CHAPTER-13

SOIL POLLUTION STATUS AND IMPACT OF PESTICIDES ON CROP DEVELOPMENT IN SELECTED REGION OF AMRAVATI DISTRICT, MAHARASHTRA (INDIA)

A.G. Thakare, G.D. Wadankar, B.P. Uchitkar, and S.K. Arsod
Department of Botany, Rajasthan Aryan Arts, Shri. Mithulalji Kacholiya **C**ommerece and Satyanarayan Ramkrushnaji Rathi **S**cience **C**ollege, Washim-444505.
Email- gdwadankar@gmail.com

Summary

Pesticides applied to the soil tend to be a mixture of different active substances. Therefore, it is difficult to analyze their influence on the biological activity of the soil. The research work did from Daryapur region of Amravati district in October 2022 to December 2022.This review attempts to discuss the activity of such compounds on microbial community and soil pollution status in the rural and urban area. It also investigates the degradation of pesticides in soil and the prevention of their negative effects on soil biological activity. So far, there are almost no studies offering a comprehensive view of biological activity in soil, with little attention paid to the effect of different pesticides and their metabolites. The impact of pesticides on soil health is still a current and important issue that requires constant monitoring. This review summarizes the latest scientific reports on soil enzymes and microbial events, as well as changes in below-ground biochemistry under the influence of pesticides. Enzymatic and microbiological responses following pesticide application are difficult to interpret due to their physical diversity and diversity of degradation pathways. The optimization of agricultural production has recently become necessary to meet the food needs of the growing world population. To address this formidable challenge, the application of agrochemicals, including synthetic pesticides in intensive farming practices, has increased alarmingly. However, the excessive and indiscriminate use of pesticides to promote food production leads to its extreme confession in the soil.

Keyword: Pesticides, microbial community, soil, degradation pathways

E-Book ISBN: 978-81-981814-9-7, DOI: https://doi.org/10.34256/adbor.25.13.99

Introduction

Changing climate conditions including global warming increase temperature negatively affect agricultural productivity. The optimization of agricultural production has recently become essential to meet the food needs of the growing world population. To address this formidable challenge, the application of agrochemicals, including synthetic pesticides, in intensive agriculture practices has increased disturbingly However, the excessive and indiscriminate use of pesticides to promote food production leads to its excessive deposition in the soil. After accumulation in the soil beyond a threshold, pesticides negatively affect the abundance, diversity, composition and function of the rhizosphere microbiota. In addition, the cost of pesticides and the emergence of insect resistance to pesticides are other reasons for concern. For this reason, the loss of soil nutrients leads to a significant reduction in agricultural output, which justifies the search for new environmentally friendly technologies for sustainable agricultural production. The bacteria in the rhizosphere, in this context, play an important role in detoxifying the polluted environment, making the soil suitable for cultivation through the detoxification of pollutants, and the treatment of the rhizosphere., bioremediation, pesticide degradation and stress decrease, resulting in optimized performance. To alleviate problems arising from current climate conditions and ensure food security, sustainable agricultural practices are the basic need of the current scenario. Biology is one of the sustainable approaches to agriculture. In this chapter, beneficial fungal bacteria are discussed in relation to their use as biofertilizers, biological control agents and also in the mold treatment of contaminated soils. Fungi are ubiquitous in nature, possessing rapid adaptability and diverse metabolic activity in natural systems. In soil, fungi can sustain themselves under different environmental conditions by producing different types of spores. These bacteria contribute significantly to the maintenance of the ecosystem by their decomposing behavior either as a biofertilizer or organic control factor.

The response of soil microorganisms to a wide range of chemical pesticides varies widely, from adverse to killing beneficial bacteria. At the cellular and biochemical levels, pesticides destroy morphology, infrastructure, cell viability/permeability, and many biochemical reactions, including protein profiles of soil bacteria. Some pesticides also disrupt the molecular interactions between plants and their symbionts, hindering all useful biological processes. However, the harmful effects of pesticides on soil bacteria have not been fully studied. In this review, recent findings regarding the potential effects of synthetic pesticides on a wide range of soil microbiota are highlighted. Focus is placed on researching and recommending strategies to minimize the use of chemical pesticides under real world conditions to preserve the viability of useful soil bacteria and soil quality for production. Safe and sustainable agricultural production even in pesticide-contaminated soil.

