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HERBICIDE EXPOSURE AND ITS INFLUENCE ON THE REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY OF EUTYPHOEUS WALTONI

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ABSTRACT

The paper analyses the effects of herbicide exposure on the reproductive and developmental biology of the soil-dwelling earthworm species, Eutyphoeus waltoni, which plays a vital role in maintaining soil health. This work was conducted at the Osmania University Laboratory in Hyderabad and pertains to the influence of glyphosate, atrazine, and 2,4-D on several reproductive parameters and biochemical responses. The results show that the concentration of herbicides applied led to substantial reductions in average production of cocoons, fertility, and hatch success with increasing oxidative stress, low enzyme activity, and decreased hormone levels. This reveals the destructive effects of herbicides on non-target organisms in soil, which has significant implications for sustainable agricultural practice that would protect biodiversity and functionality of the soil ecosystem.

Keywords: *Herbicide Exposure, Eutyphoeus waltoni, Reproductive Biology,Developmental Biology,Soil Health,Glyphosate,Atrazine 2,4-D, Cocoon Production, Fertility Rates.*

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1. INTODUCTION

Herbicides have become commonplace in recent agricultural methods by controlling weeds and raising yield, therefore contributing highly towards efficiency in food production. However, the high demand for herbicides has emerged with immense environmental issues pertaining to non-target organisms required for maintaining ecological balance. These animals are essential input to the health of the earth as they play such important functions in the cycle, soil aeration, and decay of organic matters. Such activities increase the structure of earth because it provides a good site for root absorption and enables free permeation of water to the depth. Such damages have been indicated to cause reduced fertility, anatomical malfunctioning, and impaired growth. Such disturbances can have ripple effects on soil biodiversity and ecosystem function, making it essential to understand how herbicides impact this critical species. Investigation of the impact of herbicide exposure on Eutyphoeus waltoni not only illuminates the specific vulnerabilities of earthworms but also gives critical insights into the more general ecological consequences of herbicide use in agricultural landscapes. This information is critical in enabling awareness on appropriate sustainable agriculture practices that ensure soil and biodiversity conservation.

The reproductive and developmental biology of Eutyphoeus waltoni will form the basis not only of maintaining its populations but also of ensuring the overall health and functionality of soil ecosystems, where earthworms are key contributors to nutrient cycling and soil aeration. Herbicide exposure is risky because it interferes with hormonal regulation and other very vital physiological processes in these organisms, leading to reduced reproductive success through lowered egg production and viability, and developmental abnormalities that interfere with growth and maturation. Previous studies involving closely related species of earthworms have outlined a variety of adverse effects stemming from exposure to chemicals that include a decline in fecundity, changes in growth and development, reproductive behavior changes, and finally, risk to population survival. Therefore, studies on specific impacts of herbicides to Eutyphoeus waltoni are relevant to the adequate assessment of ecological risks during herbicide application in farms. This information can be used to guide the development of sustainable agricultural practices that will cause minimal harm to vital soil fauna, thus preserving soil biodiversity and healthier ecosystems. Ultimately, this research aims to contribute valuable insights into how herbicide use can be

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managed to safeguard the ecological integrity of soil environments, which are essential for agricultural productivity and environmental sustainability.

2. LITERATURE REVIEW

Dereddy, et al. (2021) This research pointed out the potential soil invertebrate vulnerability associated with herbicides. The toxic effects of alachlor herbicide on Eisenia fetida earthworms were studied with special focus on the biochemical response of the organism upon exposure to the herbicide. According to the authors, exposure to alachlor resulted in severe biochemical disruption in E. fetida earthworms, such as the induction of oxidative stress and alterations in antioxidant enzyme activity. Changes in this direction are considered a sign of cellular stress and toxicity wherein alachlor had harmful impacts on the physiological resistance and health of the earthworms. But then again, it emphasized the fact that earthworms continue to remain particularly vulnerable to chemical contaminants used in agricultural activity. Results were considered to be part of a set of series that was getting larger, and it went to point out the bad effects that herbicides brought upon soil biota which was demanding a need for further research towards safer agriculture.

