

OBSERVATION OF HISTOLOGY OF BODY WALL IN LAMPITOMAUROITII AND SOIL PROPERTIES AFTER EXPOSURE TO CHLORANTRANILIPROLE

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ABSTRACT

Earthworms are economically important organisms and play key role in environmental management. They are the most abundant invertebrates in the soils and close contact with soil particles. In order to get maximum crop yield there is a need to protect the crop from insect pests. Farmers are applying Tons of several kinds of insecticides annually to get rid of pests. Among this, Chlorantraniliprole (CAP) are widely used insecticide in agricultural field to control insects on a variety of crops. In the present studies, an attempt was made to observe the effect of soil mixed insecticide, viz. CAP on histology of body wall of *L.mauritii* and soil properties. Different sublethal concentrations of CAPs such as 5.11, 2.04, and 1.022 mlKg⁻¹ were selected from 96 hr LC₅₀ value of 10.22mlKg⁻¹. Significant histopathological alterations were observed in *L. mauritii* from the three concentrations. Severe disruptions in the arrangement of their body wall muscle layers, distorted internal viscera, as well as cellular degeneration, pigments, moderate to severe areas of lesion, and distortion of the shape of circular and longitudinal muscles, eroding of internal and external tissues leading to total destruction of body wall were observed after exposure to adverse impacts of CAP. The results reported that histology of body muscle was highly damaged on 5th and 15th day of experiment than 30th day. Whereas soil properties such as pH, nitrogen, phosphorous and potash were observed on 30th day. Highly damaged body wall and denatured soil a property was observed in T1 than T2 and T3.

KEYWORDS: Earthworm; Soil; *L mauritii*; Chlorantraniliprole; Histopathology; Skin, soil properties.

INTRODUCTION

According to the Food and Agriculture Organization (FAO), more than 4 million tons of pesticides are used in the world annually, when released into the environment, most of them might pollute air, soil, ground and surface waters, as well as pose a threat to non-target organisms (Van der Werf, 1996; Carriger et al., 2006; Duke, 2017). Overuse of pesticides has raised major issues for biodiversity and human health (Agrawal et al., 2010). Inappropriate use of pesticides to boost agricultural productivity has damaged soil fauna, especially earthworms, which are affected either directly or indirectly as non-targeted organisms.

Earthworms are important macro invertebrates of soil fauna and make up around 80% of the biomass of terrestrial invertebrates. They are members of the Order Oligochaeta, Class Chaetopoda, and Phylum Annelida. Many tropical soils and the majority of temperate soils are home to earthworms. They are separated into about 700 genera, over 7,000 species, and 23 families. Earthworms are often known as “the intestines of earth and the restoring agents of soil fertility” (Shipley, 1970). Earthworms are essential for soil structure, microbial community activity, nutrient immobilization, nitrogen and organic matter mineralization, soil permeability, and soil characteristics (pH, organic matter, nitrogen, and granulometry), claim Kumar and Kumawat (2018). The soil is altered chemically and microbiologically as it passes through the earthworm’s digestive tracts (Lemtiri et al., 2014). Due to their ease of collection, identification, and breeding, as well as their high sensitivity to environmental pollution, earthworms are excellent sentinel species for ecotoxicological studies of pesticides in terrestrial ecosystems (Owagboriye et al. 2020, Wang et al. 2012, Chen et al. 2018).

Now-a-days, most of the farmers in south India using chlorantraniliprole (CAP) as effective insecticide to control pest. It is a human-made insecticide; class - anthranilic diamides. It controls moth, butterfly caterpillars (larvae), some beetles, “true” bugs like aphids and Spittlebugs. It was first registered for use in 2008. They are used on rice, variety of fruits, vegetables, potatoes, cotton, turf grass, ornamental plants, public landscaped areas, and as seed treatments. It may be granules, concentrates, or liquids. It is persistent and mobile in the environment. It does not easily dissolve in water but moves in the environment because it does not bind well to soil. It breaks down in soil very slowly, with half-lives of up to 1,130 days (Chlorantraniliprole Pesticide Fact Sheet, 2008).

Chlorantraniliprole binds to a specific receptor in muscles called the ryanodine receptor. When CAP binds to this receptor, it causes muscle cells to leak calcium. The muscles stop working normally. The insect is paralyzed and dies. The ryanodine receptor is different in insects than in mammals. CAP binds much more tightly to the receptor in

insects (Gutteridge et al., 2006 and Sattelle et al., 2008). It is toxic to insects mainly if it is eaten also to insect eggs, larvae, and pupae (Brugger et al., 2010 and Krishnan et al., 2021). Earthworm populations can decrease as a result of pesticides, particularly insecticides, which can kill them directly. The concentration of the pesticide and the length of exposure tend to affect the mortality rate of earthworms exposed to it.

Histology is the most useful tool for determining the influence of agricultural pesticide, industrial pollutants, organic wastes etc., at tissue level of an organism as it provides useful information on soil contamination. Pesticides may adversely affect earthworms by coming into contact with their skin or through feeding on contaminated soil litter. The earthworm mostly absorbs these chemicals through its skin and body wall. Earthworm skin is believed to be a primary conduit for the absorption of toxicants and comes into direct contact with polluted soils, according to research (Saxe et al. 2001, Jager et al. 2003, Vijver et al. 2003). The earthworm's epidermis and cuticle, which also contain ions, serve as its main barriers against the environment and either permit or prohibit the passage of xenobiotics into the body (Clauss, 2001). Determination of soil properties is one of the most useful physical tool so it also indicate soil denaturing by the application of enormous pesticides in agricultural field. many literature reported that various pest. Hence, the study was selected to observe histopathology of body wall of indigenous species of earthworm viz. *L.mauritii* and determination of soil properties with respect to pH, nitrogen, phosphorous and potash after exposed to sublethal concentrations of CAP under laboratory conditions. Many researchers found that toxic effect of various pesticides on earthworms. As per the literatures available, no study has been made concerning the insecticide CAP on *L.mauritii*.