Materials and Methods

Study Site- The research work done from Daryapur region. Field survey and soil samples were collected from fields nearby Daryapur.

Soil samples- The soil sample collected in glass bottle for laboratory test.

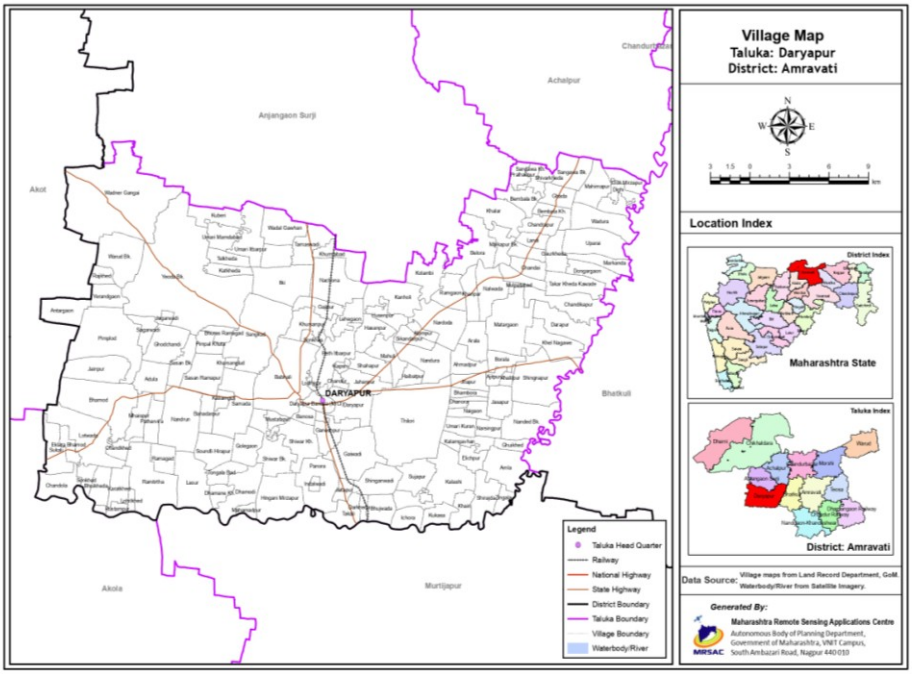

Figure 1: Study site- Daryapur Taluka, District- Amravati (MS)

Soil Testing- Soil material for chemical analysis was collected from each of the CL and natural (NH) horizons separately. The collected material was air dried and sieved through a 2 mm mesh plastic sieve. Detailed information on fieldwork and soil sampling, with the basic properties (Corg, pH, texture) of the soil studied, can be found in Mazurek et al. (2016). Soil texture was determined by air mass method described by Bouyoucos and method modified by Cassagrande & Proszy nski (Polish Standard, 1998). The organic carbon (Corg) content in each soil sample was analyzed according to the Tiurin method (Litynski et al., 1976). Potentiometric measurements of pH were performed using a glass electrode and a pH meter CPI-551 (Elmetron company) in 1 mol dm3 KCl.

Soil Profile- Soil samples were taken from the profile below the Daryapur region with a total depth of 22 cm. In general, the studied land is divided into distinct sections:-

the upper part of the soil profile includes 13 CL, horizon, from 0 to 22 cm. And (ii) burial ground consisting of 5 NH, Ab, Bw, Bw1, Bw2 and C, starting from a depth of of 224 cm to the bottom of the section, 292 cm. Soil has been classified according to WRB (IUSS Working Group WRB, 2015). The age of the deepest CL is estimated based on archaeological, while the surface layer was formed in the late.

