World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 7.409

REVIEW PORT OF EFFECT OF ROUNDUP - A GLYPHOSATE-BASED HERBICIDE ON EARTHWORM EUDRILUS EUGENIAE

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Article Received on 04/09/2024 **Article Revised on 24/09/2024** **Article Accepted on 14/10/2024**

ABSTRACT
The use of glyphosate-based herbicides such as Roundup is massively used in agriculture. However, there are negative impacts on the earthworm biodiversity. Hence, the primary quantitative empirical study aims toward understanding the impact of glyphosate-based herbicides such as Roundup on earthworm *Eudrilus eugeniae*. A review and related understanding of previous research on the impact of glyphosate-based herbicides such as Roundup on earthworms was reviewed. Indigenous viewpoints were also developed for the study using earlier research findings. IBM SPSS was used to carry out quantitative analysis following the main data gathering. Thirteen-item questionnaires were presented to seventy survey respondents, who were then chosen for an interview aimed at gathering data. Herbicides containing glyphosate have been found to affect *Eudrilus eugeniae* physiology and behaviour. It was also observed that the earthworm's survival rate and biodiversity are influenced by several aspects, including the kind of soil, feeding rate, length of exposure, and Roundup concentration. Simultaneously, it was contended that these herbicides affect both the finished product and human health. The results of the inquiry are rationally analysed, and suggestions based on statistical analysis are provided in the discussion part. Furthermore, the protein provides enough information to cover the outcomes. The research summary and a general interpretation of the findings are provided in order to provide a concise overview of the entire empirical inquiry.

KEYWORDS: glyphosate-based herbicides, Roundup, earthworm, Eudrilus eugeniae, Concentration and exposure of herbicides.

INTRODUCTION

Roundup is a glyphosate-based herbicide that is widely used for controlling weeds and optimizing yield. According to the opinion of Owagboriaye et al. (2021), vermiremediation potential was observed in the earthworms exposed to glyphosate-based herbicides. Therefore, the empirical analysis looks into the port of effect of Roundup on *Eudrilus eugeniae*. Through the past analysis of different factors, it was observed that there are some issues related to the use of glyphosate-based herbicides. For instance, Freitas-Silva et al. (2022) have pointed out that the implication of glyphosate-based herbicides impacts plant metabolism. On the other hand, it was observed that the biodiversity of earthworms is impacted due to the use of glyphosate-based herbicides (Brandmaier et al. 2023). However, E. eugeniae is a non-targeted organism, it gets impacted due to the exposure of such herbicide. Thus, a widespread ecological and unwanted impact of the herbicide can be observed due to uncontrolled use.

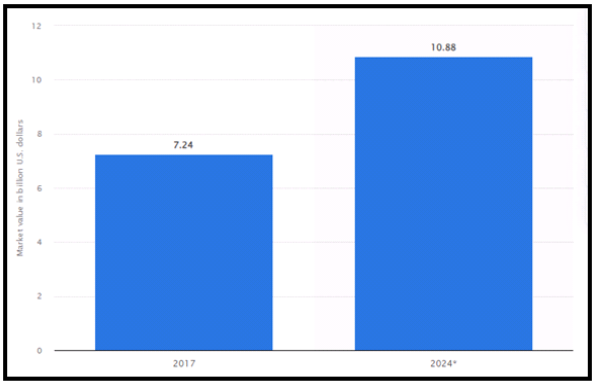

Figure 1: Glyphosate's global market worth between 2017 and 2024.
(Source: Statista, 2024)

Figure 1 of the empirical analysis is associated with the global market value of Glyphosate between 2017 and 2024. According to the graph, it can be seen that the market value of Glyphosate in 2017 was 7.24 billion USD (Statista, 2024). However, with the increasing usage of such herbicides, the market value was supposed

to grow. Therefore, for 2024 a net increase of 1.88 billion USD was predicted (Statista, 2024). Such value indicated an increase in the usage of roundups which can affect earthworms. Hence, the data justifies the rationality and the intention of the empirical analysis.

AIM

The primary quantitative empirical study aims toward understanding the impact of glyphosate-based herbicides such as Roundup on earthworm *Eudrilus eugeniae*.

