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Editorial: Environmental impacts of pesticides: Environmental fate, ecotoxicology, risk assessment, and remediation

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Editorial on the Research Topic
Environmental impacts of pesticides: Environmental fate, ecotoxicology, risk assessment, and remediation

Introduction

In the past few decades, conventional agriculture has relied heavily on the use of pesticides (including insecticides, fungicides, and herbicides etc.) for controlling pest species and enhancing crop yields (Carvalho, 2006; Dhananjayan et al., 2020; Washuck et al., 2022). However, the large-scale application of pesticides can pose a serious threat to various non-target organisms, for example, bees, birds, silkworms, earthworms, natural parasitic and predatory organisms, fishes, algae, daphnia, amphibians, etc (Stanley et al., 2016; Kenko et al., 2022). Studies on the environmental fate, toxic effects, and environmental risk of pesticides, and the combined effects of pesticides and other environmental and agricultural contaminants (e.g., heavy metals, pharmaceutical and personal care products (PPCPs), and microplastics) have attracted increasing attention in recent years (Zhou et al., 2004; Chen et al., 2015; Picó et al., 2020). Potential remediation methods and technologies for pesticides and pesticide-contaminant combinations have also been developed rapidly (Sun et al., 2018; Zhang et al., 2020).

In this Research Topic, we set up a Research Topic of *Environmental impacts of pesticides: Environmental fate, ecotoxicology, risk assessment and remediation*, which not only covers pesticides but also the combinations of pesticides and other kind of contaminants (e.g., heavy metals, PPCPs, and microplastics etc.). The following themes are included in this Research Topic: (a) Environmental fate including how pesticides enter the air, soil, and aquatic environment after being applied to agricultural crops; (b) Ecotoxicity: pesticide effects on non-target organisms, individually or in combination with other contaminants; (c) Mechanisms of interaction of pesticides and pesticide mixtures on non-target organisms; (d) Environmental risk assessment of pesticides and pesticide mixtures on non-target organisms and aquatic ecosystem; (e) Technologies and techniques that can be utilized to effectively remediate pesticide contamination and reduce the environmental risks.

Even though a lot of progresses have been made in investigating the environmental impacts of pesticides, there are still knowledge gaps exist in above themes and the goal of our Research Topic is to fill those gaps. We finally accepted and published 16 papers authored by 99 researchers from nine countries, including China, United States, Pakistan, Norway, Egypt, Saudi Arabia, the Netherlands, Kazakhstan, and Canada.

Highlights from Publications Featured in this Research Topic are as follows.

Environmental fate of pesticides and its residues in crops

Yu et al. investigated the dissipation behavior of fungicide difenoconazole in paddy sediment system under different field conditions following the application of biogas residues. Commelin et al. reported the overlooked environmental risk of overland transport of 31 pesticides in the particulate phase, which generally lasted over long period time when applied on agriculture on sloping lands. Yu et al. monitored the exposure of propiconazole in water and soil from rice–crab co-cultured fields.

In the study of Wang et al., the disappearance behavior, residue distribution and dietary risk assessment of kresoxim-Methyl in banana (*Musa nana* Lour.) was investigated based on a modified QuEChERS procedure using HPLC-MS/MS. In the research of Fan and Li, residues, dissipation and dietary risk assessment of two fungicides oxadixyl and cymoxanil in cucumber was analyzed based on a QuEChERS method using UPLC-MS/MS under greenhouse and open field conditions.

Pesticide ecotoxicology/toxicology on non-target organisms and resistance monitoring

In the study by Zhou et al., the sensory behaviors of thermotaxis, avoidance of copper ion, chemotaxis to NaCl, and chemotaxis to diacetyl were investigated in nematodes (*Caenorhabditis elegans*) exposed to six insecticides (dinotefuran, thiamethoxam, thiacloprid, nitenpyram, acetamiprid, and sulfoxaflor) in the range of micrograms per liter (μg/L). Li et al. investigated the environmental impact of trifluralin on soil microbial communities and functions in a 3-month greenhouse experiment. Yu et al. evaluated the acute toxicity, sub-chronic toxicity, and bioaccumulation of propiconazole to *Eriocheir sinensis* in the rice–crab co-culture fields. Pochron et al. found that exposure to glyphosate, the herbicidal ingredient in Roundup products Roundup Ready-to-Use III, offered no nutritional benefit, but increased movement speed and decreased body mass in earthworms (*Eisenia fetida*). According to the research of Massoud et al., low doses of malathion exposure increased several enzyme activities and caused multiple histopathological changes on Wister male rats (*Rattus norvegicus*) after 24-h and/or 21-days treatment, implying the chronic toxicity of environmental residue malathion to animals and human.