Insecticides are proved to be toxic to earthworms by various workers (Reinecke S.A. and Reinecke A.J. 2005 ; Yajuan Shi et al., 2007). They have been used to assess impact of soil pollution [Edwards, 1998; Sanchez-Hernandez, 2006]. The laboratory toxicity of insecticides on various species of earthworms have been investigated (Stenersen, 1979; Roberts, and. Dorrough, 1983.; Stenersen, et al. 1992; Ribera et al. 2001). Tong Liu et al., 2018 studied Growth, reproduction and biochemical toxicity of chlorantraniliprole in soil on earthworms (*Eisenia fetida*). Oluchi Onyinyechi Ijomah et al. (2020) studied the antioxidant enzymes and histopathological effect of body wall muscle layer on *E.fetida* after exposed to crude oil contaminated soil. Salokhe et al. (2015) studied biological ability, soil properties and gut microflora of *E. Eugeniae* after exposed to fipronil in soil. Rashi Miglani et al. (2022) studied effect of imidacloprid and chlorpyrifos toxicity on earthworm *Amyntas alexandri* under laboratory conditions. Suneel Kumar and Satyendra Singh [2017] studied the toxic effects of phorate on morphological and structural integrity of the tissues. The morphology of gonads of earthworms has been well studied Joshi and Dabral [2008]. Lakhani Leena [10] observed "the effect of an organophosphorus insecticide azodrin on the histomorphology and histochemistry of testes of an earthworm *Eudichogaster kinneri* in an exposure of twenty days".

MATERIALS AND METHODS

Materials:

Soil and cowdung: Clay loam soil and fresh cowdung were obtained from Annamalai University, Agricultural Farm and Dairy-yard.

Insecticides: Chlorantraniliprole (made in India) was purchased from an agro-center in Thanjavur, Tamil Nadu, India.

Experimental organism: *L. mauritii* was widely distributed in South India. Hence it was selected as test organisms in this study. The body of *L.mauritii* is long, cylindrical and tubular. The ventral surface is pale in colour and the dorsal surface is light brown to yellow in colour with purplish blackish band like tinge. Adult worms are 8-21 cm long, 3-5 mm in diameter, and weight 0.8-1.5 g with 165-190 segments. *L.mauritii* was obtained from Annamalai University dairy yard in Annamalai Nagar, Tamil Nadu and India. They were acclimatized to the laboratory conditions by growing in cow dung.

Experimental Setup:

Sun-dried and powdered cow dung (a nitrogen- rich natural food for earthworms) was mixed with soil (low nitrogen) in a ratio of 1:3 (vol/vol). It was termed the "soil substrate" and used throughout this study.

For chronic toxicity study, sublethal concentrations of CAP were selected from 96 h

LC50 value of 10.22 mL Kg⁻¹ (T1-1/2nd of 96 hr LC50 – 5.11 mL Kg⁻¹ ; T2 - 1/5th of

96 hr LC50 – 2.04 mL Kg⁻¹; T3-1/10th of 96 hr LC50 – 1.022 mL Kg⁻¹).

Histopathological assay

In control, soil substrate was mixed only with water. Selected sublethal concentrations of CAP was mixed with 1 Kg of soil substrate using 300 ml of water. It was considered as T1 T2 and T3. Well clitellated *L.mauritii* was introduced into each experiments conducted in troughs. The troughs were covered by nylon nets and maintained at room temperature (28±2°C) with 60-70% moisture content. Three replicates were maintained for every experiment.

Three *L. mauritii* were removed from each experimental period (5th, 15th and 30th day) then to minimize their movement while easily dissecting them, they were kept in a freezer for about 1 h before dissection. Later the animals were dissected and skin were sliced. Tissue samples from the body wall and viscera were cut and placed inside a labelled tissue embedding cassette. The cassette was then placed in a 24-hour automatic tissue processor for 18-hour for complete processing. The processing involves complete fixation in formal saline solution, chemical dehydration and finally embedding in molten paraffin wax. After the wax has hardened, the embedded sample was cut with the microtome. Sections cut from the sample was then placed on a clean grease free slide for viewing under the microscope. Before viewing, the slides were stained using the H and E (Haematoxylin and Eosin) staining method to demonstrate the general structure of the tissue. The slide is then viewed microscopically and the tissue structures between each concentration and the control were compared.

Effect on CAP on soil properties:

On 30th day of histopathological experiment, soil was collected from Initial (before inoculation of earthworms), C (insecticide free soil after 30 days introduction of worms), T1, T2 and T3. Physical properties such as pH, Nitrogen, Phosphorus and potash was analysed in this soil.

