ISSN: 2594-0252

AGRO PRODUCTIVIDAD

Bioremediation
alternatives for total petroleum hydrocarbon removal in agricultural soil

pág. 213

Año 17 • Volumen 17 • Número 5 • mayo, 2024

Colegio de Postgraduados

Colegio de Postgraduados

Agrochemicals and crop productivity losses

Valencia-Botín, Alberto J.[1]; **Zurita-Martínez, Florentina**[2]; **Tejeda-Ortega, Allan**[2]; **Cruz-Esteban, Samuel**[3*]

[1] Universidad de Guadalajara, Centro Universitario de la Ciénega, Plant Health Laboratory, Ocotlán 47820, Jalisco, Mexico.
[2] Universidad de Guadalajara, Centro Universitario de la Ciénega, Environmental Quality Research Center, Ocotlán 47820, Jalisco, Mexico.
[3] Instituto de Ecología, A.C., Centro Regional del Bajío, Red de Diversidad Biológica del Occidente Mexicano, Avenida Lázaro Cárdenas 253, 61600 Pátzcuaro, Michoacán, México
* Correspondence: julian.valencia@academicos.udg.mx

ABSTRACT
Objective: to reflect briefly on the importance of the use of agrochemicals in the productivity of some crops according to their contribution to yield, and some implications of their agricultural consumption.
Design/methodology/approach: based on related literature and some experiences in the field on the use and consumption of pesticides.
Results: pesticides are synthetic, microbial, or derived organic compounds used in plant growth programs to prevent or control pests, diseases, and weeds. Also, mineral nutrition (with macro and micronutrients) is considered as agrochemicals. However, the effects on the contamination of soils, groundwater, lakes, seas, and oceans due to its use is increasing. Mexico is a large consumer of fungicides, insecticides, fertilizers, and herbicides for agricultural uses.
Limitations on study/implications: unmeasured use of any type of pesticide can produce tons of pesticide-trash. Some traces of active or inert ingredients can be detected in bodies of water.
Findings/conclusions: the constant risk of agronomic yield losses can be substantial without the use of agrochemicals. Without the application of pesticides, yield losses can reach 100%.

Keywords: contamination, pesticides, production, yield losses.

Citation: Valencia-Botín, A. J., Zurita-Martínez, F., Tejeda-Ortega, A., & Cruz-Esteban, S. (2024). Agrochemicals and crop productivity losses. *Agro Productividad*. https://doi.org/10.32854/agrop.v17i5.2639

Academic Editor: Jorge Cadena Iñiguez
Guest Editor: Daniel Alejandro Cadena Zamudio

Received: July 17, 203.
Accepted: March 18, 202X.
Published on-line: June 13, 2024.

Agro Productividad, 17(5). May. 2024. pp: 149-152.

INTRODUCTION

In general, pesticides or agrochemicals are organic and inorganic synthetic molecules, biorational, microbiological or derived from them, for the management of pests, diseases, weeds, and nutrition, with the aim of sustaining or improving agronomic performance.

Regarding world consumption, for 2021 it was 4.1 million metric tons and is expected to grow to 4.4 by 2026. China is the largest consumer of pesticides, with 1.8 million metric tons in 2021, followed by United States, Brazil, and Argentina as the second, third and fourth main consumer, respectively. Despite its benefits in agricultural productivity, throughout the use process (from pesticide storage warehouses to its use in crop fields) a large amount of garbage is generated that ends up in groundwater deposits and surface bodies, as documented by [1] and [2]. Moo-Muñoz [3] reported that more than 106

thousand tons of agrochemicals were produced in Mexico in 2017. In addition, during 2000-2017, of the total of pesticides produced, fungicides represented 45%, followed by insecticides (28%) and herbicides (27%).

Toxicity and nobel prize related to pesticides

In the world of food production, highly carcinogenic compounds have paraded, such as the herbicidal compound 2,4-D (chlorophenoxy) and its analogue 2,4,5-T. The reason for the Nobel Prize in Physiology or Medicine in 1948 to Prof. Paul Hermann Müller was the description of the properties of the insecticide DDT, an organochlorine that was introduced since 1942, banned in 1972 in the USA and in Mexico until 1999. Its high stability and magnification caused conditions in humans.