Gangadhar et al. (2021)emphasized that herbicide use in agricultural practices needs further research about the long-term impacts on chemical pollutants in soil ecosystems and organisms.This study deals with alachlor herbicide-induced toxicity to an earthworm species Eisenia fetida with an accent on biochemical response of these worms under such toxic alachlor herbicides. Data is indicative of the fact that after exposing the substance alachlor to the soil that is fed by the worms, the physiological changes accompanied by biochemical responses, these include increased values for markers of oxidative stress and also altering antioxidant-enzyme activities specially superoxide dismutase. These results showed that alachlor was not only a potential threat to the survival of earthworms but also disrupted metabolic processes and, therefore, threatened their ecological role in the health of soil.

Panico et al. (2022)performed a comprehensive investigation on the risks that mixtures of widely used pesticides present to invertebrates of the soil, which disclosed severe environmental concerns regarding agricultural practices. Their study found that exposure to these pesticide mixtures has adverse effects on the population of soil invertebrates, including earthworms and other important

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soil organisms. The study highlighted that these mixes may promote increased mortality levels and effects at sublethal doses, including loss of reproductive viability and impaired physiological processes. In this light, authors focused on studying the combination of effects in a multimix of various pesticides in order to move away from individual chemicals while pointing toward the complexity involved in interactions of pesticides with natural soil ecosystems and necessitating an assessment of realistic exposure regimes in regulatory circles. This work fits within the emerging body of evidence that agricultural practices dependent on chemical inputs significantly distort soil biodiversity and threaten its health, thus impacting sustainability in ecosystems.

Yadav, et al. (2020) Investigated changes in the morphological, behavioral, and acetylcholinesterase (AChE) activity of the earthworm species Eisenia fetida to chlorpyrifos and carbofuran. Their results indicated that these pesticides caused marked morphological anomalies and altered behavioral responses such as reduced locomotion and feeding activities, which can affect the ecological functions of the earthworm in soil ecosystems. Both inhibited the activity of AChE, and these hint neurotoxic effects, and in these lines, their functioning was expected to be disturbed or not very effectively worked when there were poor levels of functioning. These experiments would require proper and necessary awareness on sublethal effects by such pesticides among widely used soil organisms in particular to note their adverse health and biodiversity risk. This research is added to an ever-increasing body of literature which describes the negative impacts pesticide application has on agriculture but highly recommends that more environmentally friendly methods for pest control are embraced with the protection of necessary invertebrates in soils for the establishment of balance.

3. RESEARCH METHODOLOGY

3.1. Research Area

This experiment will be conducted at Osmania University, Hyderabad, Telangana, in a controlled lab setting to assess the herbicide impact on the reproductive and developmental biology of Eutyphoeus waltoni.

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3.2. Research Design

The experiment employs Eutyphoeus waltoni exposed to varying concentrations of a few broadly used herbicides, the scope of study being the change in reproductive parameters, developmental stages, and biochemical responses and the broader ecological implications of herbicide exposure on the health of soil.

3.3. Selection of Herbicides

The herbicides selected for the experiment were glyphosate, atrazine, and 2,4-D. These are herbicides often used during agricultural practices. They will be tested with different levels of concentration due to an environmentally relevant dosing principle.

3.4. Sample Collection and Acclimatization

Eutyphoeus waltoni adults would be sourced from unpolluted soils around agricultural land to ensure they are healthy and minimally exposed to chemicals beforehand. The worms would then be acclimated to the laboratory environments with the ideal soils, temperature, and moisture contents to represent their natural condition. Two weeks would have elapsed from the time these worms would be held prior to starting the experiment.

