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The Effect Herbicides on the Growth and Reproduction in Earthworms Ballarpur Area District Chandrapur, (M.S) India

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Abstract

Earthworm are suitable bioindicator of chemicals contamination in terrestrial ecosystem. Earthworm may be the most significant members of the soil biota because they play major role in the functioning of the soil ecosystem by enhancing soil structure and the decomposition of organic materials and greater percentage (>80%) of biomass of terrestrial invertebrates Herbicide used to fight against the weeds in the agriculture are very toxic to soil biota to some extent, these herbicides are unrestrainedly the long or short terms effect in soil medium. The study was carried during month of June 2024 to May 2025, for one-year sites selected for study at Visapur and Tohogaon near Ballarpur. Study area located between latitude 19.67654^0 and longitude 79.492692^0. In present investigation 03 earthworm species identified earthworm were observed which belonging to 3 genera, Viz, Epigeic, Endogeic and Anecic, (Apporectodea calliginosa , Esenia fetida and Lumbricus terrestris). Epigeic- These worms live above soil level, Endogeic- These worms live below ground. Anecic- These worms live below soil level but come to the surface at night to find food. The present study will provide comparative information on diversity patterns for earth species in Ballarpur region of Chandrapur District, Maharashtra. The aim of study was to collect diversity of earthworm and effect of herbicide on it.

Keywords: *Ballarpur, Visapur , Tohogaon , Herbicide, Earthworm.*

Introduction

Earthworms play a crucial role in structuring and improving soil nutrients, constituting a significant portion (>80%) of the biomass of terrestrial invertebrates. Consequently, earthworms can serve as early indicators of soil quality degradation, functioning as effective bioindicators of chemical contamination within terrestrial ecosystems [1]. Earthworms exhibit numerous sensitive responses to environmental changes and also perform the role of decomposers, they are commonly utilized as test organisms. Their ecological significance is profound, as various substances pose a risk of secondary poisoning through the consumption of worms. It is possible that the worms themselves experience numerous adverse effects.

Herbicides are frequently employed in agricultural practices to control weeds and enhance crop production however they have generated considerable concerns regarding their possible effects on non-target soil organisms including earthworms [2]. Earthworms are essential for sustaining soil health as they improve soil structure, promote nutrient cycling, and facilitate the decomposition of organic matter [3]. Given their vulnerability to environmental pollutants, earthworms are commonly utilized as bioindicators for evaluating soil quality and the ecological threats associated with chemical applications, such as herbicides [4]. The impact of herbicides on earthworms can differ significantly depending on various factors, including the chemical composition of the herbicide, its concentration, and the specific species of earthworm involved.

The overuse of herbicides and pesticides contributes to the deterioration of agroecosystem sustainability [5]. Weeds and pests are significant factors in the decline of agricultural crops [6]. To address weed issues in crop production, it is essential to implement herbicide application as a regular practice [7]. Numerous studies have demonstrated that the application of herbicides leads to both qualitative and

quantitative changes in enzyme activity. The interactions between herbicides and soil biota hold practical importance due to the potential inhibition of microbial activity, which can enhance soil fertility [8]. The presence of herbicides in the soil is linked to the distress of earthworms. Earthworms have been utilized to assess the lethal and sub-lethal effects of chemically contaminated pollutants. Consequently, they are valuable for identifying contaminant fractions that may impact all organisms in contact with the soil [9]. Earthworms contribute to the formation and breakdown of soil aggregates, as well as the transfer of organic matter. As a result, they can influence various soil properties, including pH, organic matter content, nitrogen levels, and granulometry, among others.

Furthermore, earthworms play a crucial role in the cycling of nutrients, by consuming organic matter, they decompose it and transform it into forms that are more readily available to plants. This process not only enriches the soil with essential nutrients such as nitrogen and phosphorus but also improves soil structure, creating a more favorable environment for beneficial microorganisms [10]. The presence of earthworms is frequently linked to enhanced soil fertility and increased crop yields, rendering them a vital component of sustainable agricultural practices. Their contributions highlight the significance of preserving healthy earthworm populations to sustain ecosystem functionality and agricultural productivity.

Herbicides and Soil Biota

Microorganisms, including bacteria and fungi and soil fauna, which encompasses both microscopic and macroscopic animals, are collectively referred to as soil biota [11]. These soil biota are crucial for various biogeochemical cycles and the decomposition of litter, which in turn influences soil productivity and plant growth [12]. Therefore, the application of organophosphate herbicides can significantly impact the entire soil ecosystem [13]. The proliferation of undesirable plants and vegetation is inhibited through the use of these organophosphate herbicides, which represent a primary category of pesticides [14]. The residues of these pesticides contribute to ecological degradation, as they inflict adverse effects on the ecological habitat and its productivity, while simultaneously harming the soil biota as a non-target entity [15]. The efficacy of vital soil functions, along with the characteristics of the soil and the development of soil productivity, may be compromised due to these impacts [16].

