P., 2003. Relative toxicity of corbofuran to the earthworm *Lampito mauritii* (Templeton) kept in different substrates. *J. Ecol. Toxicol.*, 21(2), 137-142.
- Bartlele, M.D., Briones, M.J.I, Neilson, R., Schmidt, O., Spurgeon, D., Creamer, R.E., 2010. A critical review of lunrent methods in earthworm ecology: from individuals to populations. *Environ. Soil Biol.*, 46, 67-73.

- Bharati, C. and Subba Rao, B.V.S.S.R., 1984. Toxicity of phosphamidon to the common South Indian earthworm *Lampito mauritii*. *Bull. Environ. Contam. Toxicol.*, 32(1), 295-300.
- Darling, C.T.R. and Thomas, V.G., 2005. Lead bioaccumulation in earthworms, *Lumbricus terrestris*, from exposure to lead compounds of differing solubility. *Sci. Total Environ.*, 346, 70-80.
- Dean-Ross, D., 1983. Methods for assessment of the toxicity of environmental chemicals to earthworms. *Regul. Toxicol. Pharmacol.*, 3(1), 48-59.
- Ellis, M.S., Hodson, M.E. and Wege, P., 2007. The influence of different artificial soil types on the acute earthworm *Eisenia fetida* Fresenius. *Environ. Bull.* (2), 114-117.
- Finney, D.J., 1971. Probit analysis, Cambridge University Press, Cambridge.
- Hemibach, F., 1985. Comparison of laboratory methods using *Eisenia fetida* and *Lumbricus terrestris* for the assessment of hazard of chemicals to earthworms. *Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz*, 92(2), 186-193.
- Hobbelen, P.H.F., Koolhaas, J.T. and Van Gestel, C.A.M., 2006. Bioaccumulation of heavy metal in the earthworms. *Lumbricus ruberrus* and *Aporrecto deacaliginosa* in relation to total and available metal concentrations in field soils. *Environ Pollut.*, 144(2), 639-46.
- Jouquet, P., Plumere, T., Thu, T.D., Rempet, C., Duc, T.T. and Orange, D., 2010. The rehabilitation of tropical soil using compost and vermicompost in affected by the presence of endogenic earthworms. *Appl. Soil Ecol.*, 46, 125-133.
- Karnak, R.E. and Hamelink, J.L., 1982. A Standardized method for determining the acute toxicity of chemicals to earthworms. *Ecotoxicol. Environ. Safety*, 6(2), 216-222.
- Lanno, R., Wells, J., Conder, J., Brodham, K., Basta, N., 2004. The bioavailability of Chemicals in soil for earthworms. *Ecotoxicol. Environ. Saf.*, 57, 39-47.
- Lavelle, P. and Spain, A., 2001. Soil Ecology. Kluwer Scientific Publications.
- Lourenco, J.I., Pereira, R.O., Silva, A.C., Margado, J.M., Carvalho, F.D., Oliveira, J.M., Melta, M.P., Pariva, A.A., Mendo, S.C., and Concalaves, F.J., 2011. Genotoxic endpoints in the earthworms sub-lethal assay to evaluate natural soils contaminated by metals and radio nuclides. *J. Hazard. Mater.*, 186, 788-795.
- Lukkari, T., Aatsinki, M., Vaisanen, A. and Haimi, J., 2005. Toxicity copper and zinc assessed with three different earthworm tests. *Appl. Soil Ecol.*, 30(2), 133-146.
- Nahmani, J., Hodson, M.E. and Black, S., 2007. Effects of Metals on life cycle parameters of the earthworm *Eisenia fetida* exposed to field-contaminated, metal-polluted soils. *Environ. Poll.*, 149(1), 44-58.
- Ouellet, G., Lapen, D.R., Topp, E., Sawada, M. and Edwards, M., 2008. A heuristic model to predict earthworm biomass in agroecosystems based on selected Management and soil properties. *Appl. Soil Ecol.*, 39, 35-45.
- Parnaik, H.K. and Dash, M.C., 1990. Toxicity of monocrotophos and fenitrothion to four common Indian earthworm Species. *Poll. Res.*, 9, 95-99.
- Suthar, S., Singh, S. and Dhawan, S., 2008. Earthworm as bioindicator of metals (Zn, Fe, Mn, Cu, Pb and DJ in Soils: Is Metal bioaccumulation affected by their ecological category? *Ecol. Eng.*, 32, 99-107.
- Van Gestel, C.A.M., Ortiz, M.D., Borgman, E. and Veuveji, R.A., 2011. The bioaccumulation of molybdenum in the earthworm *Eisenia andrei* influence of soil properties and ageing. *Chemosphere*, 82, 1614-1619.