

## Effect of Selected Textile Dyes on the Survival, Morphology, and Burrowing Behavior of the Earthworm *Polypheretima elongata*

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Tiruppur town, located in Coimbatore district of Tamil Nadu, is one of the centres for hosiery and knitting industries. There are over 96 dyeing units in which different varieties of yarn and cloths are processed for dyeing. The effluents from the dyeing industries containing synthetic organic dyes and a variety of inorganic chemicals are discharged without treatment, either into water bodies or on open lands. These chemicals may directly affect the biotic community of the recipient environment or indirectly by making the environment unsuitable for habitation. Organic dyes being the principal component used in the dyeing process, in the present study, the effect of two extensively used textile dyes, Navy blue M3R and Direct brown 2G belonging to reactive and direct group of dyes respectively, on the survival, morphology and burrowing behaviour of the earthworm, Polypheretima elongata have been studied.

Earthworm in its natural habitat is at the risk of being exposed to dyes present in the dye effluent due to the latter's disposal on open lands or irrigation of agricultural lands with dye contaminated water, hence selected as the test organism.

### MATERIALS AND METHODS

The effect of dyes on the survival of earthworm, P. elongata, was assessed following the static type of bioassay method. Acute toxicity studies were conducted to determine the 24 hours LC<sub>50</sub> value of dye solutions following the procedure given in standard methods for the examination of water and waste water (APHA 1980). Earthworm in its natural environment is prone to be subjected to hypoxic condition as a result of removal of air contained between soil particles due to utilization of oxygen for various oxidative reactions

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or when the soil is flooded with rain or dye contaminated irrigated water. Therefore, the effect of dyes under progressive hypoxic condition was studied by subjecting the earthworms to total submersion in six different concentrations of dye solutions in suitable containers over laid with liquid paraffin.

The soil selection and burrowing behaviour of earthworm was studied by introducing five earthworms into each beaker containing known concentration of dye mixed soil to a height of five cm. Earthworms were considered to be burrowed if 3/4 of their body length was under sand.

## RESULTS AND DISCUSSION

The effect of dyes was concentration dependent and the percentage of survival decreased with increasing concentration of dye solutions (Table 1). Mortality was observed only after 12 hours in various concentrations of dye solutions. The median lethal concentrations were

Table 1. Percentage survival of earthworms in different concentrations of dye solutions under normoxic and progressive hypoxic conditions

Concentration of dyes	Hours			
	6	12	18	24
(i) Navy blue				
M3R				
200 ppm	100.0 (100.0)	100.0 (100.0)	100.0 (100.0)	100.0 (75.0)
300 ppm	100.0 (100.0)	100.0 (100.0)	100.0 (75.0)	83.3 (66.6)
450 ppm	100.0 (100.0)	100.0 (100.0)	100.0 (66.6)	44.4 (50.0)
700 ppm	100.0 (100.0)	100.0 (100.0)	100.0 (25.0)	22.2 (16.6)
1000 ppm	100.0 (100.0)	100.0 (75.0)	83.3 (16.0)	0 (0)
ii) Direct Brown				
2G				
700 ppm	100.0 (100.0)	100.0 (100.0)	100.0 (91.6)	100.0 (58.3)
1000 ppm	100.0 (100.0)	100.0 (100.0)	100.0 (66.6)	77.7 (33.3)
1500 ppm	100.0 (100.0)	100.0 (100.0)	100.0 (41.6)	44.4 (16.6)
2200 ppm	100.0 (100.0)	100.0 (83.3)	83.3 (41.6)	11.1 (0)
3300 ppm	100.0 (100.0)	100.0 (58.3)	55.5 (0)	0 (0)

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Values in parentheses are for progressive hypoxic condition

461 ppm for Navy blue M3R and 1391 ppm for Direct brown 2G. When earthworms were subjected to progressive hypoxic conditions in dye solutions, higher percentage of mortality was observed in addition to decrease in the duration of survival. Further, apart from a decrease in the  $LC_{50}$  value of Navy blue M3R from 461 ppm to 367 and that of Direct brown 2G from 1391 ppm to 1148, the concentration of dyes (200 ppm of navy blue M3R and 700 ppm of direct brown 2G) which were sublethal under normoxic condition became lethal when the oxygen tension decreased, indicating synergistic action of hypoxia with dyes in increasing the magnitude of stress on earthworm. Earthworm in its natural environments is prone to be subjected to hypoxic condition and if the dyes are already present in the soil or the irrigated water is contaminated with dyes, they may produce acute toxic effects even in low concentrations.

Morphological changes such as constrictions and swellings started appearing from the posterior region within 24 hours of exposure to dyes. They are not equispaced and differ in their size and shape. Though prolonged submersion under water coupled with starvation resulted in degenerative changes commencing from the posterior end, constrictions and swellings were not observed. The posterior degenerative changes can be considered as an indication of complete drain of utilizable level of stored metabolites and dependence on the source provided by autolysis of its own tissues for the purpose of energy requirements. In view of the inherent capacity of regeneration, the utilization of its own tissues starting from the posterior region, sparing the anterior region containing vital organs, can be considered as an adaptive strategy to tide over the adverse condition, which warrants energy drain beyond its storage capacity without affecting its survival and perpetuation. The morphological changes observed in earthworms exposed to dyes were different in nature, therefore, the effect of dyes in causing such changes deserves further investigation.

Avoidance behaviour of oligochaetes was used as an index of stress caused by pollutants (White and Keilty 1988). Earthworm failed to burrow in soil containing even sublethal concentrations of Navy blue M3R, and Direct brown 2G, indicating the effectiveness of sensory mechanism in assessing the suitability of dye contaminated soil for habitation and prevalence of avoidance behavior. The avoidance behaviour though of adaptive value, however, will not help the animal to wriggle away from the toxic effects of dyes if spread over large areas as it may occur when lands are irrigated with dye contaminated water.

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