MORPHOLOGICAL AND BEHAVIOURAL CHANGES IN EARTHWORMS DURING MALATHION INTOXICATION AND EFFECT ON SOIL FERTILITY

BANSIWAL, K., RAI, N., KURAWAR, R. AND RATHOR, D. S.

Department of Environmental Sciences, Mohan Lal Sukhadia University, Udaipur 313 001.
E. mail: vinitabansi@yahoo.com

Received: July 1, 2010; Revised: July 17, 2010; Accepted: July 27, 2010

Abstract: The aim of the present study was the evaluation of toxic stress of malathion on the morphological and behavioural changes in earthworms, Eisenia fetida as well as to analyse the soil fertility. Soil beds were prepared in plastic tubs containing about 1 kg dry filtered soil + 250 grams dry powdered cow dunk, mixed thoroughly with water. Total 6 such beds were used for each experiment. Five doses of malathion, (0.010 %, 0.025%, 0.050%, 0.075% and 0.1%) mixed separately in first 5 tubs and the 6th tub was kept for control. 20 mature healthy earthworms of approximately same size and weight were kept in each tub. All containers were cover with wet muslin cloths. Such experiments were set for 10, 20 and 30 days. The soil properties (pH, electrical conductivity, organic carbon, available nitrogen, available phosphorus and chloride) were analysed before and after each experiment. The results show several morphological and behavioural changes in earthworm and remarkable changes in physico-chemical parameters of soil.

Key words: Earthworms, Malathion, Morphological changes, Soil fertility.

INTRODUCTION

The pesticides are used to protect the crops from pests so as to increase the agricultural production. A huge amount of pesticides are used annually in the agricultural fields [1], that also affect the non target components along with eradicating unwanted insects and controlling disease vectors [2]. Among pesticides, organophosphorus compounds are commonly used as insecticides [3]. They constitute the largest group of chemicals used to control of pests, including invertebrates, vertebrates and, to a lesser extent, plants. About 200 organophosphorus compounds are available in this class, which has been formulated into literally thousands of different products [4]. Malathion (S-1,2-di (ethoxycarbonyl) ethyl, dimethyl phosphorothionate) is a nonsystemic, wide spectrum organophosphate insecticide. It was one of the earliest organophosphate insecticide introduced in 1950. It is used for agricultural and non-agricultural purposes. Once malathion is introduced into the environment, it may cause serious trouble to non-target organisms like fish, earthworms and other wild life. All the organophosphates are neuro-poisons and also, much less persistent then the organochlorine [5,6].

The toxicity of organophosphate is primarily due to powerful inhibitor of true and pseudo-cholinesterase activity through phosphorylation
of serine hydroxyl group of the ecstatic site in insects and target organisms [7,8]. This causes the increase of acetylcholine level at the nerve synapse resulting continual stimulation of the nerve fibres and showed symptoms like tremors convulsion etc. which ultimately produces biochemical lesions in target and host organisms. The main advantage of the organophosphate is their low cumulative ability and short-term persistence in the environment [9].

Malathion resides in the soil and water for several days and poses a constant threat to non-target organisms. The present study deals with the negative effect of Malathion on different soil parameters like, pH, electrical conductivity, chloride, available phosphorus, available nitrogen and organic carbon.

Soil is a complex substrate for plant growth which is a mixture of, solids, liquids and gases that provides the life support system for roots of the growing plants and micro-organisms such as bacteria. When a pesticide enters soil, some of it gets stuck to the soil particles, particularly organic matter and bind to it. Hence the pesticides treated soil exhibits low value of organ carbon which is not available to plant roots, a vital component of plant growth system [10]. In past effects of several organophosphates on soil bacterial and fungi numbers, soil enzymes, as well as reduction in earthworm reproduction have been discovered [11-15]. In present investigation on attempt has been made to evaluate the morphological and behavioural changes in earthworms during malathion intoxication as well as to examine its effect on soil fertility.

