探討歐洲與阿根廷農作物農藥殘留的發生率及風險

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摘要

在歐洲作物生產中廣泛且大量使用農藥以減少雜草、病害和昆蟲造成的損失，可能會對生態系統和人類健康造成嚴重後果。根據二十種具高度健康風險活性物質在環境基質（土壤、作物、水體和沉積物）的檢出頻率（Detection Frequency，DF），辨識並確定其相關的危害效應。於 11 個研究地點（10 個位於歐洲，1 個在阿根廷），包括傳統慣行耕作和有機耕作農場。在土壤中，31%檢測到的物質濃度高於相應作物中的濃度，其中 93%的化合物是殺真菌劑，其餘為殺蟲劑。有 43%的物質僅在土壤中檢測到，其中 57% 是殺蟲劑。葡萄牙的土壤（釀酒葡萄）檢出物質數量最多（12 種），平均濃度（Average Concentrations, AC）介於 1 至 162 μg/kg 之間，其次是法國（釀酒葡萄中的 11 種物質）（1≦ AC ≦64 μg/kg）和西班牙土壤（蔬菜中的 9 種物質）（3≦ AC≦ 59 μg/kg）。傳統慣行農場的風險商數（risk quotient, RQ）一致高於有機農場。對於傳統慣行農場的土壤，有 5 種活性物質（陶斯松 [*Chlorpyrifos*]、嘉磷塞 [*Glyphosate*]、白克利 [*Boscalid*]、待克利[*Difenoconazole*]、賽洛寧 [*Lambda-cyhalothrin*]）和 1 種代謝物（胺甲基磷酸 [AMPA]）被認為是高風險。對於水樣，檢測到的 2 種物質（地特靈 [*Dieldrin*] 和特丁津 [*Terbuthylazine*]）屬於高風險，而對於沉積物，則有 3 種物質（右滅達樂[*Metalaxyl-M*]、螺環菌胺 [*Spiroxamine*] 和賽洛寧 [*Lambda-cyhalothrin*]）。在作物中檢測到 6 種疑似會對人類健康造成影響的物質。建議建立跨季節、跨基質、跨地點之同步監測網絡，納入土地管理史與作物輪作資訊，持續以預測無效應濃度與 RQ 進行風險篩選並擴充上市後監測至環境基質，同時釐清多重暴露途徑與沉積物、河川及地下水間之交互作用機制，優先於未受污染土壤推動永續農業，以系統性掌握暴露途徑與污染來源，支持法規的制定並降低潛在人類與生態之風險。

關鍵字：土壤、作物、水體、沉積物、農藥殘留、風險評估

参考文献

Beketov, M.A., Keford, B.J., Schfer, R.B., Liess, M., 2013. Pesticides reduce regional biodiversity of stream invertebrates. *Proc. Natl. Acad. Sci. USA* 110, 11039–11043.

Casado, J., Brigden, K., Santillo, D., Johnston, P., 2019. Screening of pesticides and veterinary drugs in small streams in the European Union by liquid chromatography high resolution mass spectrometry. *Sci. Total Environ*. 670, 1204–1225

Chaudhari, Y.S., Kumar, P., Soni, S., Gacem, A., Kumar, V., et al., 2023. An inclusiveoutlook on the fate and persistence of pesticides in the environment and integrated eco-technologies for their degradation. *Toxicol. Appl. Pharmaco*l. 466, 116449.

Close, M.E., Humphries, B., Northcott, G., 2021. Outcomes of the first combined national survey of pesticides and emerging organic contaminants (EOCs) in groundwater in New Zealand 2018. *Sci. Total Environ*. 754, 142005.

Collard, M., Camenzuli, L., Lyon, D., Saunders, D., Vallotton, N., Curtis-Jackson, P., 2023. Persistence and Mobility (defined as organic-carbon partitioning) do not correlate to the detection of substances found in surface and groundwater: criticism of the regulatory concept of Persistent and mobile substances. *Sci. Total Environ.* 865, 161228.

Cui, S., Hough, R., Yates, Kyari, Y., Osprey, M., Kerr, C., Cooper, P., Coull, M., Zhang, Z., 2020. Effects of season and sediment-water exchange processes on the partitioning of pesticides in the catchment environment: implications for pesticides monitoring. *Sci. Total Environ*. 698, 134228.

Duffner, A., Moser, T., Candolfi, M.P., 2020. Feasibility of assessing vegetative and generative endpoints of crop- and non- crop terrestrial plant species for non-target terrestrial plant （NTTP) regulatory testing under greenhouse conditions. *PLoS One* 15 (3), e0230155.

Dulsat-Masvidal, M., Ciudad, C., Infante, O., Mateo, R., Lacorte, S., 2023. Water pollution threats in important bird and biodiversity areas from Spain. J. *Hazard Mater*. 448, 130938.

EASAC, 2023. Neonicotinoids and Their Substitutes in Sustainable Pest Control. ISBN 978-619-92418-1-3 (PDF)

FAOSTAT, 2020. *Pesticides indicators*. http://www.fao.org/faostat/en/#data/EP/visualize2020.