The total nitrogen was estimated by the Kjeldahl method, as detailed by Tandon (1993). Total phosphorus content of the sample was estimated as per Tandon (1993) by colorimetric method. Total potassium content of the sample was determined by Flame Photometric method as described. The determination of organic carbon was carried out as per the procedure of

a

RESULTS AND DISCUSSION

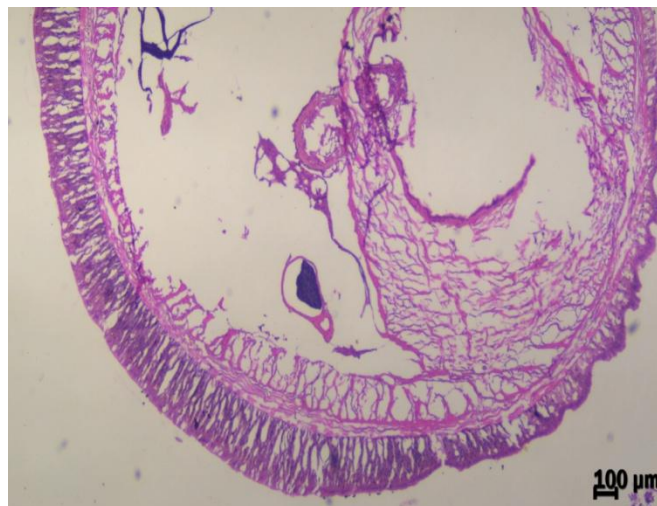
Effect of CAP on Soil properties

Properties	Initial	On 30th day			
		Control	T1	T2	T3
pH	6.54	7.01	6.42	6.65	6.72
Carbon	0.396%	0.311%	0.258%	0.271%	0.268%
Nitrogen	1.67 ± 0.026	1.78 ± 0.021	1.28 ± 0.034	1.49 ± 0.042	1.65 ± 0.031
Potassium	13.645 kg/h	16.342 kg/h	14.134%	14.723%	15.01%
Phosphorus	376.09 kg/h	422.43 kg/h	326.771 kg/h	338.21 kg/h	375.33 kg/h

The present results showed that pH, nitrogen, carbon, phosphorus and potash content in initial, control, T1, T2 and T3. They were decreased in initial than control. But in treatments, they were highly reduced in T1 followed by T2 and T3. It was reported that higher concentration of Cap was highly affected physical properties of soil.

Studies were made to analyze properties of CAP treated and control soil with respect to pH, carbon, phosphorus and potash content to monitor the effect on soil fertility. It was observed that there was reduction in pH, carbon, phosphorus and potash content in CAP treated soil than in control. The results were proved by the finding of Salokheet al. (2015). They reported that fipronil reduced the soil properties and also found number of gut microflora of *Eudriluseugeniaeas* well as their enzymes production ability was reduced as compared to that in the control. It is one of the major evidences to this study. In conclusion, the data suggests that insecticide CAP is not only toxic to earthworms but also reduces the fertility of soil to a greater extent.

FIGURE 1.A – T1

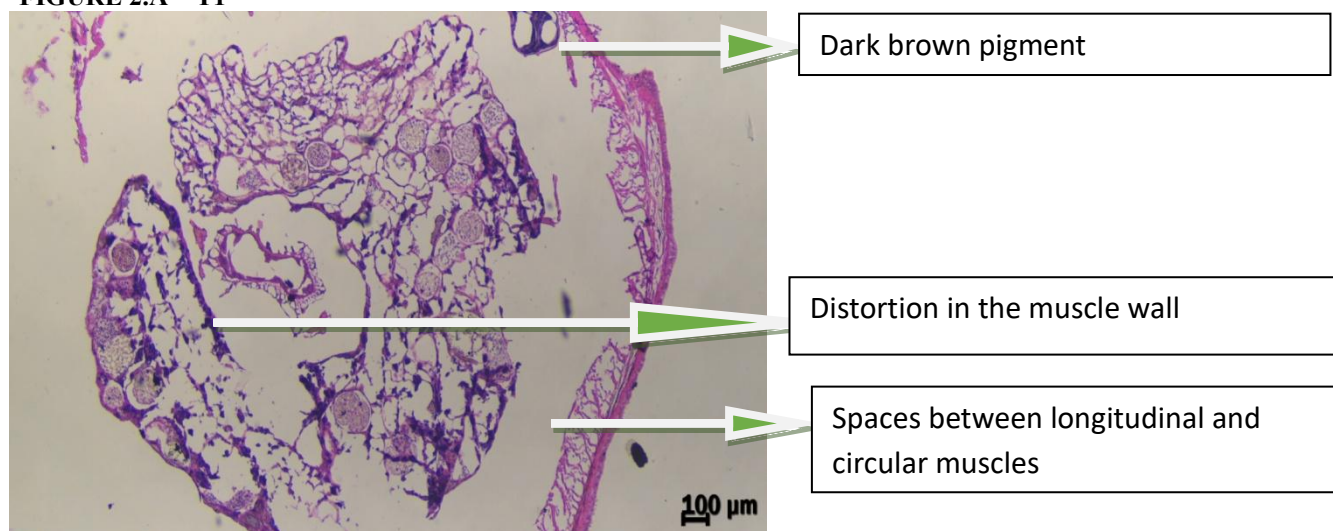


Figs. 1. Control skin showing normal longitudinal and circular muscles (x100)