There are too many stories for and against the use of agrochemicals in the scientific literature.

Notwithstanding the effects on the contamination of soils, groundwater, lakes, seas and oceans, the dependence on its use is increasing [4].

Dr. Michael Herrman, a United Nations specialist, stated that the world population at the end of 2022 would be about 8 billion. This leads us to ask ourselves: How could we feed a growing population without the intensive use of agrochemicals? Could we reduce its use in agriculture? As an example, in wheat if it were possible to reduce at least 50% of agrochemicals, yield losses would be of the order of 5 to 13% compared to traditional intensive methods [5]. Therefore, it has been shown that agrochemicals will continue to be used in agriculture despite scientific documentation of adverse effects.

Modes of action insecticides and fungicides

According to Crop Life International, there are many modes of action that allow counterattacking or preventing various pests and diseases in the fields. The information from IRAC (Insecticide Resistance Action Committee) and FRAC (Fungicide Resistance Action Committee) are useful tools to teach our students in a summarized way (Tables 1 and 2). It is important to note that IRAC information is also reported for microbial organisms. For detailed information, visit www.irac.info and www.frac.info/.

Yield losses

Yield losses in agriculture is something that has been sought to be prevented since ancient times. Due to this, production environments, genetics of the cultivated materials, as well as the incidence of pests and diseases, among other factors, have led to the coexistence of the use of agrochemicals and productivity. Some time ago many crops were completely devastated despite the use of pesticides due to poor technology and little understanding of damaging factors. Today, yield losses range from 5 to 100%, the latter in extreme conditions.

Total crop losses from pest feeding or plant damage can be as high as 100 percent. In summary, Table 3 is presented, showing examples of losses in some crops caused by pests, diseases, and weeds of anthropocentric importance.

Table 1. Classification of modes of action of insecticides (including acaricides and nematicides). Based on https://www.frac.info/

Group 1: Acetylcholinesterase (AChE) inhibitors	**Group 7: Juvenile hormone Mimics**	**Group 13: Uncouplers of oxidative phosphorylation via disruption of proton gradient**	**Group 19: Octopamine receptor agonists**	**Group 25: Mitochondrial complex II electron transport inhibitors**	**Group 33: Calciumactivated potassium channel (KCa2) modulators**
Group 2: GABA-gated chloride channel antagonists	Group 8: Miscellaneous non-specific (multi-site) Inhibitors	Group 14: Nicotinic acetylcholine receptor (nAChR) channel blockers	Group 20: Mitochondrial complex III electron transport inhibitors – Qo site	Group 28: Ryanodine receptor modulators	Group 34: Mitochondrial complex III electron transport inhibitors – Qi site
Group 3: Sodium channel modulators	Group 9: Chordotonal organ TRPV channel modulators	Group 15: Inhibitors of chitin biosynthesis affecting CHS1	Group 21: Mitochondrial complex I electron transport inhibito	Group 29: Chordotonal organ nicotinamidase inhibitors	
Group 4: Nicotinic acetylcholine receptor (nAChR) competitive modulators	Group 10: Mite growth inhibitors affecting CHS1	Group 16: Inhibitors of chitin biosynthesis, type 1	Group 22: Voltage-dependent sodium channel blockers	Group 30: GABA-gated chloride channel allosteric modulators	
Group 5: Nicotinic acetylcholine receptor (nAChR) allosteric modulators site I	Group 11: Microbial disruptors of insect midgut membranes	Group 17: Moulting disruptors, Dipteran	Group 23: Inhibitors of acetyl CoA carboxylase	Group 31: Baculoviruses	
Group 6: Glutamate-gated chloride channel (GluCl) allosteric modulators	Group 12: Inhibitors of mitochondrial ATP synthase	Group 18: Ecdysone receptor Agonists	Group 24: Mitochondrial complex IV electron transport inhibitors	Group 32: Nicotinic Acetylcholine receptor (nAChR) allosteric modulators site II	

Table 2. Classification of modes of action of fungicides *. Based on https://www.frac.info/

A: Nucleic Acids Metabolism	G: Sterol Biosynthesis in Membranes
B: Cytoskeleton and Motor Proteins	H: Cell Wall Biosynthesis
C: Respiration	I: Melanin Synthesis in Cell Wall
D: Amino Acid and Protein Synthesis	P: Host Plant Defense Induction
E: Signal Transduction	M: Chemicals with Multi-Site Activity
F: Lipid Synthesis or Transport / Membrane Integrity or Function	

* Groups were designed by the fungal control agents by cross resistance pattern and mode of action 2022.