Materials and Methods

Study Site: Present work was conducted between June 2024 to May 2025 on farmlands in Visapur and Thogaon village located in Ballarpur Tahsil. Ballarpur, a significant town in District Chandrapur Maharashtra's, is located around 19.84° N Latitude and 79.36° E Longitude (or approximately 19° 57' N, 79° 22' E in degrees/minutes). The commercially available fallowing herbicides was used i) Atrazine (2-chloro-ethylamino-6-isopropylamino-s-triazine). 3 Kg/ha Atrazine was Recommended ii). Glyphosate (Glyphosate 41% w/w) 2.4 ltr/ha hector Glyphosate was recommended.

Results and Discussion

The result of this study showed that herbicide Atrazine used had significant effect on earthworm activity and survivability. Glyphosate is among the most extensively utilized herbicides worldwide. Research suggests that exposure to glyphosate can considerably impede the growth of earthworms. This was similar to the finding of [17]. who found that atrazine had significant effect on the earthworm species. The average dose of glyphosate used demonstrated that its effect on earthworm activity and survivability is dependent on the dosage. An increase in glyphosate concentration, especially beyond the recommended levels, showed a significant impact on both earthworm activity and survivability. Consequently, the observed decrease in activity and survivability aligns with the findings of [18]. who noted that earthworms *Esenia fetida* were adversely affected by glyphosate application.

Effects of Herbicides on Earthworm Growth

Glyphosate: Glyphosate is among the most extensively utilized herbicides worldwide. Research suggests that exposure to glyphosate can considerably impede the growth of earthworms. Investigations reveal that species such as *Eisenia fetida, Apporecto caliginosa, and Lumbricus terrestris* exposed to glyphosate demonstrated diminished growth rates and compromised reproductive success. The oxidative stress induced by glyphosate results in cellular damage, which adversely affects growth and development. Sublethal levels of glyphosate can modify earthworm behavior, resulting in reduced foraging activity and lower energy intake, ultimately affecting their growth, Similar findings noted by [19].

Atrazine: Research has demonstrated that atrazine negatively impacts the growth of earthworms through various mechanisms. Investigations involving *Lumbricus terrestris* reveal that exposure to atrazine diminishes growth rates and overall biomass due to hormonal disruptions that compromise reproductive health[20]. Additionally, atrazine exhibits a bio accumulative effect, with elevated concentrations detected in earthworm tissues over time, resulting in chronic toxicity and stunted growth [21]. Moreover, atrazine can disrupt soil microbial communities, which indirectly hinders earthworm growth by decreasing the availability of organic matter and essential nutrients.

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stunted growth [23]. Moreover, atrazine can disrupt soil microbial communities, which indirectly hinders earthworm growth by decreasing the availability of organic matter and essential nutrients.

Effect of Herbicide on Earthworm Reproduction

Glyphosate: Glyphosate, recognized as one of the most extensively utilized herbicides, has been examined for its effects on soil organisms, particularly earthworms. This herbicide operates by blocking the shikimic acid pathway, a crucial metabolic process in plants. Despite the absence of this pathway in earthworms, exposure to glyphosate can still have indirect effects on their physiological functions. A study conducted by [24]. reveals that exposure to glyphosate can induce oxidative stress in earthworms, subsequently impairing their reproductive abilities by causing damage to cellular structures essential for reproduction.

Effects on Cocoon Production

Eisenia fetida exposed to glyphosate has indicated a decline in cocoon production. noted that earthworms treated with glyphosate generated considerably fewer cocoons than those in the untreated control group. This decrease in cocoon output is believed to stem from disrupted energy allocation, wherein resources typically dedicated to reproduction are diverted to manage the toxic impacts of the herbicide[25].

Impact on Juvenile Growth and Survival

In addition to cocoon production, glyphosate exposure can also affect the viability and growth of juvenile earthworms[26]. This impaired growth in early life stages can have long-term effects on earthworm populations, as the herbicide compromises the earthworms' ability to reach reproductive maturity.

Atrazine: Atrazine, a commonly utilized herbicide, has been found to interfere with the endocrine systems of non-target species. In earthworms, this interference significantly impacts reproductive processes [27]. illustrated that exposure to atrazine resulted in hormonal disruptions in Lumbricus terrestris, which is directly associated with diminished fertility and modified reproductive cycles. Atrazine has a tendency to bioaccumulate within the tissues of earthworms over prolonged exposure[28]. observed that atrazine levels in earthworm tissues increased with exposure time, leading to chronic toxicity that further compromised reproductive health.

Altered Soil Microbiome and Indirect Effects on Reproduction

Atrazine impacts earthworms not only directly but also modifies the microbial communities present in the soil. Alterations in microbial composition may diminish the availability of essential nutrients necessary for earthworm reproduction. The research conducted by [29]. emphasized that earthworms subjected to atrazine in soils with diminished microbial communities showed a significant decrease in reproductive success as a result of lowered nutrient absorption.

Conclusion

The study conclude that the notable disparities were noted in the treatments involving Atrazine and Glyphosate herbicides, suggesting that their application did not improve survivability. This further indicated that the comparison of earthworms and their survivability in soil was validated by variations in soil herbicide concentration. Consequently, it demonstrates that the application rates of different herbicides exceeding the manufacturers recommendations such as 3.5 to 4.0 kg/h for Atrazine and up to 3 L/h for Glyphosate diminished the survivability of earthworms.

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