Grunewald, K., Schmidt, W., Unger, C., Hanschmann, G., 2001. Behavior of glyphosate and aminomethylphosphonic acid (AMPA) in soils and water of reservoir Radeburg II catchment (Saxony/Germany). *J. Plant Nutr. Soil Sci*. 164 (1), 65–70.

Hallmann, C.A., Foppen, R.P.B., van Turnhout, C.A.M., et al., 2014. Declines in insectivorous birds are associated with high neonicotinoid concentrations. *Nature* 511, 341–343.

Islam, F., Wang, J., Farooq, M.A., Khan, M.S.S., Xu, L., Zhu, J., Zhao, M., Mu˜ nos, S., Li, Q. X., Zhou, W., 2018. Potential impact of the herbicide 2,4-dichlorophenoxyacetic acid on human and ecosystems. *Environ. Int*. 111, 332–351.

Kruse-Plaß, M., Hofmann, F., Wosniok, W., Schlechtriemen, U., Kohlschütter, N., 2021. Pesticides and pesticide-related products in ambient air in Germany. *Environ. Sci*. Eur. 33, 114.

MAPAMA, 2017. Estadística anual de consumo de productos fitosanitarios y Estadística quinquenal de utilizacion de productos fitosanitarios en la Agricultura. April 2020.

Mengoni Gonalons, ˜ C., Farina, W.M., 2018. Impaired associative learning after chronic exposure to pesticides in young adult honey bees. *J. Exp. Biol*. 221 (7), jeb176644.

Milan, M., Dalla Rovere, G., Smits, M., Ferraresso, S., Pastore, P., Marin, M.G., Bogialli, S., Patarnello, T., Bargelloni, L., Matozzo, V., 2018. Ecotoxicological effects of the herbicide glyphosate in non-target aquatic species: transcriptional responses in the mussel Mytilus galloprovincialis. *Environ. Pollut.* 237, 442–451.

Moschet, C., Wittmer, I., Simovic, J., Junghans, M., Piazzoli, A., Singer, H., Stamm, C., Leu, C., Hollender, J., 2014. How a complete pesticide screening changes the assessment of surface water quality. *Environ. Sci. Technol*. 48, 5423–5432

Papadakis, E., Tsaboula, A., Kotopoulou, A., Kintzikoglou, K., Vryzas, Z., PapadopoulouMourkidou, E., 2015. Pesticides in the surface waters of Lake Vistonis Basin, Greece: occurrence and environmental risk assessment. *Sci. Total Environ*. 536, 793–802.

Qi, Y., Li, J., Guan, X., Yan, B., Fu, G., He, J., Du, L., Zhao, C., Zhang, D., 2020. Effects of herbicides on non-target plant species diversity and the community composition of fallow fields in northern China. *Sci. Rep.* 10 (1), 9967.

Rundl¨of, M., Andersson, G.K.S., Bommarco, R., et al., 2015. Seed coating with a neonicotinoid insecticide negatively affects wild bees. *Nature* 521, 77–80.

Schreiner, V.C., Szocs, ¨ E., Bhowmik, A.K., Vijver, M.G., Sch¨ afer, R.B., 2016. Pesticide mixtures in streams of several European countries and the USA. *Sci. Total Environ*. 573, 680–68

Silva, V., Gai, L., Harkes, P., Tan, G., Ritsema, C.J., et al., 2023. Pesticide residues with hazard classifications relevant to non-target species including humans are omnipresent in the environment and farmer residences. *Environ. Int*. 181, 108280.

Stehle, S., Schulz, R., 2015. Agricultural insecticides threaten surface waters at the global scale. *Proc. Natl. Acad. Sci. U.S.A*. 112, 5750–5755.

Tauchnitz, N., Kurzius, F., Rupp, H., Schmidt, G., Hauser, B., Schrodter, M., Meissner, R., 2020. Assessment of pesticide inputs into surface waters by agricultural and urban sources - a case study in the Querne/Weida catchment, central Germany. *Environ. Pollut*. 267, 115186.

Tudi, M., Ruan, H.D., Wang, L., Lyu, J., Sadler, R., Connell, D., Chu, C., Phung, D.T., 2021. Agriculture development, pesticide application and its impact on the environment. Int. J. *Environ. Res. Publ. Health* 18, 1–24.

Yadav, M., Shukla, A.K., Srivastva, N., Upadhyay, S.N., Dubey, S.K., 2016. Utilization of microbial community potential for removal of chlorpyrifos: a review. Crit. Rev. *Biotechnol*. 36, 727–742.

Zhang, Z., Yan, X., Jones, K.C., et al., 2022. Pesticide risk constraints to achieving Sustainable Development Goals in China based on national modeling. npj Clean Water 5, 59.

Zioga, E., White, B., Stout, J.C., 2023. Pesticide mixtures detected in crop and non-target wild plant pollen and nectar. *Sci. Total Environ*. 879, 162971.