Impact of pesticides on human body due to soybean farming in the state of Madhya Pradesh

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Abstract-The study investigates the health implications of prolonged exposure to pesticides on soybean spray farmers in Bhopal, Madhya Pradesh. The research was conducted in three districts, focusing on the use of Thiamethoxam and Novaluron pesticides. The study involved 120 male participants aged 18-45, categorized by exposure duration (6, 12, 18 months) and a control group. The results showed that pesticide exposure, particularly for 12 and 18 months, correlated with increased health complaints, with skin-related issues and respiratory problems being prevalent. The study also investigated the impact of pesticides on soil microbial activity, finding that all pesticide types, except Thiamethoxam, Novaluron, and Indoxacarb, significantly reduced CO2 production, indicating their toxicity to soil bacteria. The study also highlighted the need for ongoing monitoring and environmental assessment. The study emphasizes the interconnected impact of pesticide exposure on human health, soil microbial activity, and water quality. It advocates for increased awareness, protective measures, and the transition to bio-pesticides and organic farming to promote environmental and human well-being.

Keywords: **soybean, pesticides, health complaints, water quality, organic farming**

1 INTRODUCTION

Madhya Pradesh's soybean farming industry is an important component of India's agricultural landscape, making a significant contribution to the country's economy and overall food production. Madhya Pradesh is the state in which this industry is situated. The widespread use of pesticides is concerning and should be cautiously evaluated when agricultural productivity is high. Pesticides are necessary to achieve efficient pest management and maximize agricultural yields, but they also seriously endanger the health of people and the environment. The aim of this study is to assess potential health risks associated with pesticide exposure among local farmers and residents. The study delves further into the crucial subject of how Madhya Pradesh's soybean farming directly affects human health through the use of pesticides. By examining all facets of this problem—from the kinds and amounts of pesticides applied to the health impacts on individuals—this study seeks to offer a thorough grasp of the difficulties presented by the use of pesticides in soybean farming. Furthermore, the goal of this research is to make suggestions for sustainable and health-conscious agricultural practices in the area.

1.1 Pesticide Usage in Agriculture

The use of pesticides is widespread because of the need of preventing agricultural and animal losses caused by insects, weeds, and illnesses. Around one million pounds, or one percent, of the total 900 million pounds of conventional pesticide that is sprayed yearly in the Madhya Pradesh. The Environmental Protection Agency (EPA) has estimated that agricultural production accounts for 76% of the overall use of pesticides in the MP, with the other 24% being utilized in urban, industrial, forest, and public sectors[1]. These compounds have contributed to an increase in agricultural productivity as well as a reduction in the expenses of labour. However, difficulties linked with incorrect use of pesticides have led to disease in humans, harm to non-target animals, and a decline in water quality. Pesticides may be broken down into three primary categories: insecticides, herbicides, and fungicides. Herbicides are the pesticides that are detected in ground and surface water the most regularly. This is because herbicides are the type of pesticides that are used in agricultural and urban settings the most frequently [2]. Over the last several years, there has been a significant increase in our capacity to identify pesticides in their natural environments. The development of exceptionally

sensitive detection technologies has led to the finding that conventional management practices may contribute to the introduction of trace levels of pesticides into ground and surface water sources. This was made possible by the increased sensitivity of detection methods. Because we get our drinking water from these water sources, those who apply pesticides have a responsibility to exercise an exceptionally high degree of caution and to use effective pesticide management in order to prevent contamination. This handbook provides information on the Best Management Practices (BMPs) that may be used to avoid agricultural pesticides from becoming a nonpoint cause of pollution to water resources. The good news is that there are a variety of crop management and pesticide application practices that may be employed to cut down on the possibility of water sources being contaminated [3].

1.2 Overview of Soybean as a Major Crops

The soybean, also known as Glycine max, is a crop that is important on a worldwide scale and is well-known for the many different ways it may be used in agriculture, the production of food, and a variety of other sectors [4]. Soybeans, which are believed to have originated in East Asia, have become a staple food in many regions of the globe, with the United States, Brazil, Argentina, and China being among the main producers of the crop. These beans are prized for their high protein content, which makes them an important part of the diets of both humans and animals [5]. They are also the primary ingredient in a variety of foods and beverages, including tofu, soy milk, and soy sauce. In addition, soybean oil is an important component of cooking oils and is used in a variety of industrial applications, such as the manufacturing of biodiesel. In addition to their usefulness as a food source, soybeans improve the fertility of the soil via the process of nitrogen fixation, which in turn encourages the practice of sustainable agriculture. In addition to this, soybeans are a key cash crop that are sold all over the world and have an effect on the economic stability of agricultural communities[6]. Since soybeans may be used in a wide variety of non-food applications, including the production of bio fuels and industrial chemicals, they are an essential component of both contemporary agriculture and the expansion of the economy. In simple terms, soybeans are an important crop across the world, and their production has significant repercussions for agriculture, the food industry, and other sectors. Their protein-dense composition, flexibility, and contributions to the health of the soil all highlight their relevance as a main commodity, supporting both human consumption and a wide variety of industrial uses [7]. As a direct consequence of this, soybeans occupy a significant role in the agricultural and economic structures of the modern world.