NOTES

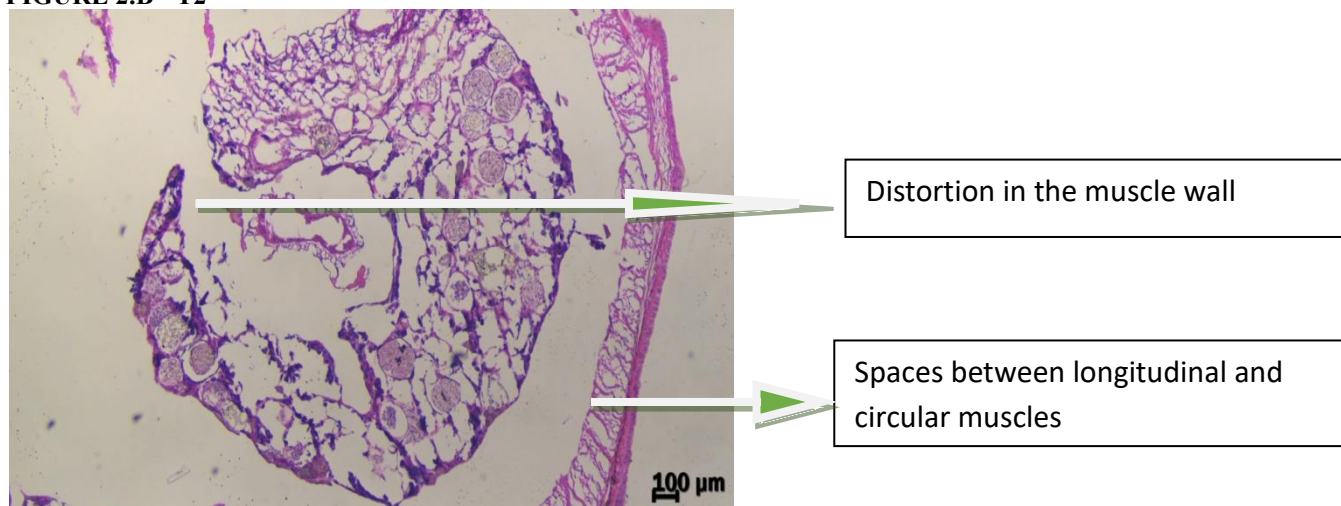
Histopathological effects of Observation of histology of body wall in *Lampitoma mauritii* and Soil properties after exposure to chlorantraniliprole 7 days (H&E x 400). (A) Control samples; (B) 1 mL samples (0.25%); (C) 2 mL samples (0.50%); (D) 3 mL samples (0.75%).

FIGURE 2.A – T1



On 5th day of higher sublethal concentration of CAP exposure (T1), the first layer of cuticle is highly destructed. Whereas CAP affected development of epidermis. In muscle layer, outer circular muscle fibres were very thin when compared to control. In most of the sites, degenerated and vacuolized longitudinal muscle fibres were observed.

FIGURE 2.B - T2



Similarly In T2, CAP affected the development of cuticle and epidermis. In muscle layer, outer circular muscle fibres were poorly formed. More vacuoles were found in longitudinal muscle fibres

FIGURE 2.C -T3

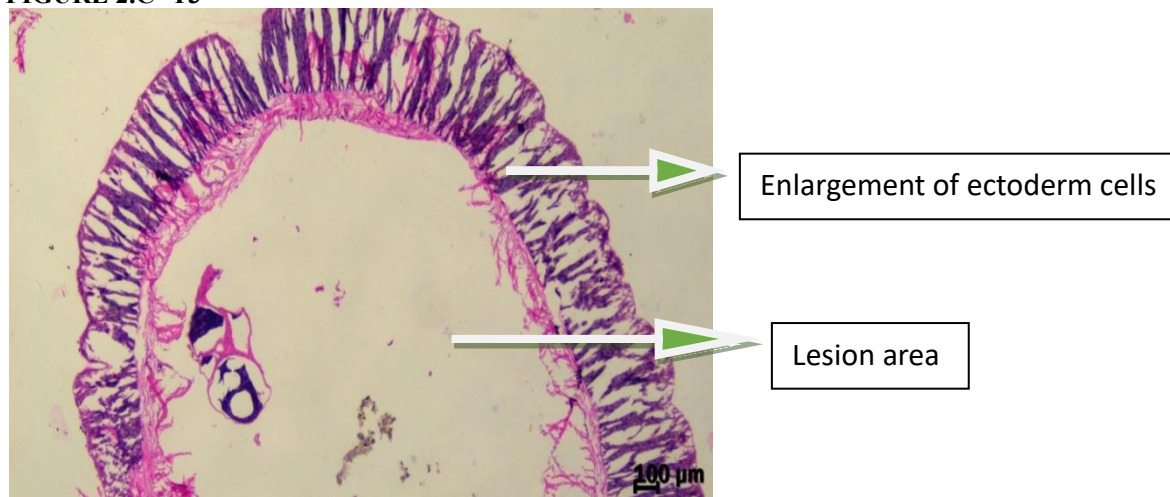


Figure 2: Histopathological effects of CAP exposure on *L.mauritii* after 5 days (H&E x 400). (A) Control samples; T1 B)T2; (C) T3

NOTES: S = NOTES: Cuticle (C) , Epidermis (E), Muscular (M) and Longitudinal (L) layer
In T3, very thin and damaged cuticle was found. More vacuoles were found in epidermis. Circular and longitudinal muscle layer was highly damaged.