Research Objectives

RO1: To analyse the impact of Roundup or glyphosate-based herbicides on earthworm *Eudrilus eugeniae*

RO2: To understand the overall impact of glyphosate-based herbicides on the Yield.

RO3: To discuss the change in the survival rate of *Eudrilus eugeniae* after the use of Roundup.

RO4: To understand the impact of glyphosate-based herbicides on the behaviour of *Eudrilus eugeniae*.

Research Questions

RQ1: How to analyse the impact of Roundup or glyphosate-based herbicides on earthworm *Eudrilus eugeniae*?

RQ2: What is the overall impact of glyphosate-based herbicides on the Yield?

RQ3: What are the changes in the survival rate of *Eudrilus eugeniae* after the use of Roundup?

RQ4: What is the impact of glyphosate-based herbicides on the behaviour of *Eudrilus eugeniae*?

Literature Review

Critical discussion of the Impact of glyphosate-based herbicides like Roundup

Herbicides such as Roundup have glyphosate as the main component which has different negative impacts. At the same time, earthworm which are essential for soil health is impacted by such herbicides. According to the opinion of Ahmed & Al-Mutairi (2022), earthworms aid in increasing the nutrient content and aeration of the soil. Therefore, with the implication of glyphosate-based herbicides, the soil quality and potential are heavily impacted. On the other hand, Sang et al. (2021) stated that glyphosate-based herbicides not only impact weeds but also impact beneficial plants and insects. Therefore, an impact on biodiversity is observed with the implication of glyphosate-based herbicides such as Roundup.

Figure 2: Diverse impact of glyphosate-based herbicides.

(Source: Inspired by Berry, 2020)

Figure 2 illustrates the diverse impact of glyphosate-based herbicides. It can be seen that human health is further impacted by such herbicides. As pointed out by Berry (2020), glyphosate is a carcinogen that is present in herbicides such as Roundup. Therefore, indirect consumption of such herbicides can cause or increase the risk of cancer for humans. On the other hand, Peillex & Pelletier (2020) have discussed different health concerns associated with the usage of such herbicides. For instance, it was noted that acute issues such as allergies and chronic issues such as reproductive problems are directly or indirectly caused by exposure to glyphosate. At the same time, Ojelade et al. (2022) issues such as water contamination and indirect impact on biodiversity can be noted as an impact of glyphosate-based herbicides. Thus, from the aforementioned discussion, it can be contemplated that glyphosate-based herbicides have a diverse impact on the environment and can harm biodiversity and the quality of yield. However, such concerts are associated with an uncontrolled usage of such herbicides.

Impact of glyphosate-based herbicides on the survival rate and behaviour of earthworms

Through the analysis of the past literature, it was noted that glyphosate-based herbicides have a direct impact on earthworms. According to the opinion of Pochron et al.

(2020), the survival rate is heavily impacted by the use of glyphosate-based herbicides. In addition, such depreciation in herbicides impacts the overall quality of survival and quality of produce. At the same time, Feng et al. (2022) have stated that overuse of glyphosate-based herbicides causes physiological changes in the earthworms. Moreover, Exposure to glyphosate has the potential to disturb physiological functions such as enzyme functioning, resulting in oxidative stress and altering the composition of the gut flora. Hence, such factors impact the biodiversity of earthworms on a large scale.

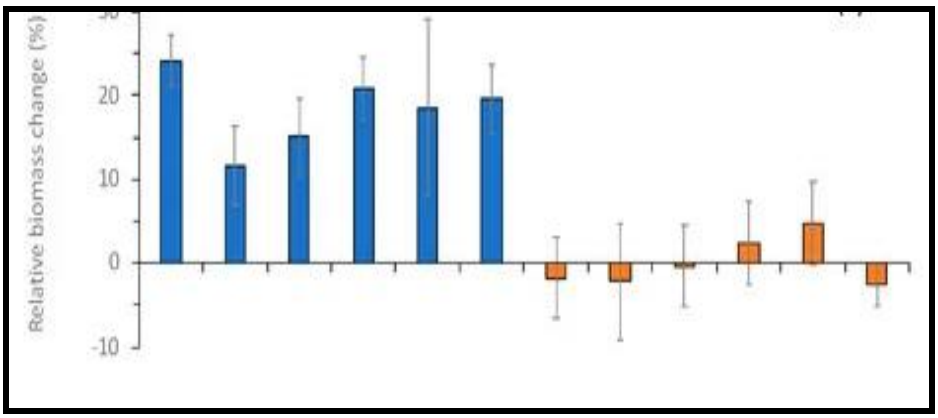

Figure 3: Changes in the biomass of the earthworm.