1.3 Significance of Soybean Farming in Madhya Pradesh

Soybean agriculture is highly significant in the Indian state of Madhya Pradesh, both economically and agriculturally. Madhya Pradesh is known as the "Soybean Bowl of India" because it is the state in India that produces the most soybeans. This moniker derives from the state's dominance in the soybean sector. [8] This crop is particularly essential to the state's agricultural environment and contributes significantly not only to the state's economy but also to the way of life of those who live in rural regions. To begin, soybean cultivation has emerged as a substantial source of cash for farmers in Madhya Pradesh. The crop's high production potential, along with excellent weather conditions and suitable soil types, has made it a popular choice among farmers. Not only is soybean a significant income crop, but it also serves an important function as a rotation crop, improving soil fertility and minimizing the likelihood of pest infestations in future seasons [9]. The state has hundreds of agricultural households, and the cash generated by soybean farming helps to stabilize their financial situation. Second, the soybean industry, which is focused in the state of Madhya Pradesh, contributes considerably to India's edible oil output. Oil extraction from soybean seeds is a critical stage in the manufacturing of culinary oils in this country. The high soybean output in Madhya Pradesh reduces India's reliance on edible oil imports, hence ensuring domestic food security and reducing India's outflows of foreign currency [10]. Last but not least, soybean growing in Madhya Pradesh has a substantial influence on the local ecosystem. The capacity of soybean plants to fix nitrogen improves soil fertility, reducing the quantity of artificial fertilizer needed. This, in turn, has a positive impact on the long-term sustainability of agriculture in the region and reduces the quantity of pollutants emitted into the

environment. Thus, the cultivation of soybeans in the state of Madhya Pradesh plays an essential part in the economy of the state, contributes to the production of edible oil in India, and has favourable repercussions for the environment. It continues to be an essential component of the agricultural industry, which is to the advantage of both individual farmers and the country as a whole [11].

1.4 Effects of Pesticides on Human Health

Pesticides have become increasingly harmful due to their toxicity, persistence in the environment, and ability to enter the food chain. They can enter the human body through direct contact with chemicals, contaminated food, contaminated water, or polluted air. Both acute and chronic diseases can result from pesticide exposure.

Acute illness, which usually appears a short time after contact or exposure, can result from pesticide drift from agricultural fields, exposure during application, or intentional or unintentional poisoning. Symptoms include headaches, body aches, skin rashes, poor concentration, nausea, dizziness, impaired vision, cramps, panic attacks, and in severe cases, coma and death. The severity of these risks depends on the toxicity, quantity of agents used, mode of action, mode of application, length and frequency of contact, and the person exposed during application.

Current illness results from prolonged exposure to sub-lethal quantities of pesticides for years to decades. Agricultural workers are at a higher risk, but the general population is affected, especially due to contaminated food and water or pesticide drift from fields. As pesticides become an increasing part of our ecosystem, chronic diseases are becoming more prevalent, affecting the nervous, reproductive, renal, cardiovascular, and respiratory systems.