FIGURE 3.A – T1

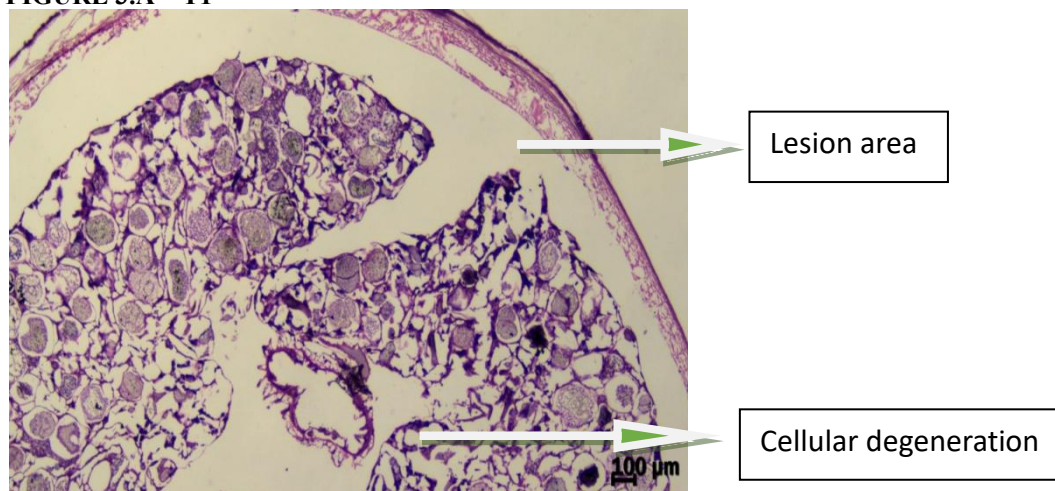


FIGURE 3.B– T2 ,FIGURE 3C – T3

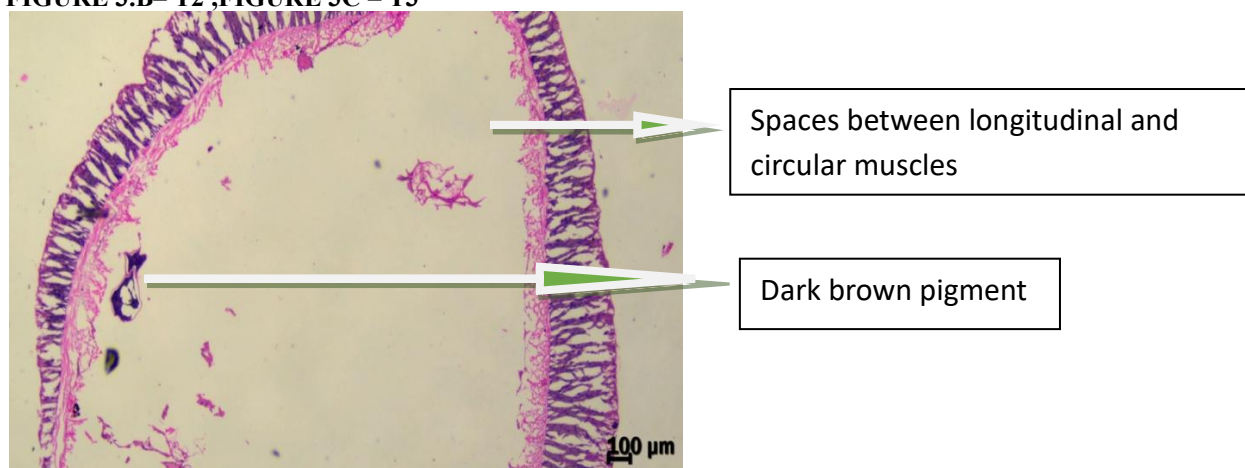


Figure 3 Histopathological effects of CAP exposure on *L.mauritii* after 15 days (H&E x 400). (A) T1 B)T2; (C) T3
NOTES: Cuticle (C) , Epidermis (E), Muscular (M) and Longitudinal (L) layer

On 15th day of exposure, in T1, cuticle and epidermis were not developed. Very thin circular muscle layer was observed. Lesion longitudinal layer. But in T2 and T3, moderately damaged cuticle and epidermis was observed. Severe damaged muscle layers were found.