Soil Texture- pH value and organic carbon content Particle size analysis indicates that some CLs have a sandy texture and others a sandy texture. In NH, sand predominates. The total sand content of in CL was lower than in NH and ranged from 81 to 95% and 93 to 98%, respectively. The proportion of alluvium in CL ranged from 4 to 16%, while in NH it ranged from 2 to 6%. The clay content (<2 mm) in CL was lower than in NH and did not exceed 4% and 2% respectively (Mazurek et al., 2016).

Apparatus- Pesticide recycling equipment, based on the principle of recovering liquid pesticides not retained in the research area, has been designed and manufactured. The device is built on the basis of the commercial air- assisted sprayer which is used for pest and disease control in study site. The sprayer is equipped with an axial fan that generates the necessary airflow to agitate the leaves of the canopy, thus allowing the deposition of liquid pesticides on both sides.

Results and Discussion

The research work deals with study of pesticide impact and fourteen pesticides have been screened and identified through a fast, easy, inexpensive, effective, robust and safe extraction process (QuEChERS) in combination with GC-MS/MS in Daryapur region. The objective of the present survey was to report on the presence of organochlorine (OCP) and organophosphate (OPP) pesticide residues as well as pyrethroid (PYR), carbamate and bio pesticide groups. using a combination of QuEChERS and GC- MS/Ms techniques. in agricultural soils in the Daryapur region, and to study the correlation between the amount of pesticides lost in the soil and some physico- chemical properties of pesticides, especially the distribution of pesticides. octanol-water coefficient (Kow) and vapor pressure (Vp). Predicting the fate of pesticides taking into account both the physico-chemical properties of pesticides and the soil will facilitate the management of pesticide use and reduce the risk of environmental pollution. The fate of pesticide residues in the soil is generally controlled by soil/air exchange, water interactions and biodegradation.

The results indicated that for 14 pesticide residues measured in samples collected from various soils, spinosad, methyl chlorpyrifos, dimethoate, chlorpyrifos, lindane (γ-HCH), permethrin and methomyl were the sources of contamination. most contaminated in the study area. p,p-DDT, o,p-DDT, bifenthion, β- cyfluthrin and methidathion were less frequently detected. The single-parameter least squares (sp-LSRE) regression equations for Vp and Kow for the loss of each pesticide residue showed a significant change in concentration ($p < 0.05$) between two seasons. The outcomes show that gas pressure and octanol-water divider co-efficient data are not sufficient to model pesticide residue losses in arid soils with lower carbon content. More soil data are need to do characterize the dispersion mechanisms of these pesticide residues in the region.

Table 1: Pesticide chemical group, impact and properties

S.No.	**Pesticide impact and properties**	**Effect on Microorganism**	**Pesticide chemical group**
1.	Selective, absorbed through leaves and root.	Pseudomonas putida. Flavobacterium. Ralstonia	Chloroacetamide
2.	an acetyl CoA carboxylase inhibitor and inhibits fatty acid synthesis (ACCrue).	Eutropha	Diphenyl ether
3.	Selective, systematic, absorbed throughroots and increase biosynthesis and production or ethylene causing uncontrolled cell division and sm damages vascular tissue. synthedc auxin.	*Ptstalotiopsis* spp	Alkylchlorophenoxy
4.	Induces accumulation of tetrapyroles which anack plant cells, protoporphyrinogen oxidase (PPO).	*Trichmporm domtsricwn*	Organochlorine
5.	Selective, inhibition of cell division andfatty acid	*Sphingobiwn quisquUiarum Sphingobiwn lxidtri Mycobacreriwnfonuirum, bacillus , Microbactriurn sp., Gordmia polyi.sopnnttvCTaru,*	Phoophonoglycine
6.	systemic with contact action acts by leaf and shoot.	*Canamonas* sp. *Sphinpyxis* spp	Sulfonylurea
7.	inhibiting photosynthesis at Photooystem D.	*Pseudomonas utrichous* BY·I,	Triazine
8.	Selective, absorbed by leaves and	*Brevundimonas* sp. *F!avcbacttriaceae, Pseudomonoidaceae, Sphingobactreriacea*	Triketone
9.	protoporphyrinogen oxl dase (PROTOX), leading to drought stress	*Arrhrobacrer* sp, *Achromobacur* sp.,*Straptomyus* sp.,	Uracil
10.	irreversibie cell membrane damage.	Pseudomonas spp. Bacillus spp	Urea