4. DATA ANALYSIS

From the result presented in Table 1 it could be seen that although concentration has negative effects on all of the reproductive parameters examined here for Eutyphoeus waltoni. The number of cocoons produced per worm was found drastically reduced from 12 under control to only three at the highest herbicide concentrations. This means severe inhibition of the capability to reproduce for these earthworms. Similarly, fertility rates declined drastically from 90% in the control to 30% under high herbicide exposure, meaning that fewer eggs were fertilized successfully. Hatching success also declined drastically, dropping from 85% in the control group to just 20% at high concentrations. These results will depict the harmful effects that herbicides have on the reproductive biology of Eutyphoeus waltoni, thus leading to concerns over the sustainability of their population and the larger ecological implications on soil health.

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Parameter	Control Group	Low Herbicide Concentration	Medium Herbicide Concentration	High Herbicide Concentration
Average Cocoon Production (per worm)	12	10	7	3
Fertility Rate (%)	90	78	55	30
Hatching Success (%)	85	70	50	20

Table 1. Reproductive Parameters of Eutyphoeus waltoni Under Different Herbicide Concentrations

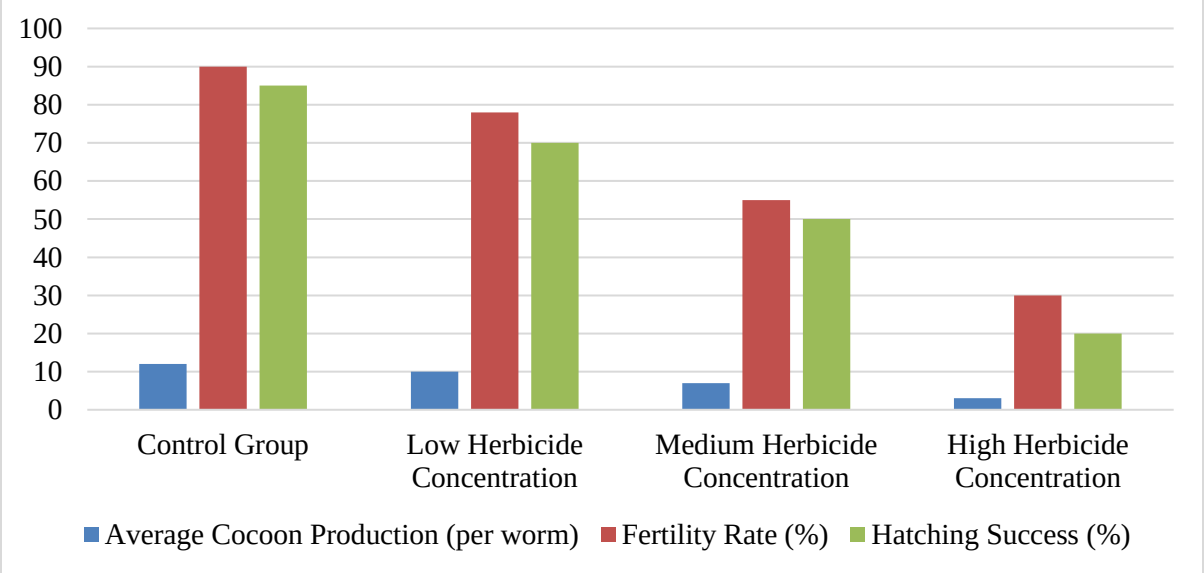

Figure 1: Graphical representation of Reproductive Parameters of Eutyphoeus waltoni Under Different Herbicide Concentrations

The following table describes the biochemical changes in Eutyphoeus waltoni after the treatment with different concentrations of herbicides, showing high levels of oxidative stress markers and alterations in enzyme activities, hormone levels, etc. MDA (a marker of oxidative stress) increased from 5.2 µmol/g of the control to 15 µmol/g at higher herbicide concentration

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levels; thus, earthworms showed higher oxidative stress as herbicides increased. This increase suggests that herbicides induce cellular damage, thus affecting the general health and survival of these organisms. Besides, enzyme activity, by way of acetylcholinesterase (AChE) levels, reduced significantly from 120 µmol/min/mg for the control group to 50 µmol/min/mg at high concentrations, indicating neurophysiological malfunction that may affect locomotion and behavior. The hormone levels also decreased considerably from 30 µg/g in the control to 12 µg/g in the high concentration treatment that could interfere with endocrine functions crucial for growth and reproduction. Collectively, these results underscore the adverse biochemical effects of herbicide exposure on Eutyphoeus waltoni, indicating potential risks to their reproductive and developmental biology as well as their ecological role in soil ecosystems.