FIGURE 4.A – T1

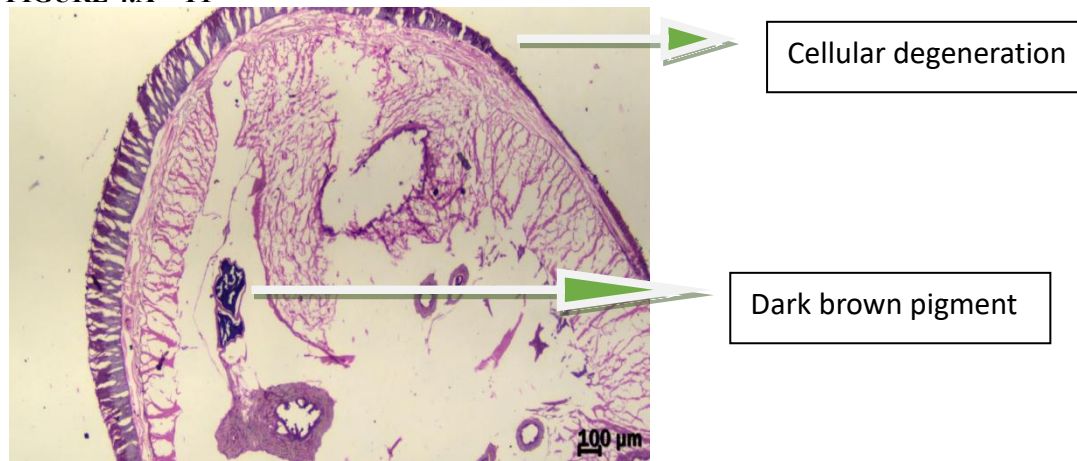


FIGURE 4.B – T2

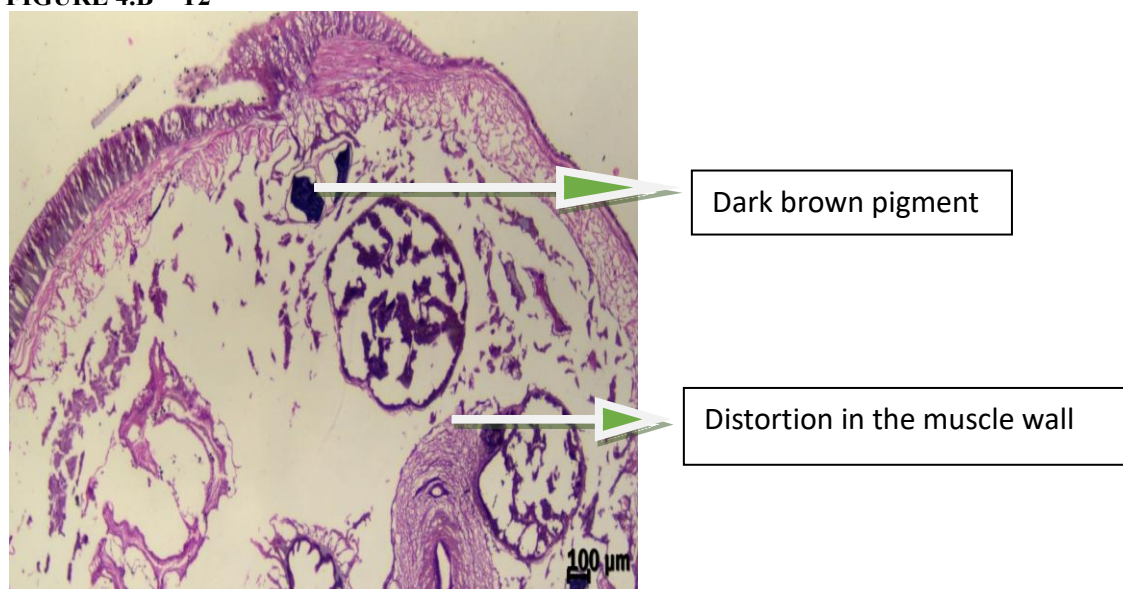


FIGURE 4.C – T3

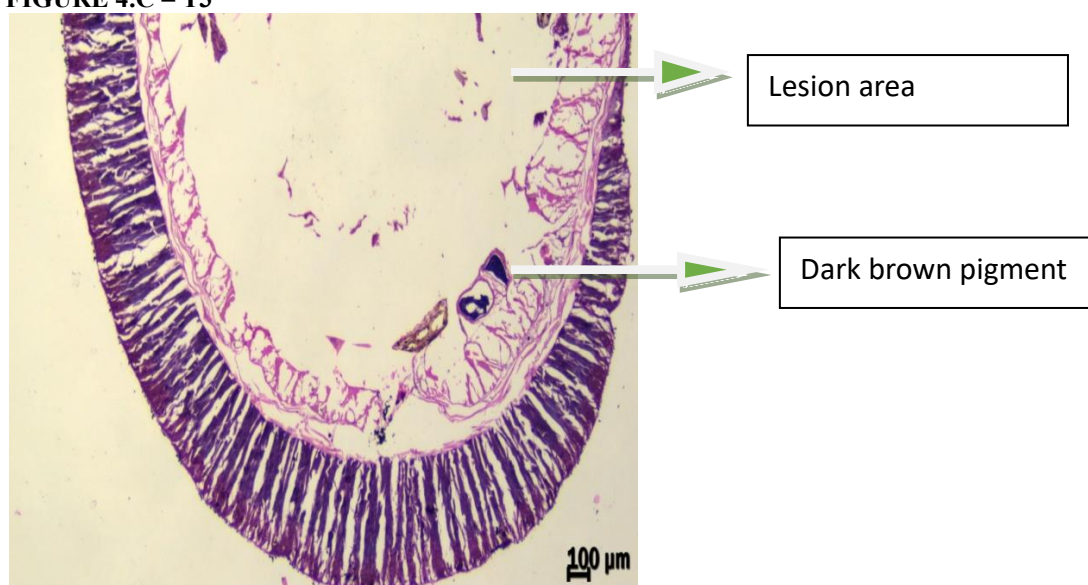


Figure 4: Histopathological effects of CAP exposure on *L. mauritii* after 30 days (H&E x 400). (A) T1B)T2 (C) T3NOTES: Renewed Cuticle (C) , Epidermis (E), Muscular (M) and Longitudinal (L) layer

In the present study, the degree of histopathological changes in body wall was more in T1 than T2 and T3. Compared with all the experimental period, severe damages were observed on 5th followed by 15th and 30th day.

Histology of Body wall

The body wall of an earthworm is very thin, soft, shiny, elastic, and highly vascular. It consists of: Cuticle, Epidermis, Muscular Layer and coelomic epithelium.

1. Cuticle

It is a thin, elastic, and non-cellular and finely striated layer. It is a layer that is secreted by the columnar epithelial or supporting cells of the underlying epidermis. They remain perforated by a minute pore through which integumentary nephridial and epidermal glands open out. It is a protective layer. It is made of 2 layers of collagenous proteins forming fibers and a polysaccharide with a small amount of gelatin.