**MATERIALS AND METHODS**

**Experimental Model:** Earthworms (*E. foetida*) were procured from the vermicompost unit of Rajasthan College of Agriculture, Udaipur. They were maintained in the laboratory conditions and acclimatization for 15 days. The worms used in the experiment were of approximately same body weight and body length.

**Chemical:** The pesticide used in the experiment was Malathion (50%). It was purchased from the local market’s shop.

**Preparations of soil beds:** The method used by Yasmin and Souza [16] was followed. Plastic tubes were used for preparations of soil beds. Dried soil (from nearby farmland) was crushed and filtered through a fine mesh sieve. One kg of fine soil was then poured in each plastic tub and then water was added to moistened the soil then 250 mg dried powdered (3 week old) cow dung was also added to each plastic tub to avoid starvation, as recommended by the International Workshop on Earthworm Ecotoxicology held in Sheffield in 1991 (IWEE1).

**Addition of Malathion:** Five doses (0.010 %, 0.025%, 0.050%, .0750% and 0.1%) of Malathion were selected and mixed thoroughly in above 5 plastic tubs. The 6th tub was kept as control.

**Experimental set-up:** 20 mature earthworms (same age group) were added to each plastic tub. The tubes were covered with wet muslin cloth. Thus one control set and one experimental set were prepared. 3 replicates were used for each set. To maintained up-to 70 percent moisture level water was supplied regularly. After 10, 20 and 30 days the changes were observed in activity, morphology and growth of earthworms. The soil samples were analysed to determine various physico-chemical parameters after same time.

**Statistical Analysis:** Statistical analysis for change in the total biomass and growth pattern of the earthworm at an interval of 10 days was conducted for one month and one way ANOVA was applied.

**RESULTS AND DISCUSSION**

Malathion is organophosphate pesticide and was found to be moderately toxic to earthworm. At 0.010 percent concentration of malathion, the changes in the behavior and morphology were
Table 1: Effect of different doses of malathion on soil fertility

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Sample name</th>
<th>Organic carbon (%)</th>
<th>Available Nitrogen (%)</th>
<th>Available Phosphorus (%)</th>
<th>Chloride (%)</th>
<th>pH</th>
<th>EC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>0.6</td>
<td>0.0042</td>
<td>0.0012</td>
<td>0.012</td>
<td>7.1</td>
<td>0.18</td>
</tr>
<tr>
<td>2.</td>
<td>0.010%</td>
<td>0.62</td>
<td>0.0042</td>
<td>0.0013</td>
<td>0.012</td>
<td>7.04</td>
<td>0.18</td>
</tr>
<tr>
<td>3.</td>
<td>0.025%</td>
<td>0.57</td>
<td>0.0055</td>
<td>0.0015</td>
<td>0.010</td>
<td>7.0</td>
<td>0.19</td>
</tr>
<tr>
<td>4.</td>
<td>0.05%</td>
<td>0.42</td>
<td>0.0058</td>
<td>0.0016</td>
<td>0.008</td>
<td>6.95</td>
<td>0.19</td>
</tr>
<tr>
<td>5.</td>
<td>0.75%</td>
<td>0.36</td>
<td>0.0058</td>
<td>0.0017</td>
<td>0.0071</td>
<td>6.9</td>
<td>0.20</td>
</tr>
<tr>
<td>6.</td>
<td>0.1%</td>
<td>0.30</td>
<td>0.0058</td>
<td>0.0018</td>
<td>0.0056</td>
<td>6.8</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Table 2: Effect of Malathion 50% on soil fertility CRD ANOVA for different characters. Statistical analysis of growth pattern after 10 days explains highly significant difference with respect to weight loss as compared to the control experimental setup. We found $F = 728.272$, $df = 5,12$, $p < 0.001$. Statistical analysis after 20 days of exposure in reference to growth of earthworms, shows a similar significant result where $F = 311.909$, $df = 4,10$ and $p < 0.001$. After one month of malathion exposure show value of $F = 2357.630$, $df = 2,6$ and $p < 0.001$ which is highly significant. Result exhibits highly significant difference between treatment and soil pH, EC, organic carbon, available nitrogen, available phosphorus and chloride. All the results were found to be significant at 1% ($p < 0.01$) as revealed in table.