In the research of Riaz et al., the frequency of pyrethroid insecticide resistance gene kdr (knockdown resistance) in housefly populations of District Jhang, Pakistan was investigated. In the study of Wang et al., levels of resistance to cyantraniliprole in whiteflies (*Bemisia tabaci*) with 18 field-sampled populations across China were measured.

Pesticide contamination remediation techniques and technologies

Massoud et al. synthesized a zinc oxide nanocatalyst and obtained the most effective process ($ZnO(s)/H_2O_2/UV$) for detoxification of some highly toxic insecticides (dimethoate and methomyl) in an aquatic system. Wang et al. prepared a montmorillonite–biochar composite (MMT/BC) and demonstrated that MMT/BC has higher removal capacity of atrazine in aqueous solution compared to raw biochar (BC). In the study of Aziz et al., the constructed wetland with the bacterial–plant consortium showed its potential to biodegrade insecticide chlorpyrifos and its major metabolites. Tussipkan and Manabayeva reviewed the genetic diversity of alfalfa (*Medicago Sativa* L.), and transgenic alfalfa plants for enhanced phytoremediation of persistent organic pollutants (POPs), petroleum and heavy metals. Khalid et al. examined the effect of sewage sludge-amended soil on growth, enzyme activities, and genotoxicity in earthworms (*Pheretima posthuma*) and demonstrated that wheat straw and biochar ameliorated the toxic effects of sewage sludge in earthworms.

Future research

Overall, the Research Topic of published articles and reviews in this Research Topic already advanced our understanding of environmental fate, ecotoxicology, risk assessment and remediation of pesticides. Nevertheless, great challenges still exist in computational toxicology for predicting environment risk of pesticides and in understanding the "cocktail effect" of pesticides and their combination with other environmental and agricultural contaminants (e.g., heavy metals, PPCPs, and microplastics). More research on those fields is warranted.

Author contributions

This editorial draft was written by LM. All authors revised and contributed to the article and approved the submitted version. LM, YG, JG, MZ, and YW as guest topic editors have worked extensively on the call for submissions, and edited the manuscripts submitted to this Research Topic.

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Conflict of interest

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References

Carvalho, F. P. (2006). Agriculture, pesticides, food security and food safety. *Environ. Sci. policy* 9 (7-8), 685–692. doi:10.1016/j.envsci.2006.08.002

Chen, C., Wang, Y., Qian, Y., Zhao, X., and Wang, Q. (2015). The synergistic toxicity of the multiple chemical mixtures: Implications for risk assessment in the terrestrial environment. *Environ. Int.* 77, 95–105. doi:10.1016/j.envint.2015.01.014

Dhananjayan, V., Jayakumar, S., and Ravichandran, B. (2020). "Conventional methods of pesticide application in agricultural field and fate of the pesticides in the environment and human health," in *Controlled release of pesticides for sustainable agriculture*. Editors K. R., R.S. Thomas and T. Volova, (Cham: Springer). doi:10.1007/978-3-030-23396-9_1

Kenko, D. B. N., Ngameni, N. T., and Kamta, P. N. (2022). Environmental assessment of the influence of pesticides on non-target arthropods using PRIMET, a pesticide hazard model, in the Tiko municipality, Southwest Cameroon. *Chemosphere* 308, 136578. doi:10.1016/j.chemosphere.2022.136578

Picó, Y., Alvarez-Ruiz, R., Alfarhan, A. H., El-Sheikh, M. A., Alshahrani, H. O., and Barceló, D. (2020). Pharmaceuticals, pesticides, personal care products and microplastics contamination assessment of Al-Hassa irrigation network (Saudi Arabia) and its shallow lakes. *Sci. Total Environ.* 701, 135021. doi:10.1016/j.scitotenv.2019.135021

Stanley, J., Preetha, G., and Stanley, J. (2016). *Pesticide toxicity to non-target organisms*, 502. Berlin, Germany: Springer.

Sun, S., Sidhu, V., Rong, Y., and Zheng, Y. (2018). Pesticide pollution in agricultural soils and sustainable remediation methods: A review. *Curr. Pollut. Rep.* 4 (3), 240–250. doi:10.1007/s40726-018-0092-x

Washuck, N., Hanson, M., and Prosser, R. (2022). Yield to the data: Some perspective on crop productivity and pesticides. *Pest Manag. Sci.* 78 (5), 1765–1771. doi:10.1002/ps.6782

Zhang, H., Yuan, X., Xiong, T., Wang, H., and Jiang, L. (2020). Bioremediation of co-contaminated soil with heavy metals and pesticides: Influence factors, mechanisms and evaluation methods. *Chem. Eng. J.* 398, 125657. doi:10.1016/j.cej.2020.125657

Zhou, Q., Cheng, Y., Zhang, Q., and Liang, J. (2004). Quantitative analyses of relationships between ecotoxicological effects and combined pollution. *Sci. China Ser. C* 47, 332–339. doi:10.1360/03yc0042