Table 2: Soil properties of Rural and Urban area

Sample	pH	Sand (g kg^{-1})	Clay (g kg^{-1})	Pb (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})	Ni (mg kg^{-1})
Rural 1.	7.3	704	79	50	172	109	84
Rural 2.	7.1	709	75	59	149	78	69
Rural 3.	7.4	692	77	54	142	85	56
Urban 1.	6.8	690	89	110	392	180	154
Urban 2.	6.9	720	86	118	410	145	129
Urban 3.	7.2	708	88	107	455	174	117

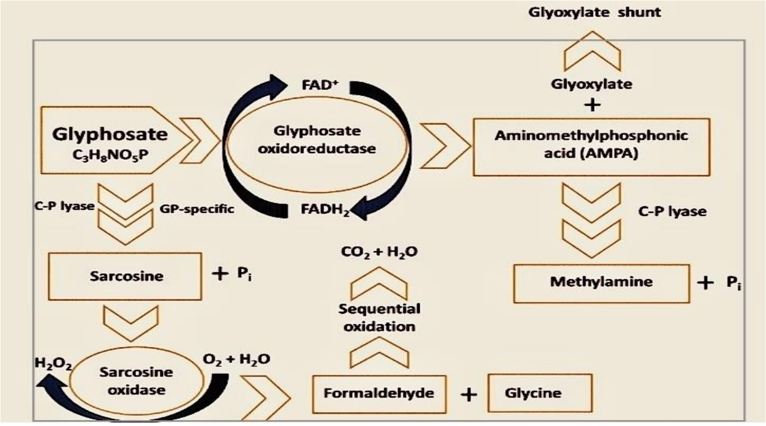

Figure 2: Microbial degradation of glyphosate via AMPA and via sarcosine (Sviridov et al., 2015)

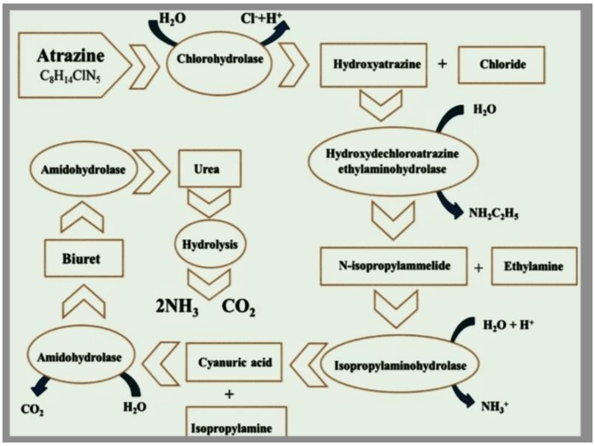

Figure 3: Pathway enzymatic degradation of atrazine in soil (Lin et al., 2011)

Conclusion

Pesticides are seen as a boon to farmers around the world as they optimize agricultural productivity and provide many secondary benefits to society. However, queriesregarding the safety of pesticides are regularly elevated due to their risks to human health and the environment. While the risks associatedwith pesticide use cannot be completely eliminated, the toxicity of pesticides to soil, bacteria, plants, and human health can be significantly reduced. The role of plants in the control and reduction of soil pollution (phytoremediation) is decrease in human diseases, the extinction of many plants, grass species and the risk of threatening generations of animals is strongevidence support the above declaration. To this end, biologists and ecologists have been forced to think about natural ways to combat pollution. The use of plants is a simple biological route most important because theuse of plants is a non-technical, cost effective and technologically profitable method.