2 LITERATURE REVIEW

[12] analyzed the limits of soybean growing in the Ujjain district of Madhya Pradesh, India, as well as the costs and returns of producing soybeans on various-sized farms. [13] Pest and disease outbreaks, deficient soil fertility, a lack of adequate water supply, and climate change are among the issues causing India's agricultural production to stagnate. This has significant economic ramifications, leading to decreased output, declining markets, and rising unemployment in the food and agricultural industry. In order to implement preventative measures, it is necessary to draw attention to the issue of plant diseases. Plant pathology has a unique role in addressing emerging sustainability concerns and advancing Indian agriculture. [14] The present study will contribute to future research and increase knowledge of the benefits of organic farming and food production. Large organic farms must nonetheless provide enough food to feed India's entire population despite the fact that organic farming has the ability to provide high-quality food with little impact on the environment, the soil, or human health. [1] According to the review research, agricultural growth has a lengthy history in many parts of the globe. Pesticide usage may be separated into three historical eras. Pesticides are categorized using a variety of categories, including chemical classes, functional groups, modes of action, and toxicity. Pesticides employ chemical substances to kill pests and manage weeds; as a result, they may be dangerous to other creatures such as birds, fish, beneficial insects, and non-target plants, as well as air, water, soil, and crops. Furthermore, climate change-related variables influence pesticide application, resulting in increased pesticide consumption and pesticide contamination. [15] In India, soybean output is 13.79 Mt, yield is 12.19 q/ha, and area is 11.32 Mha. The outcomes unmistakably show that demonstration practices are superior than local practices. Benefit cost ratios were also seen to be greater throughout the year under demonstrations compared to local control treatments.

3 PROBLEM STATEMENT

Madhya Pradesh, a major soybean-producing state in India, has seen a significant increase in soybean cultivation, boosting the state's economy. However, this growth has raised concerns about the health risks associated with the extensive use of pesticides in soybean farming. The widespread use of pesticides is a common practice to control pests and improve crop yields, but there is a growing need to assess the impact on the human body. Limited research has been conducted on the specific effects of soybean farming-related pesticides on human health in Madhya Pradesh, which is crucial for understanding the problem and developing effective mitigation strategies. This study aims to address this gap by

examining pesticide use patterns, assessing pesticide residue levels in soil, water, and crops, and investigating the association between pesticide exposure and health outcomes among individuals in or near soybean farming areas. The findings will contribute to evidence-based policymaking, promote sustainable agricultural practices, and safeguard the health and well-being of communities in soybean farming regions.

4 OBJECTIVES OF THE STUDY

- To make extensive study on the varieties of pesticides used in soybean farming in the districts of Bhopal, Hoshangabad, Sehore and Dewas of Madhya Pradesh
- To analyze the Presence of pesticides in Soil. Water and soybean plants in the soybean farming lands of Bhopal. hoshangabud. Sehore and Dewas districts of Madhya Pradesh.
- To analyze the presence of pesticides in soil and water in the agriculture land where organic farming is carried out.
- To examine the presence of Carcinogens and Pesticidal residue in the blood samples of general public where pesticides are used.
- To make a study on the impact of pesticides on human health based on data obtained.

5 METHODOLOGY

5.1 Study area

The current study focused on the spray farmers in Bhopal, Madhya Pradesh, which is well-known for its massive soybean production. For the study, three districts known for their soybean cultivation in Bhopal—Hoshangabad, Sehore, and Dewas—were chosen at random. Insecticides were applied on the soybean crops in the fields during the study's July–October from 2021 to 2023. Six days a week, from 8:00 am to 11:00 am and 3:00 pm to 6:00 pm, was when the spraying was usually done. A few working days after the pesticide spraying, the farmers were inspected. The most commonly applied pesticides on soybean crops are Thiamethoxam (12.60% + Lambda-cyhalothrin 09.50% ZC), and Novaluron 05.25% + Indoxacarb 04.50% SC. The participants in this study were those who had been exposed for six to eighteen months.

5.2 Sample collection

Gathering soil and water samples from different sites is an essential stage in environmental monitoring and evaluation. The sample was conducted at three distinct locations: the agricultural field, a site located one kilometer away from the primary agricultural field, and another site situated two kilometers away from the agricultural field. The gathered samples will be subjected to laboratory examination to assess different parameters like nutritional levels, pH, concentrations of heavy metals, and the existence of any pollutants.

5.3 Tools for data collection

5.3.1 Interview questionnaire

The questionnaire was specifically crafted to gather specific information regarding land ownership, the current plantation where the farmer is employed, exposure to pesticides, the utilization of pesticides, precautions taken, as well as any signs and symptoms associated with pesticide exposure. Additionally, the sprayers were inquired about whether they encountered these signs and symptoms during or directly after pesticide application. During the interview, several chronic symptoms were noted, including blurred vision, tremors, skin patches, excessive sweating, and itching. As a cross-sectional survey, information on signs and symptoms was gathered based on self-reports from the farmers. The data collected were specifically related to the timing of pesticide application (17). The questionnaire has yielded data on the types of sprayers employed by farmers for spraying purposes, including hand compression sprayers, backpack sprayers, and tractor mounted sprayers. None of the subjects in the current study adhered to the mandatory criteria for spraying, which include wearing protective gear such as plastic raincoats, masks, gloves, and boots.