(Source: Schmidt et al. 2022)

Figure 3 of the empirical analysis is associated with the changes in the biomass of the earthworm with the extensive use of glyphosate-based herbicides. According to the opinion of Schmidt et al. (2022), behavioral changes can be seen in earthworms after the use of glyphosate-based herbicides. For instance, movement, feeding, and burrowing activities of the species were seen to be affected. On the other hand, Gains et al. (2023) have stated that The interactions between *Eudrilus eugeniae* and its soil environment can be disrupted by glyphosate, which can affect the breakdown and cycling of nutrients. Thus, it can be stated that with the uncontrolled use of roundups, a vivid negative impact on the earthworm and its environment can be noticed.

Critical Discussion on the Impact of Roundup on eudrilus eugeniae

It was noted that there are differences in the impact of Roundup on *eudrilus eugeniae* that were clinically proven. According to the opinion of Mishra et al. (2022), The risk of death for earthworms exposed to Roundup is higher than that of unexposed earthworms. Therefore, the survival rates of the earthworms are significantly impacted with the use of Roundup. On the other hand, Owagboriaye et al. (2020) has stated that the reproduction of *eudrilus eugeniae* is impacted due to the use of Roundup. Therefore, it can be understood that the survival rates and the reproduction of the worms are significantly impacted due to the use of roundup.

At the same time, it was noted that the growth of the worms is impacted due to the use of round-ups. According to the opinion of Malla et al. (2023), roundup creates an include in the body that creates an imbalance in the growth process of *eudrilus eugeniae*. On the other hand, Zaller et al. (2021) has stated that a change in the behaviour of the worms can be noted due to the use of roundup. Moreover, it was noted that compared to unexposed earthworms, earthworms subjected to Roundup may move, feed, and burrow less. Hence it can be understood that there is a significant impact of roundup on the *eudrilus eugeniae*.

METHODOLOGY

Primary qualitative methods were used in the investigation. Purwanto (2021) asserts that obtaining primary quantitative data facilitates the acquisition of accurate and to-the-point knowledge that contributes to the production of meaningful outcomes. The study also contained a deductive research approach and a descriptive research design, which served to make the research topic clearer. A questionnaire was issued to individuals associated with agriculture moreover data related to demographics and overall experience of the participants were collected for the sake of producing relevant research. Additionally, demographic data aids in understanding the impact of those factors in the collated data.

The questionnaire consisted of thirteen closed-ended questions, three of which were connected to demographic characteristics and the remaining ten to factors of the study. The degree of expertise for data analysis has been evaluated using operational datasets (Fasya, Darmayanti, and Arsyad, 2023). Throughout the whole research process, SPSS analysis was employed to get relevant study outcomes. Determining the significance of the correlational analysis, ANOVA test, and regression analysis was another technique the research study employed to operate. Descriptive statistics were thus added in order to ascertain the dataset's outlines and level of comprehension.

FINDING AND ANALYSIS

Demographic Analysis

Table 1: Age.