Parameter	Control Group	Low Herbicide Concentration	Medium Herbicide Concentration	High Herbicide Concentration
Oxidative Stress Markers (MDA, µmol/g)	5.2	6.8	9.5	15
Enzyme Activity (AChE, µmol/min/mg)	120	100	80	50
Hormone Levels (µg/g tissue)	30	25	18	12

Table 2. Biochemical Responses of Eutyphoeus waltoni to Different Herbicide Concentrations

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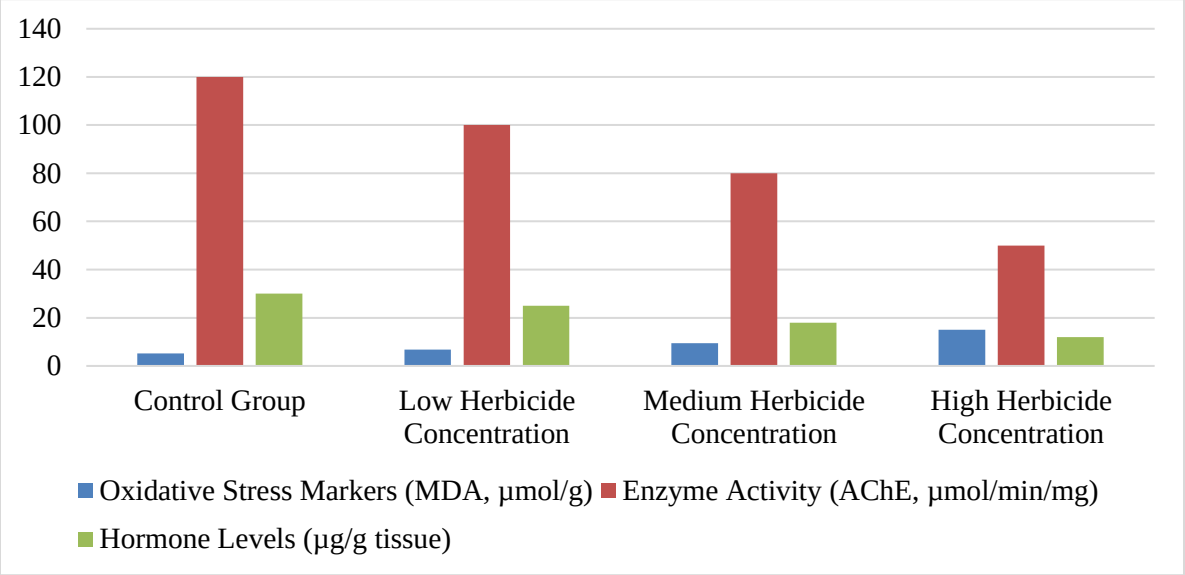

Figure 2: Graphical representation ofBiochemical Responses of Eutyphoeus waltoni to Different Herbicide Concentrations

5. CONCLUSION

This study presents convincing evidence of the injurious effects of herbicides exposure on the reproductive and developmental biology of Eutyphoeus waltoni. The drastic reductions in various parameters of reproduction, namely, cocoon production, fertility rates, and successful hatchings, indicate weaknesses in this species to chemical stressors employed in agriculture. In addition, biochemical alterations that have been documented in earthworms like elevated oxidative stress markers and diminished activity of enzymes and hormones, highlight the physiological impact herbicides cause to earthworms. This again underlines the urgent need for sustainable agriculture with minimal use of herbicides in protecting vital soil organisms and ecological balance. Thus, maintaining the health and functional capacity of earthworm populations has great importance for soil biodiversity and the general sustainability of agricultural ecosystems.

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