5.3.2 Data collection

The study was carried out on a total number of 120 human subjects who were males and ranged between 18-45 years of age, belonging to same socioeconomic status. The groups were selected on the basis of the questionnaires filled by the sprayers of Bhopal from Hoshangabad, Sehore, and Dewas. 95 subjects were randomly selected from various farms on the basis of

full time active involvement in the preparation, storage and spraying of the pesticides on crop for at least six months. Analysis was done on four groups based on the duration of pesticide exposure (i.e 28 subjects with 6 months exposure, 32 subjects with 12 months exposure and 35 subjects with 18 months exposure). The study was compared with 40 healthy males having no previous or current occupational exposure to pesticides which were taken as controls from nearby areas with same socioeconomic status. Questionnaires were asked to be filled by the subjects of each group. The questionnaire provided detailed information regarding the socioeconomic status; family history and personal habits which were recorded for each subject. The purpose of the academic study was explained to all the participants and their consent was obtained.

6 RESULTS

6.1 Effect of pesticides on human health

Based on the results of the questionnaire, it was discovered that the human participants who were sprayed with organophosphate pesticides in their farms for 12 and 18 months had higher incidence of general health complaints right after the spraying. The symptoms included blurred vision, redness, white patches on the skin, increased perspiration, dyspnea, and shortness of breath, among other general symptoms. (Table 1).

Table 1: Effects of Pesticide Exposure on General Health Parameters in Farm Sprayers and Control Group Over 6, 12, and 18 Months

Exposure Duration	Symptoms→ Groups of Human Subjects (n)↓	Burning / Stinging / itching eyes	Blurred vision	Skin redness/ white patches on skin/ skin scaling	Excessive sweating	Dry / Sore throat	Runny/ Burning nose	Shortness of breath / cough
6 Months	Group- 1 (28)	0	2(3.70)	4(9.11)	3(6.41)	0	0	3 (6.41)
	Control-1 (16)	0	0	0	0	0	0	0
12 Months	Group- 2 (32)	6 (17.1)	3(7.7)	5(14.4)	7(21)	4 (11)	6 (17.7)	6 (16.7)
	Control-2 (12)	0	0	0	0	0	0	2 (10)
18 Months	Group- 3 (35)	8 (19.4)	10 (24.69)	18 (51)	14 (35.1)	9 (22.06)	12 (29.9)	13 (31.6)
	Control-3 (16)	0	3(14.4)	0	2 (7.7)	0	0	2 (6.7)

* Group-1= 28 sprayers exposed to pesticides for 6 months with Control-1 = 15 subjects with no exposure, Group 2 =32 sprayers exposed to pesticides for 12 months with Control-2 =10 subjects with no exposure and Group-3 = 35 sprayers is exposed to pesticides for 18 months with Control-3 = 15 subjects with no exposure and belong to same socioeconomic status.

An interesting aspect of the present study was the prevalence of ophthalmological problems arising due to pesticide spraying being dose and duration dependent. In the 6 months exposure period only 3.70% subjects complained of blurred vision whereas in 12 months it was 7.7% and in 18 months it was 24.69% being the highest. In the control human subjects of same age and same social status it was observed that there were only 2 subjects who complained of blurred vision in the 18 months of exposure that may be because of age or environment. Similarly burning of eyes was found to be highly prevalent among pesticides sprayers. In the 12 months exposure duration 17.1% subjects complained of burning of eyes and in 18 months 19.4% farm sprayers complained itching in their eyes which was quite significant. It was observed that there were no such ophthalmological symptoms found in the control human subjects who were of the same age and socioeconomic status.

With regard to the skin related problems in the 6 months exposure duration only 9.11% subjects complained of skin rashes whereas in the 12 months 14.4% and in 18 months 51 % subjects complained of skin patches, redness and irritation which was also found to be highest in the longer exposure duration period. In the control human subjects it was observed that there were no skin symptoms found in the non exposed workers.

Similarly in the present study respiratory related problems like excessive sweating, dry/sore throat, running/ burning nose and shortness of breath/cough were found quite common in the farm pesticides sprayers exposed to organophosphate pesticides from 6 months, 12 months and 18 months. Table 1 shows that in the 6 months exposed sprayers 5.4% subjects showed excessive sweating and shortness of breath during the pesticide spraying as compared to their well matched controls. While in 12 months exposed sprayers the prevalence of symptoms were found higher. 21% sprayers complained the problem of

excessive sweating, 11% sprayers reported dry throat, 17.7% reported burning nose and 16.7% farm sprayers reported shortness of breath whereas in the controls only 1 subject showed shortness of breath. In the 18 months exposed sprayers 35.1% sprayers complained excessive sweating, 22.06% reported dry throat, and 29.9% reported burning nose and 31.6% reported shortness of breath and cough. While from the control group 1subject showed excessive sweating and cough. (Table 1 and Fig 1)

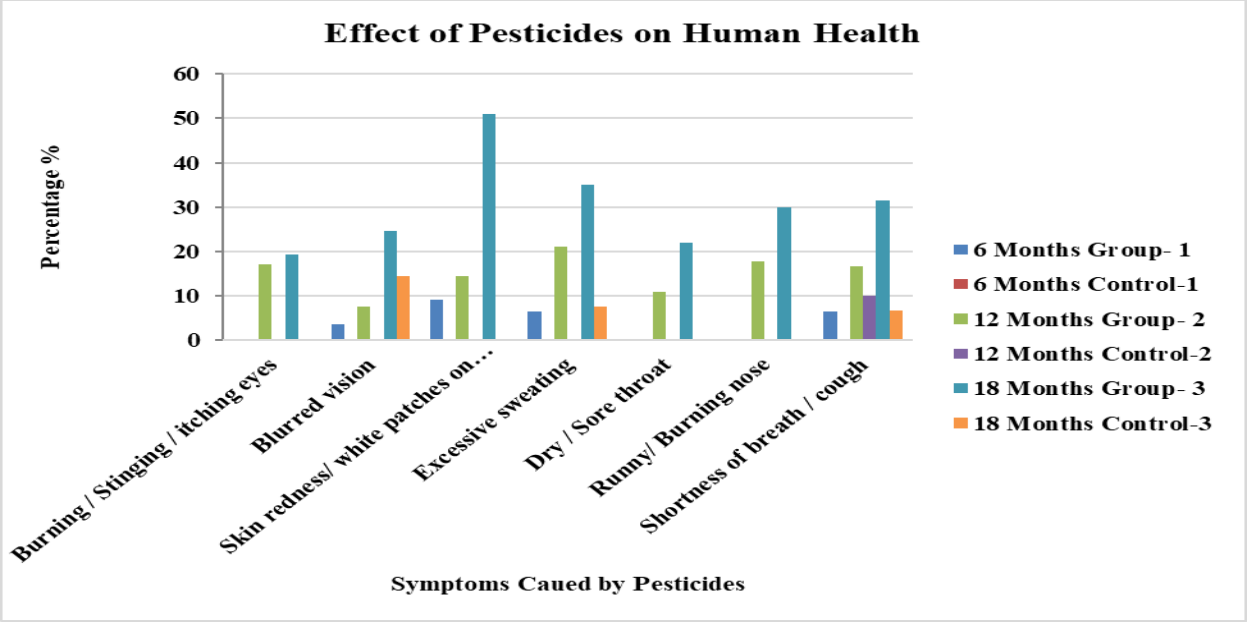

Figure 1: Comparative Analysis of General Health Parameters: Impact of Prolonged Exposure to Organophosphate Pesticides on Eyes, Skin, and Respiratory Symptoms in Farm Sprayers and Controls Over 6, 12, and 18 Months

Table 2 presents the Chi-square comparison between the exposure duration and the general health symptoms of farm sprayers showed due to organophosphate pesticides spraying. The subjects exposed to organophosphate pesticide from 12 months and 18 months are statistically significant than the control who have no exposure to pesticide and from the same socio economic status. No significant difference was noticed in the subjects exposed to pesticide from 6 month ($x\ 2 = 1.73$, $p=0.18$) which is not statistically significant whereas the subjects exposed from 12 months ($x\ 2 = 4.77$, $p < 0.05$) is moderately significant similarly the subjects exposed from 18 months ($x\ 2 = 12.73$, $p < 0.001$) is highly significant as compared to the control.