2. Epidermis

It is single-layered but multicellular. It lies just below the cuticle. It consists of tall and cylindrical epidermal cells which are of the following type, performing different functions..

3. Muscular Layer

The muscle layer lies below the epidermis. It consists of an outer thin layer of circular muscle fibers running around the body. And an inner longitudinal muscle fiber running along the length of the body.

4. Coelomic epithelium

It is the outer envelope of the coelomic cavity and hence called the coelomic epithelium or parietal peritoneum or parietal layer. It consists of flat cells. These flat cells are recognized by nuclei.

Histopathology of body wall

Earthworms are known as biological indicator and are extensively used as model organisms in studies of ecotoxicology. Histopathological changes in earthworms have been identified as important markers of toxicity. Insecticides affect earthworms by dermal contact and by ingesting the contaminated soil.

Earthworms' histologic changes after exposure to 5.11 mL/kg, 2.04 mL/kg, 1.022 mL/kg revealed induced marked histopathological changes in the body wall of earthworms at all the experimental period (Figures 1, 2.A, B, C, 3.A, B, C and 4.A, B and C).

The results in the present study reported that body wall of *L. mauritii* was severely affected on 5th and 15th day of exposure but on 30th day, damages were renewed. It was supported by various researchers. They found that effect of pesticides on various organs of earthworms. Histopathological alterations such as cellular degeneration, moderate to severe areas of necrosis, areas of inflammation, inclusion bodies, pigments, and distortion of the shapes of circular and longitudinal muscles also showed the adverse impacts of crude oil pollution in the soils (Oluchi Onyinyechi Ijomah et al., 2020). Sensory tubercles on the surface body and chemoreceptors on their anterior segments, earthworms are able to detect a wide variety of pollutants (Reinecke et al. 2002). Dominant gut bacterial genera which are sensitive to pesticide treatment play an important role in organic matter decomposition and nutrient cycling both in earthworm's guts and soils (Byzov et al., 2015). It has been established that *Rhodococcus* and *Bacillus* bacteria from the earthworm's intestine can degrade pesticides (Kuipae et al., 2016). Numerous studies have demonstrated the crucial role of bacteria inhabiting the earthworm's guts in the transformation of organic pollutants in the environment (Sun et al., 2020). It is known that there are different ways to transform organic pollutants in the earthworm's gut such as the activity of transit bacteria, their free enzymes and intestinal symbionts (Byzov et al., 2015). The fungicide benomyl may cause the disruption of cell's microtubules (Hess and Nakai, 2000) and affect the development of *E. fetidispermatozoa* (Sorour and Larink, 2001). Besides, Kavitha et al. (2019) noted that organophosphate insecticide monocrotophos led to a reduction of the bacterial and fungal biodiversity and abundance in gut of *Lampitoma*.

Some biological and biochemical researches also stated the effect of pesticides on earthworms. Espinoza-Navarro and Bustos-Obregon (2004) described that malathion also has a direct cytotoxic effect that causes the sperm count to change, with increase of metachromasia of the chromatin of the spermatozoa and the tail to coil. According to Lionetto et al. (2012), pesticide exposure may result in changes in enzyme activity that represent metabolic disruptions and cell damage in particular tissues. According to Oruc et al. (2004), an increased amount of GST may provide greater defence against the harmful effects of pesticides and can therefore be utilized as a biomarker for pollution monitoring.

Acetylcholinesterase is a crucial enzyme that is involved in the nervous system's transport process. Organophosphorus mostly inhibited the activity of acetyl cholinesterase (Tiwari et al., 2016). AChE activity has been shown to be strongly inhibited when *Eisenia fetida* is exposed to the carbamate insecticide methiocarb (Calisiet al., 2009). Chlorpyrifos (OP) has been demonstrated to dramatically reduce the ChE activity in *Lumbric terrestris* (Martinez et al., 2013). Assays of the enzyme amylase, cellulase, invertase and pectinase from the gut of *E. eugeniae* revealed that their production was reduced in the fipronil mixed with soil as compared to that of control (Salokhet et al., 2014).

Histopathological investigations may indicate a harmful impact of organisms brought on by past or ongoing exposure to harmful substances. It has been demonstrated that pesticides in soil have an impact on earthworms at the tissue level. Nutrient absorption is significantly influenced by the gut wall's epithelial cell layer. Earthworms exhibit cellular expansion and the loss of chromatin components in their nuclei with exposure to various chemicals and pesticides (Muthukaruppan et al. 2005). Morowati (2000) examined the histopathology of earthworms (*Pheretima elongata*) exposed to glyphosate in the field. He found that the worms' intestinal epithelial cell structure was lost, there was no cell regeneration, and there was a complete loss of chromatin from the first to the third week of exposure. However, in the fourth week of exposure, there was a noticeable cell regeneration. Muthukaruppan et al. (2005) investigated the sublethal toxicity of the herbicide butachlor on the intestine of the *Perionyx excavatus* earthworm. They found that the earthworm's intestine had glandular cell enlargement after being exposed to the herbicide. They also noted that changes in the intestinal region may have a significant impact on food intake, which may in turn indirectly limit the earthworm's ability to reproduce. The impact of the organophosphorus insecticide profenofos on the histological alterations in the body wall of the earthworm *Eisenia fetida* has been studied by Reddy & Rao (2008). According to Bansiwala and Rai (2010), a sublethal dosage of the organophosphate insecticide malathion caused noticeable pathological alterations in the body wall, including a perforated cuticle and a deformation of the longitudinal muscle cells' structure. According to Oluah et al. (2016), the earthworm *Naucaloeus* showed damage to its chloragogenous layer, epithelial tissues, glandular expansion of the epithelial tissues, significant vacuolations, and pyknotic cells following atrazine exposure. When they applied the herbicide profenofos to earthworms, they saw that the subterranean fluid was not well regulated, causing the earthworms to break apart and the muscles in their body walls to deteriorate [Zhang et al., 2023].