Table 3. Relevance of the use of agrochemicals and potential losses in agronomic yield by crop.

Crop	**Yield losses (%) by avoiding the use of agrochemicals**	**Reference**
Corn	20 a 41	[6], [7]
Bean	37 a 100	[8]
Wheat	10 a 28	[7]
Tomato	15 a 95	[9]
Rice	25 a 41	[7]
Potato	8 a 21	[7]
Soybean	11 a 32	[7]

CONCLUSIONS

The ongoing risk of agronomic yield losses can be substantial without the use of agrochemicals. However, the integration of complementary techniques to synthetic pesticides (for example, biorational management, ethological control strategies or microbial control) should be considered in the cases or environments where they are applicable. The measured use of pesticides is mandatory to protect human health and ecosystems in general.

REFERENCES

1. Elfikrie, N, Ho, Y. B., Zaidon, S. Z. Juahir H. and Tan, E. S. S. (2020). Occurrence of pesticides in surface water, pesticides removal efficiency in drinking water treatment plant and potential health risk to consumers in Tengi River Basin, Malaysia. *Science of The Total Environment*, 712, 136540. https://doi.org/10.1016/j.scitotenv.2020.136540
2. Saleh, I. A., Zouari, N., & Al-Ghouti, M. A. (2020). Removal of pesticides from water and wastewater: Chemical, physical and biological treatment approaches. *Environmental Technology & Innovation*, 19, 101026. https://doi.org/10.1016/j.eti.2020.101026
3. Moo-Muñoz, A. J., Azorin-Vega, E. P., Ramírez-Durán, N. and Moreno-Pérez, P. 2020. Estado de la producción y consumo de plaguicidas en México. *Tropical and Subtropical Agroecosystems*, 23, 1-12. doi: 10.15174.au.2014.570
4. Khalid, S., Shahid, M., Murtaza, B., Bibi, I., Natasha, Asif Naeem, M., Niazi, N. K. 2020. A critical review of different factors governing the fate of pesticides in soil under biochar application. *Science of The Total Environment*, 711, 134645. https://doi.org/10.1016/j.scitotenv.2019.134645
5. Hossard, L., Philibert, A., Bertrand, M., Colnenne-David, C., Debaeke, P., Munier-Jolain, M. H., Richard, G. and Makowsky, D. (2014). Effects of having pesticide use on wheat production. *Scientific Reports*, 4, 4405-4412. https://doi.org/10.1038/srep04405
6. Sulong, Y., Zakaria, A. J., Mohamed, S., Sajili, M. H. and Ngah, N. (2019). Survey on Pest and Disease of Corn (*Zea mays* Linn) grown at BRIS Soil Area. *Journal of Agrobiotechnology*, 10, 75-87.https://journal.unisza.edu.my/agrobiotechnology/index.php/agrobiotechnology/article/view/201
7. Savary, S., Willocquet, L., Pethybridge, S. J., Esker, P., Mc Roberts, N., and Nelson, A. 2019. The global burden of pathogens and pests on major food crops. *Nat. Ecol. Evol.*, 3, 430-439. https://doi.org/10.1038/s41559-018-0793-y
8. Etana, D. (2022). Major Insect Pests and Diseases in Common Bean (*Phaseolus vulgaris* L.) Production in Ethiopia. *Frontiers*, 22, 79-87. doi: 10.11648/j.frontiers.20220202.11
9. Tonessia, D. C., Soumahin, E. F., Boyé, M. A. D., Niangoran, Y. A. T., