S.B. Biological and Agricultural Sciences
Vol.1, No.1, January-June 2025: P.15-18
Original Article
Available online at www.bpaspublications.com

Pesticides Pollution in Agroecosystems and Their Social and Ecological Consequences

[1]Vashundhara Arora, [2]Anjali Kanwal, and [3]Raj Singh*

Author's Affiliation:
[1]Department of Botany C.C.S. University, Meerut, Uttar Pradesh 250001, India.
[2,3]Department of Bio-Sciences and Technology, Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala, Haryana 133207, India.

***Corresponding Author: Raj Singh,** Department of Bio-Sciences and Technology, Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala, Haryana 133207, India.
E-mail: dr.rajsingh09@gmail.com

How to cite this article: Arora V., Kanwal A., and Singh R. (2025). Pesticides Pollution in Agroecosystems and Their Social and Ecological Consequences. *S.B. Biological and Agricultural Sciences,* 1(1), 15-18.

ABSTRACT
Numerous biological and cultural methods have been used to manage pests since the dawn of agriculture. But as the population grew, it became necessary to discover quick fixes for these pests. Pest-toxic chemicals turned out to be a practical tool for pest management. Given the rising need for agricultural products, the use of agrochemicals in agriculture has become unavoidable. Agrochemical production, marketing, and use have expanded many times since the start of the green revolution. In addition to having detrimental effects on non-target species, the chemical-based agriculture production system has societal and ecological repercussions, including contaminating food, rivers, soils, and bottom sediments. The detrimental effects of agrochemicals on the environment and human health were only discovered in the latter part of the nineteenth century. Agrochemical toxicity to humans and other environmental components was evaluated once the negative effects of excessive use were recognized. The effects of these agrochemicals, particularly pesticides, were examined at various trophic levels of the agroecosystem, influencing the main environmental elements like soil, water, and air. The effects of pesticide residues were discussed in this article along with potential remedies to lessen their effects.

KEYWORDS: *Pests, Pesticide, Agrochemicals, Agroecosystem, Toxicity, Trophic Levels.*

INTRODUCTION

Any organism that interferes with human welfare or activities in some way or the other is called a "pest". Approximately 600 species of insects, 1800 species of plants and numerous species of nematodes and microbes are considered to be serious pests in agriculture; and if left uncontrolled they would significantly reduce crop yields (Dunwell, 2003). For thousands of years since the beginning of agriculture, these pests were controlled by a variety of cultural and biological means. However, as the population increased, need was felt to find fast-acting means for managing these pests. Chemicals toxic to pests proved to be a convenient weapon for dealing with pests. The chemicals synthesized expressly for the long of unwanted species are called chemical pesticides (Chapman and Reiss, 1999, Wong *et al.*, 2023). The pesticides may be divided into various categories like herbicides, insecticides and fungicides etc.

Received on 15.09.2024/ Revised on 24.12.2024/ Accepted on 04.01.2025
Online First Published on Feb 15, 2025 at https://bpaspublications.com/
©BPAS PUBLICATIONS, Delhi, India. 2025

The first recorded description pesticides dates back to around 2500 B.C. when Sumerians are believed to have used sulphur compounds as insecticides to control insects and mites (WHO/ UNEP, 1989). The Chinese are credited with having developed pesticides for the treatment of seeds and for fumigation as far back as 1200 B.C. They used chalk and wood ash for the control of indoor and storage pests. There are also references to the use of mercury and arsenic compounds for the control of body lice and other pests (Gipps, 1990, Rasool *et al.*, 2022). Chinese also used the application of white arsenic to rice roots for protecting rice transplants from pest attacks while sulphur and copper were used to control lice (Michael, 1987).

In Greece and Italy, a variety of fumigants, oil sprays or sulphur ointments were in use. In fact, the use of inorganic chemicals goes back to classical Greece and Rome. While Hormer had mentioned fumigant value of Sulphur, Pliny the Elder has referred to the insecticidal value of arsenic and soda (Conway and Pretty, 2013).

Discovery and Types of Pesticides

Nineteenth century saw the trend towards systematic scientific approach towards the use of chemicals for plant pest control. This led to the use in 1867 of Paris Green in crude form of copper arsenate, iron sulphate and lead arsenate (Dudani, 1999). In the late nineteenth century, the Bordeaux mixture (lime plus copper sulphate) was discovered by Millardet (1885) which gave spectacular results in downy mildew of grapes. Bordeaux mixture emerged as a very useful fungicide and is still preferred in a member of cases. Another landmark was the discovery of organo-mercury dressings in Germany in 1913. This may be regarded as an era of first generation pesticides followed by second generation pesticides (Dudani, 1999). P. H. Mueller, in 1934, discovered insecticidal potential of DDT (dichlorodiphenyl trichloroethane) which was successfully used in 1939 and 1942 to control potato beetle and lice (Wright, 1992). In 1934, the first dithiocarbamate fungicide (thiram) was discovered by Tisdale and Williams (1934) which led to the development of a series of effective and widely used fungicides like ferbam, zineb and maneb. Many groups of chemical compounds are now available for plant disease management. These include heterocyclic nitrogen compounds, quinones, phenols and antibiotics. Figure 1 also depicted the chronological development of pesticides.

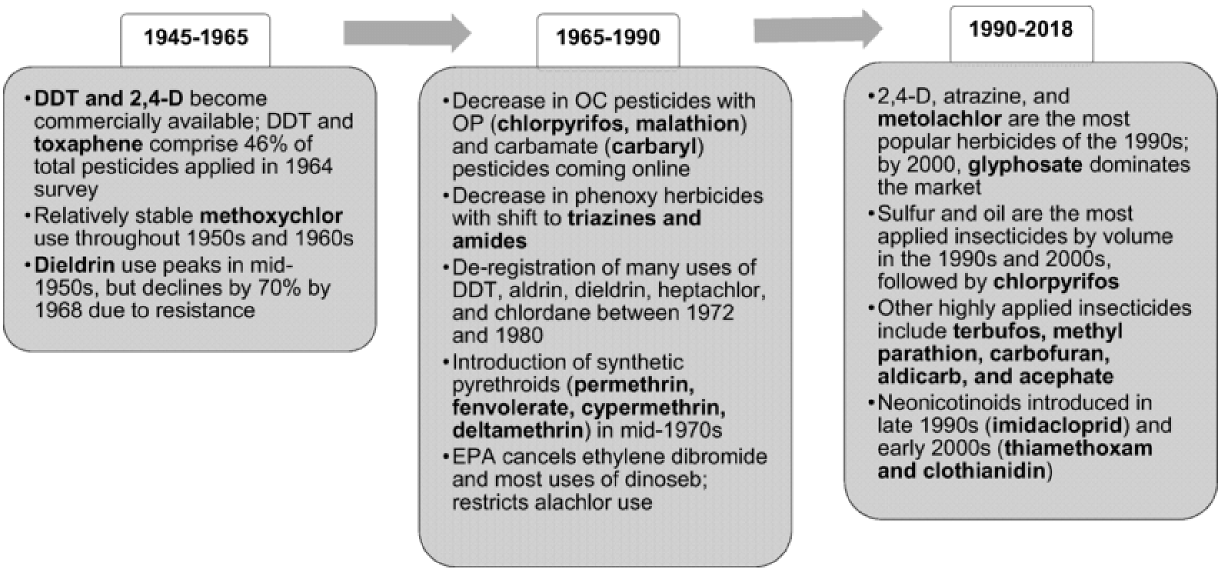

Figure 1: Pesticides development and uses

The Bordeaux mixture, named after the Bordeaux region of France where it was developed and used against the downy mildew of grapes, is the product of reaction of copper sulphate and calcium hydroxide (hydrated lime). It was first fungicide to be developed and still is the most widely used copper fungicides throughout the world (Agrios, 2005). It controls many fungal and bacterial leaf spots, blight, anthracnoses, downy mildews and cankers. Copper is the only ingredient in the Bordeaux mixture which is toxic to pathogens and sometimes it is toxic to plants also.

Organic sulphur compounds are one of the most important, versatile and widely used group of modern fungicides. These include thiram, ferbam, nabam, maneb, zineb and mancozeb. They are all derivatives of dithiocarbamic acid. The zinc ion maneb, also called mancozeb (and also sold as Dithane M-45) is used for the control of foliage and fruit diseases of many vegetables especially tomato, potato and vine crops. It is believed that dithiocarbamates are toxic to fungi mainly because they are metabolised to the isothiocyanate radical which inactivates the sulfhydryl group (-SH) in amino acids and in enzymes within pathogen cells, thereby inhibiting the production and function of these compounds (Agrios, 2005).

Ideally a pesticide must be lethal to target pest, but not to non-target species, including man. Unfortunately, this is not so (Fig. 2). Therefore, the controversy ever use and abuse of pesticides has surfaced up (Burtling et al., 2024). Some of the negative effects of pesticides overuse include low crop yield, destruction of soil life, and undesirable accumulation on food crops (Edwards, 1986).

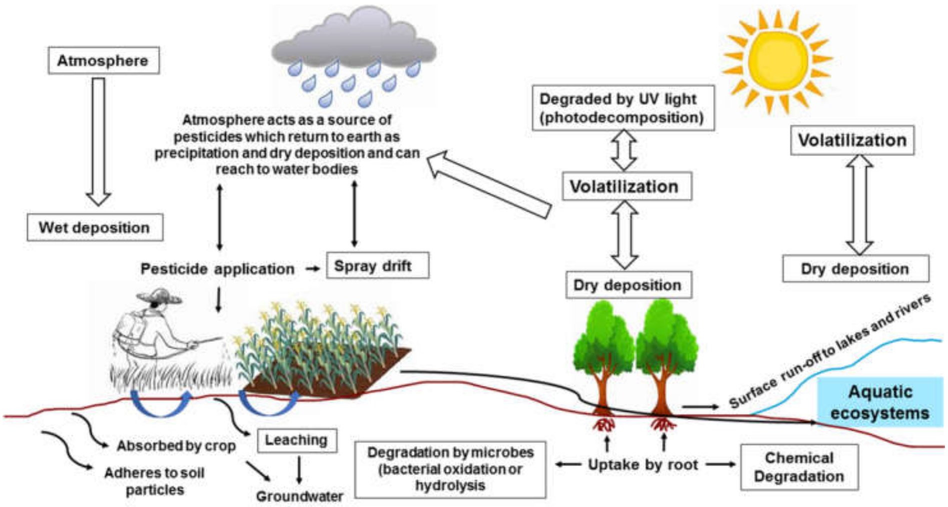

Figure 2: Pesticide contamination in agro-ecosystems: toxicity, impacts, and bio-based management (Umesh Pravin Dhuldhaj *et al.*, 2023).

Carson (1962), an American scientist, pointed out sudden dying of birds caused by indiscrimination spraying of pesticides (DDT) in her book "Silent Spring". It stimulated public concern on pesticides, since then, adverse effects of pesticides on human beings, animals, plants and soil microbes have been recognized worldwide. A number of articles and reviews covering different aspects of pesticides have appeared. These include those by Pimentel (2005), Navarro *et al.*, (2007), Akhtar *et al.,* (2009), Yaashikaa *et al.,* (2022), Sharma *et al.,* (2023) and Kaur et al (2024).

CONCLUSION

The environment and human health are more at risk from the ongoing increase in pesticide use in agro-ecosystems to guarantee food supplies for the world's expanding population. In addition to the microbes, fauna, and plants that live in the soil, the characteristics of the soil and the type of pesticides used impact the fate and transportation of pesticides once they are introduced into the agro-ecosystem. The buildup of pesticides in plant-based diets, feeds, and animal products is associated with indiscriminate applications. It is essential to conduct bio-monitoring studies in order to analyze the risks posed by agrochemicals and comprehend their effects on the environment.

REFERENCES

Agrios, G. N. (2005) Plant Pathology (Fifth Edn.), Elsevier Academic Press. California, U.S.A.

Akhtar, M. W., Sengupta, D. and A. Chowdhury (2009) Interdisciplinary Toxicology 2:1-12.

Bartling, M. T., Brandt, A., Hollert, H. and Vilcinskas, A. (2024). Current Insights into Sublethal Effects of Pesticides on Insects. *International Journal of Molecular Sciences*, *25*(11), 6007.

Carson, R. (1962), Silent Spring. Houghton Mifflin.

Chapman, J. L. and Reiss, M. J. (1999). *Ecology: principles and applications*. Cambridge University Press.

Conway, G. R., & Pretty, J. N. (2013). *Unwelcome harvest: agriculture and pollution*. Routledge.

Dunwell, J. M. (2003) Plant genetic engineering, ecological issues. In "Encyclopedia of applied plant sciences" (Thomas, B., Murphy D. J. and B. G. Murray eds.); Elsevier Academic Press, Oxford, UK. eda); Swedish Science Press, Uppsala

Edwards, C. A. (1986) Agrochemicals as environmental pollutants. In "Control of pesticide

Gipps, T. (1990) Breaking the pesticide habit, IOCU, Penang.

Kaur, R., Choudhary, D., Bali, S., Bandral, S. S., Singh, V., Ahmad, M. A. and Chandrasekaran, B. (2024). Pesticides: An alarming detrimental to health and environment. *Science of the Total Environment*, 170113.

Michael, H. (1987) Escape from the pesticide treadmill. Institute for consumer policy research, New York, USA.

Millardet, P.M.A. (1885) Sur l'historique du traitement du mildiou par le sulfate de cuivre Journal of Agriculture Practice. 2:801-805.

Mueller, G. J. (1934). The Distribution of Initial Velocities of Positive Ions from Tungsten. *Physical Review*, *45*(5), 314.

Navarro, R. M., Pena, M. A. and Fierro, J. L. G. (2007). Hydrogen production reactions from carbon feedstocks: fossil fuels and biomass. *Chemical reviews*, *107*(10), 3952-3991.

Pimentel, D. (2005) Environmental and economic costs of the applications of pesticides primarily in the United States. Environment, Development and Sustainability 7:229-252.

Rasool, S., Rasool, T. and Gani, K. M. (2022). A review of interactions of pesticides within various interfaces of intrinsic and organic residue amended soil environment. *Chemical Engineering Journal Advances*, *11*, 100301.

Sharma, J. K., Kumar, N., Singh, N. P. and Santal, A. R. (2023). Phytoremediation technologies and their mechanism for removal of heavy metal from contaminated soil: An approach for a sustainable environment. *Frontiers in Plant Science*, *14*, 1076876.

Tisdale, W. H. and I. Williams (1934) Disinfectant. U.S. Patent no.1, 972, 961.

WHO/UNEP (1989) Public health impact of pesticides used in agriculture. UNEP Nairobi, Kenya.

Wong, W. L. and Pangging, M. (2023). Bioremediation of Pesticide-Contaminated Soils through Composting: Mechanisms, Factors, and Prospects. *Industrial and Domestic Waste Management*, *3*(2), 103-114.

Wright, A. (1992) The death of Ramon Gozalez. University of Texas Press, Austin, Texas.

Yaashikaa, P. R. and Kumar, P. S. (2022). Bioremediation of hazardous pollutants from agricultural soils: a sustainable approach for waste management towards urban sustainability. *Environmental Pollution*, *312*, 120031.

****