Table 2: Chi- square comparison between the symptoms and the pesticides exposure duration of the sprayers with their well matched control

Exposure Duration		Total number of subjects	Subjects reported symptoms	P value*
6 Months	Control 1	16	0	0.18
	Group 1	28	8	
12 Months	Control 2	12	1	< 0.05*
	Group 2	32	30	
18 Months	Control 3	35	4	< 0.001**
	Group 3	16	78	

*=Moderately significant, **= highly significant

6.2 Effects of pesticides on Soil Microbial Activity

Table 3: Effect of pesticides on CO2 evolution (mg CO2 100g soil) during different incubation periods

Treatments	Incubation Periods

	1	2	3	4	5	6	7
Unnamed Control	140	122	111	118	116	120	117
Thiamethoxam (12.60%)	131	115	106	119	110	114	109
Novaluron 05.25%	127	110	119	115	107	112	110
Lambda-cyhalothrin 09.50% ZC)	115	88	85	89	91	92	87
Indoxacarb 04.50% SC	126	120	122	106	110	111	109

The use of pesticides in the current investigation had a detrimental effect on soil microbial activity, resulting in the creation of CO2 (table 3). With the exception of Thiamethoxam (12.60%), Novaluron 05.25%, and Indoxacarb 04.50% SC, all pesticide kinds and concentrations exhibited significant reductions in CO2 generation. In the first and seventh weeks of incubation, the addition of Lambda-cyhalothrin 09.50% ZC) reduced CO2 production by 18% and 26%, respectively. The herbicides were extremely toxic to soil bacteria, as seen by the drop in CO2 production.

6.3 Effect of pesticides on water quality

This study analyzed the presence of pesticides in water samples obtained from soybean agricultural areas in Bhopal, Hoshangabad, Sehore, and Dewas districts of Madhya Pradesh. The concentrations of several pesticides were evaluated in parts per billion (ppb).

Districts	Thiamethoxam (12.60%)	Novaluron 05.25%	Lambda-cyhalothrin 09.50% ZC)	Indoxacarb 04.50% SC
Bhopal	0.17	0.09	0.12	0.04
Hoshangabad	0.15	0.08	0.11	0.03
Sehore	0.16	0.09	0.11	0.05
Dewas	0.14	0.08	0.10	0.03

The concentrations of Thiamethoxam (12.60%) exhibit minor variations among districts, with levels ranging from 0.14 to 0.17 parts per billion (ppb). The concentration of Novaluron 05.25% in water samples consistently falls within the range of 0.08 to 0.09 parts per billion (ppb). The amounts of Lambda-cyhalothrin 09.50% ZC) range from 0.10 to 0.12 parts per billion (ppb), with minor differences seen across different districts. The water samples contain Indoxacarb 04.50% SC at trace levels, with amounts ranging from 0.03 to 0.05 parts per billion (ppb).

7 DISCUSSION

The study reveals a significant association between pesticide exposure and adverse health effects among farm sprayers. Participants exposed to organophosphate pesticides for 12 and 18 months reported symptoms such as blurred vision, skin issues, respiratory problems, and other discomforts. The prevalence of ophthalmological problems was higher in those exposed for 18 months, with higher instances of burning and itching of the eyes. Skin-related problems, such as redness, white patches, and scaling, increased with prolonged exposure, with 51% reporting these symptoms in the 18-month exposure group. Respiratory problems were common among farm pesticide sprayers, with the highest levels in the 18-month group. The Chi-square comparison confirmed the association between exposure duration and health symptoms. The effects of different pesticides on soil microbial activity were also found to be negative, with Lambda-cyhalothrin showing the most significant impact. Thiamethoxam, Novaluron, and Indoxacarb showed varying degrees of impact on soil microbial activity.

The study highlights the interconnected impact of pesticide use on human health, soil microbial activity, and water quality. Prolonged exposure to organophosphate pesticides is associated with various health issues, emphasizing the need for protective measures and regulatory controls in agricultural practices. Sustainable and environmentally friendly pest management practices are also crucial to mitigate the adverse effects on ecosystems and human well-being.

8 CONCLUSION

According to the findings of the current research, the sprayers who were exposed for the longest possible

period of time reported the majority of the symptoms that were associated with respiratory issues.

It was discovered that the prevalence of respiratory problems was higher among agricultural sprayers that had been exposed for 12 and 18 months on average. The results of the current study make it abundantly clear that repeated exposure to pesticides over an extended period of time results in acute symptoms transmitted by inhalation, as well as skin or dermal issues, and it also has an impact on the quality of the soil and water. As a result of the current inquiry, it has been determined that there is a need to raise awareness among farmers regarding the utilization of personal protection measures when they are working with pesticides. Farmers should be educated about bio-pesticides and their benefits, and they should be encouraged to reduce, if not completely eliminate, their use of pesticides. Additionally, incentives should be offered to farmers in order to assist them in transitioning from synthetic pesticides to bio-pesticides and organic farming. This will allow for the introduction of a new revolution.

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