What is your age (In Years)?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Above 60	10	14.3	14.3	14.3
	Below 20	10	14.3	14.3	28.6
	Between 20 to 35	30	42.9	42.9	71.4
	Between 35 to 60	20	28.6	28.6	100.0
	Total	70	100.0	100.0	

(Source: SPSS analysis)

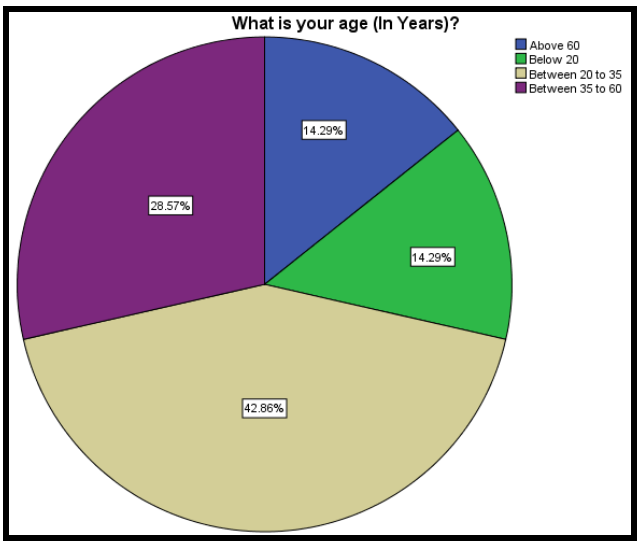

Figure 4: Age.

(Source: SPSS analysis)

Table 1 and Figure 4 of the statistical analysis are associated with the age-related distribution of the participants where the frequency and percentage can be significantly understood. It is evident that those under the age of twenty were covered by the frequency of 10. Similarly, participants above 60 years of age have a similar frequency. The frequency for those in the 20 to 25 age range was 30. Furthermore, those in the 35 to 60 age range had a frequency of 20. The equitable distribution of the participation percentage is seen in the Pie chart. As a result, 14.3% of participants were younger than twenty years old. Further, a similar percentage is observed for the participants older than 60 years. Twenty to twenty-five-year-olds made up 42.9% of the participation pool. As can be observed from the pie chart, which shows that 28.6% of participants were between the ages of 35 and 60, the majority of participants were in the 20 to 35 age range.

Table 2: Association with Agriculture.

How long have you been associated with agriculture?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	11 to 15 years	20	28.6	28.6	28.6
	6 to 10 years	30	42.9	42.9	71.4
	Less than 5 years	20	28.6	28.6	100.0
	Total	70	100.0	100.0	

(Source: SPSS analysis)

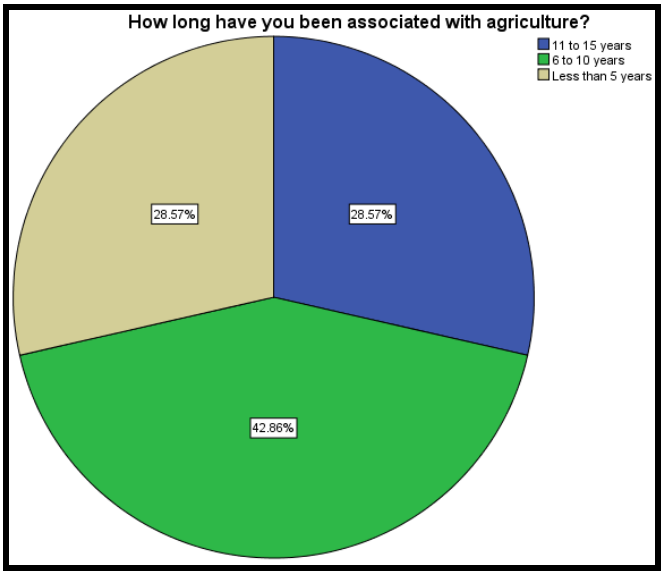

Figure 5: Association with agriculture.

(Source: SPSS analysis)

Table 2 and Figure 5 of the statistical analysis are associated with the participants associated with agriculture or the experience of the participant. It can be seen that participants having 11 to 15 years of experience have a frequency of 20. A similar frequency of 20 was seen for the participants having experience of less than 5 years. Participants having 6 to 10 years of experience had a frequency of 30. At the same time, the percentage data of the pie chart illustrates that participants having less than 5 years of experience and participants having 11 to 15 years of experience, each, had 28.6% representation. However, participants having experience between 6 to 10 years had a representation of 42.9% in the overall data set.

Table 3: Profession.