<table>
<thead>
<tr>
<th>SN</th>
<th>Character</th>
<th>Treatment</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Organic carbon</td>
<td>0.065876669**</td>
<td>7.2222134e-05</td>
</tr>
<tr>
<td>2</td>
<td>Chloride</td>
<td>1.9667555e-05**</td>
<td>1.705556e-07</td>
</tr>
<tr>
<td>3</td>
<td>Nitrogen</td>
<td>1.8453336e-06**</td>
<td>4.444423e-09</td>
</tr>
<tr>
<td>4</td>
<td>Phosphorus</td>
<td>1.5655555e-07**</td>
<td>3.8888893e-09</td>
</tr>
<tr>
<td>5</td>
<td>pH</td>
<td>0.017088887**</td>
<td>0.00026110982</td>
</tr>
<tr>
<td>6</td>
<td>EC</td>
<td>0.00030666652**</td>
<td>5.5555516e-05</td>
</tr>
</tbody>
</table>

observed like coiling after 24 h. No mortality was found after one month. In this concentration weight of animals after 10, 20 and 30 days was increased but less than the control (Figs. 1-3).

At 0.025 percent of malathion the earthworm also showed coiling, and weight was increased but less than the control. After 20 days earthworm’s weight was increased as compared to control. This was due to swelling of earthworm body. The animal body became blackish in colour.

At 0.05 percent concentration of malathion earthworm showed coiling like other concentrations. Constrictions were seen after 8 days of exposure. After 10 days of experiment earthworm weight was less than the control and appears to be very weak. However, after 20 days of exposure weight of earthworm was more than respective control due to swelling of earthworm’s body and more than half worms were died in this concentration.

More drastic coiling was found at 0.075 percent concentration of malathion and yellowish fluid oozed out from the cuticle. A negligible growth and increased weight was observed after 10 and 20 days respectively in compared to the control, which is due to swelling of animal body due to storage of water.

After 20 days of pesticide exposure earthworm clitellum was found in squeezed condition and reddish secretion was discharged from this region. A number of constrictions were noticed in all earthworms. Out of twenty earthworms used in experiment, twelve died in 0.075 percent concentration after 24 days of exposure.

The malathion adversely affect to the growth and development of the earthworm. At high concentration there were many cracks in cuticle of entire body from where oozing of coelomic fluid, swelling and yellow colouration of body, softening of tissues and sluggish movement were
Fig. 1: Change in the total biomass and growth pattern of the earthworm in Malathion treated soil after 10 days.

Fig. 2: Change in the total biomass and growth pattern of the earthworm in Malathion treated soil after 20 days.

Fig. 3: Change in the total biomass and growth pattern of the earthworm in Malathion treated earthworm after 1 month.
recorded. Similar observations were reported by several workers [15,17-20].

Along with affecting the earthworm body malathion also reveals deleterious effect on soil properties as well as on macro- and micro-fauna of the soil, although the pesticide considered to be non-persistent in soil.

The physico-chemical properties of the soil such as organic carbon, available phosphorus, chloride, available nitrogen, pH and electrical conductivity are also affected with malathion. Indiscriminate use of pesticide in different fields alters the soil properties in a negative way, which ultimately decreases its fertility. Our study showed decreased pH with increasing the doses of malathion and non-significant effect on the concentration of available nitrogen, significant increasing effect on available phosphorus and decreased organic carbon and chloride in treated soil. Similar results were observed by Singh et al. [21] and Jaiswal [22].

Thus it can be inferred after this study that applied doses of malathion (50%) in agricultural lands affect the most tolerant species of earthworm, *Eisenia fetida* as well as posing a negative impact on some physico-chemical properties of soil.

**REFERENCES**