Suneel Kumar and Satyendra M. Singh suggested that phorate exert its toxic effects on morphological and structural integrity of body wall of both earthworms *Metaphire posthuma* and *Lampitoma*. Gobi Muthukaruppan et al. observed "glandular cell enlargement in the intestinal region of *perionyx ansibaricus* after exposure to butachlor and suggested that which may massively affect food intake and which in turn may indirectly inhibit the earthworms' growth and reproductive capacity". Sherwan Taieb Ahmed showed that four pesticides Cyren, Ridomil, Triplen and Mamba significantly decreased sperm numbers of *Lumbric terrestris*. Sophie et al. showed that "low concentration dieldrin caused structural damage, especially to the nucleus of the sperm which may cause several changes in morphology, motility, and sperm density".

On 30th day of experiment, damages in the body wall was started to renewed due to biodegradation of CAP by the presence of degradable bacteria and fungi in intestine. It was supported by many researcher's findings. Kavitha et al. reported that "organophosphate insecticide, monocrotophos was affected microbial population and histology of intestine

upto 15 days due to toxicity of monocrotophos. Thereafter, they were recovered by presence of some of the pesticide degrading bacteria and fungi in the gut".The results of the study showed that insecticide lambda cyhalothrin highly inhibited the biomass and histology of testis than herbicide pretilachlor.

Doherty et al. reported sub-lethal levels of benzene, toluene, ethylbenzene and xylene (BTEX) compounds induced pathological changes in the body of the earthworms (*E. eugeniae*) including cellular degeneration, moderate to severe areas of necrosis, areas of inflammation, inclusion bodies, pigments, and distortion of the shapes of circular and longitudinal muscles as observed in this study. Kilic also detected enlargement of epithelial cell lining, necrosis, and loss of structural integrity of circular and longitudinal muscles in *Lumbricusterrestris*in polluted soil. Bansiwali and Rai also observed similar result as they observed obvious pathological changes which include ruptured cuticle and distortion of shape of muscles after exposure of earthworm to Malathion.

Rashimigilani et al., (2022) reported that Earthworms exposed to various concentrations of Chlorpyrifos and Imidacloprid exhibited significantly higher levels of DNA damages ingastrointestinal tract than did the corresponding controls. Gajanan Vishnu Mali (2019) indicated the adverse toxic effects of bifenthrin and very little effect of metabolites of bifenthrin on the morphological properties and structural integrity of the tissues. Many earlier reports also suggest the morphological and histopathological changes in earthworms on exposure to different toxic metals and organophosphate pesticides. The disintegrations of cuticularand ectodermal membranes were recorded by Amaral et al. (2006).There are certain investigations made on the damage caused by insecticides at the genomic level i.e., Chlorpyrifos causes DNA damage and also induces cell apoptosis in different types of cells (Li et al., 2015).

The novel insecticide chlorantraniliprole (CAP), which has a specific mode of action: it activates ryanodine receptors that can release stored calcium and, hence, cause an impaired muscle contraction regulation(Cordova et al., 2007; Larson et al., 2012). Due to the differential receptorselectivity of CAP between ryanodine receptors in various animalgroups, CAP is relatively safe for mammals, birds and fish, but veryhighly toxic for several aquatic invertebrates (Lavtižar et al., 2016).Salokhe et al., (2015) observed that in Fipronil treated soil the earthworm, *EudrilusEugeniae*population, growth and reproductive potential, carbon and phosphorus content gut microflora as well as enzyme production ability was adversely affected.After 48h exposure of phorate, a thinning of the earthworm's body wall started due to atrophy, which ultimately led to necrosis and erosion of the entire body wall (Suneel Kumar and Satyendra Singh, 2017).Tong Liu et al., 2018 reported that the weight of earthworms was significantly reduced at 5.0 and 10.0 mg/kg at 28 and 42 days after CAP application whereas on 14th day , CAP induced excess production of reactive oxygen species (ROS) resulting in oxidative damage to biomacromolecules.

Summary

By boosting agricultural output and reducing infectious diseases, pesticides were utilized to improve human life and survival, but their negative effects on the environment and human health were disregarded. The findings of the present study open many vistas on the effect of insecticides on earthworms. Worldwide many insecticides have been strictly banned but it was observed that a sizeable number of insecticides are still being produced, marketed and used in India including in this study. It is concluded that when earthworms are in direct or indirect contact with insecticides face a huge of its diversity. Many histological changes were also observed in earthworms when exposed to different concentrations of insecticides. These findings will help to understand the harmful effect of insecticides on earthworms and other non-target organism.

CONCLUSION

The present study concludes that chlorantraniliprole caused significant histopathological damage to the body wall of *Lampito mauritii* on the 5th and 15th days of exposure. Partial recovery was observed on the 30th day, possibly due to microbial degradation of the pesticide. These findings highlight the ecological risks of pesticides to earthworms and emphasize the need for sustainable pesticide management and soil protection.

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