What is your profession?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Business	10	14.3	14.3	14.3
	Farmer	40	57.1	57.1	71.4
	Others	10	14.3	14.3	85.7
	Student of agriculture	10	14.3	14.3	100.0
	Total	70	100.0	100.0	

(Source: SPSS analysis)

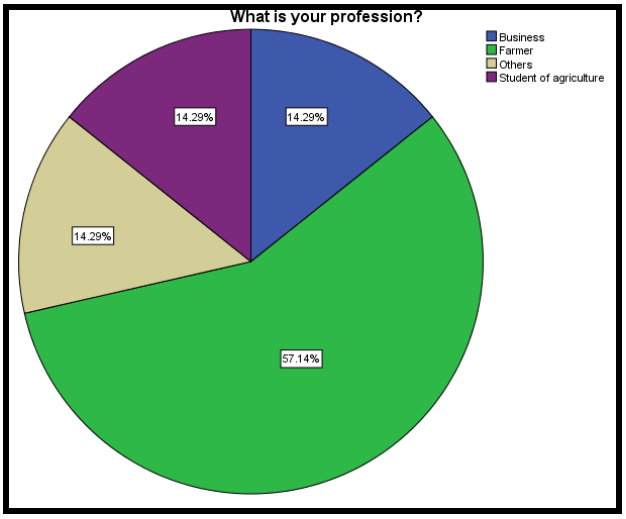

Figure 6: Profession.

(Source: SPSS analysis)

Figure 6 and Table 3 of the empirical analysis are associated with the profession of the participants where a diverse representation of the participant can be seen. It can be noted that businessmen, students of agriculture, and other professions have a similar frequency of 10. However, farmers have a frequency of 40 in the data set. Therefore, the consecutive representation of businessmen, students of agriculture, and other professions had a representation of 14.3%. At the same time, it was noted that farmers had a representation of 57.1% in the overall dataset. Thus, it can be stated that most of the participants were from the farmer background.

STATISTICAL ANALYSIS

Table 4: Descriptive analysis of different variables.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DV	70	2.00	8.00	4.1429	1.82006
IV1	70	2.00	8.00	3.7143	1.84267
IV2	70	3.00	8.00	4.1429	1.89802
IV3	70	2.00	8.00	4.0000	2.01444
IV4	70	2.00	8.00	4.1429	1.97290
Valid N (listwise)	70				

(Source: SPSS analysis)

The descriptive analysis of the study's associated variables is included in Table 4. According to Mishra et al. (2019), descriptive statistics aid to examine the relationship between several variables. Factor outliers can also be taken into consideration using descriptive statistics. The study employed descriptive statistics as a result. The DV has a mean of 4.1429 and a standard deviation of 1.82006. The mean value of the first independent variable is 3.7143 with a standard deviation of 1.84267, whereas the mean value of the second independent variable is 4.1429 with a standard deviation of 1.89802. The third independent variable has a standard deviation of 4.0000 and a mean value of 2.01444. The standard deviation is 4.1429 and the mean value is 1.97290 for the fourth independent variable. The data are centered around the means since all of the variable means are bigger than the standard deviations (Siedlecki, 2020). It is also evident that the data set is extensively dispersed and that there are relatively few outlines. It also lends credence to the idea that the data may not be advancing at a rapid rate.

Hypothesis 1: ***The survival rate of the earthworms has a relation with the concentration of Roundup.***

Table 5: Regression analysis of H1.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.747	.558	.551	1.21895

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	127.535	1	127.535	85.834	.000
	Residual	101.037	68	1.486		
	Total	228.571	69			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.402	.330		4.253	.000
	IV1	.738	.080	.747	9.265	.000

(Source: SPSS analysis)

Table 5 of the empirical analysis is associated with the regression analysis of the first hypothesis of the study. As per the opinion of Kepler et al. (2020), the concentration of herbicide impacts the overall soil quality and flora of a certain land. Therefore, a relation of the survival rate with the concentration of herbicide is pretended. It can be seen that the significance value is 0.000 indicating that the values are supported with sufficient evidence.