As a result, soil loses its structure as well as the important nutrients are present in the soil. Some causes of soil pollution may include:

- Industrial wastewater such as toxic gasesand chemicals release in rural area and water body.
- Use of chemicals in agriculture suchas pesticides, fertilizers and pesticides Inadequate or ineffective land management system.
- Unfavorable irrigation practices , Poor management and maintenance of septic systems.
- Sanitary waste leaks Toxic smoke fromindustries mixed with raincauses acid rain.
- Fuel leak from car washed away by rain and settled on surrounding land.
- Unhygienic waste managementtechniques dumping wastewater into nearby landfills and water sources.
- The use of pesticides in agriculture retains chemicals in the environment for a long time
- These chemicals also affect beneficial organisms such as earthworms in the soiland lead to soil quality.
- Lack of proper wastetreatment system resulted in waste beingdispersed in the ground.

References

[1] Andersson, A. (1975). Relative effciency ofnine different soil extractants. *Swedish J. Agric. Res. 5*, 125 – 135.

[2] Cook, C. M., Sgardelis, S. P., Pantis, J. D., & Lanaras, T. (1994). Concentrations of Pb, Zn and Cu in Taraxacum spp. in relation to urban pollution. Bull. Environ. *Contam. Toxicol.* 53: 204- 210.

[3] Glazovskaja, M. A. (1994). Criteria for classification of soils according to lead-pollution risk. *Eurasian SoilScience,* 26: 58-74.

[4] Grzebisz, W., Kociałkowski, W. Z., and Chudziński, B. (1997). Copper geochemistry and availability in cultivated soils contaminated by a copper smelter. *Jour. of Geochemical Exploration,* 58: 301-307.

[5] Hooda, P. S., and Alloway, B. J. (1994). The plant availability and DTPA extractability of trace metals insludge-amended soils. *Sci. Total Environ,* 149: 39-51.

[6] Kabata-Pendias, A., and Pendias, H. (1992). Trace elements in soils and plants. CRC Press Inc, Boca Raton, Florida, USA. (2nd Edition), 365.

[7] Kabata-Pendias, A., and Dudka, S. (1991). Trace metal contents of Taraxacum officinale (dandelion) as a convenient environmental indicator. *Environ. Geochem. Health.* 13: 108-113.

[8] Kabata-Pendias, A., Terelak, M., Piotrowska, M., Terelak, H., & Witek, T. (1993). Ocena stopnia zanieczyszczenia gleb i roślin metalami ciężkimi i siarką [Assessment of the level of contamination of soils and plants by heavy metals and Sulphur]. *IUNG P- 53*, Puławy p. 5-14 [in Polish].

[9] Lara-Cazenave, M. B., Levy, V., Castetbon,A., Potin-Gautier, M., Astruc, M., and Albert, E. (1994)). Pollution of urban runoff waters by heavy metals. Part I: Total metal. *Environ. Technology,* 15: 1135-1147.

[10] Mielke, H. W. (1994). Lead in New Orleans soils: new images of an urban environment. Environ. *Geochemistry and Health,*. 123-128.

[11] Mocek, A., Drzymała, S., & Maszner, P. (2000). Genesis, analysis and soil classification [Geneza, analiza i klasyfikacja gleb. Wyd. AR Poznań,]. *Poznan AU Publ., 416* p. [in Polish].

[12] Moreno, A. M., Prerez, L., & Gonzalez, J. (1994). Soil parameters contributing to heavy metal dynamics in perimetropolitan farmland areas.*Geomicrobiology J.,* 11: 325-332.

[13] Polish Standard: Polish Committee of Normalization, ref no. Pr PN – ISO 10 390 (E), Soil Quality and pH determination. First Edition [Polska Norma 1994. Polski Komitet Normalizacyjny, nr ref. Pr PN – ISO 10 390 (E), Jakość gleby i oznaczanie pH. Pierwsze wydanie] [in Polish].

[14] Sanka, M., Strnad, M., Vondra, J., and Paterson, E. (1995). Sources of soil and plant contamination in an urban environment and possible assessment methods. *Intern. J. Environ. Anal.Chem.,* 59: 327-343