Hypothesis 2: ***Duration of exposure and the survival rate of the earthworms have a relation among them***
Table 6: Regression analysis of H2.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.791	.626	.620	1.12143

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	143.054	1	143.054	113.751	.000
	Residual	85.517	68	1.258		
	Total	228.571	69			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.000	.324		3.089	.003
	IV2	.759	.071	.791	10.665	.000

(Source: SPSS analysis)

Table 6 is associated with the regression analysis of the second hypothesis where a relation of the exposure duration and survival rates of the earthworms is presumed. As stated by Ergenler & Turan (2023), long exposure aggravates the negative impact of the herbicide. The significance value of the analysis can be seen to be 0.000 indicating that the hypothesis is supported with evidence and a null hypothesis of the same can be rejected.

Hypothesis 3: ***The survival rate of the earthworms has a relation with the type of soil***
Table 7: Regression analysis of H3.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.712	.506	.499	1.28828

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	115.714	1	115.714	69.722	.000
	Residual	112.857	68	1.660		
	Total	228.571	69			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.571	.344		4.564	.000
	IV3	.643	.077	.712	8.350	.000

(Source: SPSS analysis)

Table 7 is associated with the third hypothesis of the quantitative analysis. Soil type is associated with the impact of herbicides (Hallam & Hodson, 2020). Therefore, the relation between soil type and the survival of earthworms is presumed in the third hypothesis. Based on the significance value of 0.000 it can be stated that the third hypothesis is supported with sufficient evidence and the null hypothesis can be rejected.

Hypothesis 4: ***The feeding rate of the earthworms is associated with survival rates of the same***

Table 8: Regression analysis of H4.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.721	.519	.512	1.27094

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	118.731	1	118.731	73.504	.000
	Residual	109.840	68	1.615		
	Total	228.571	69			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.388	.355		3.906	.000
	IV4	.665	.078	.721	8.573	.000

(Source: SPSS analysis)

Table 8 of the statistical analysis is associated with the fourth hypothesis of the empirical study. As stated by Jochum et al. (2021), the feeding rate is a significant indicator of earthworm biodiversity. Therefore, a relation is presumed between the feeding rate and survival rate of the earthworm. The significance value is 0.000 indicating a strong support for the third hypothesis. At the same time null hypothesis for the hypothesis can be rejected.

DISCUSSION

A quantitative analysis is presented regarding the impact of glyphosate-based herbicides on the *Eudrilus eugeniae*. For the empirical study primary data was collected and quantitative analysis using IBM SPSS software was conducted. Further for the study 4 hypotheses were selected and regression analysis was conducted.

In the regression analysis of the first hypothesis, it was noted that the significance value is 0.000 indicating that it is supported. As per the opinion of Samadi et al. (2022) survival rate of the earthworm is impacted by the concentration of Roundup. Thus, based on the regression analysis it was noted that the hypothesis is supported. Similarly, it was noted that the second hypothesis is supported with evidence.

The third and fourth hypothesis is supported as well with a significance value of 0.000. As per the opinion of Hudu, Issifu & Zarouk (2021), understanding the biodiversity and behaviour of the earthworms can aid in understanding the issues. Thus, based on the understanding of earthworm behaviour moderation in the use of herbicide can be implemented. Further, such moderation of herbicides such as Roundup is required as it is harmful to the flora of earthworms.

CONCLUSION

Thus, a quantitative analysis for understanding the impact of glyphosate-based herbicides on the *Eudrilus eugeniae* was conducted. It was noted that glyphosate-based herbicides impact the behaviour and physiology of *Eudrilus eugeniae*. Therefore, the survival rates and working process of the earthworm are impacted. For the study related data was created with 13 questions. 70 individuals were interviewed to collect the data. It was further noted that factors such as concentration of Roundup, duration of exposure, type of soil, and feeding rate impact the survival rate and biodiversity of the earthworm. At the same time, it was argued that such herbicides impact human health and the final product. Therefore, moderating the use of herbicides can benefit the overall impact. However, glyphosate-based herbicides have indicated and significant impact on the earthworm, alternative solutions need to be maintained.

ACKNOWLEDGEMENTS

The author would like to express gratitude to Kavayitri Bahinabai Chaudhari North Maharashtra University,

Jalgaon, for their generous research funding provided through the Vice Chancellor Research Motivating Scheme (VCRMS).

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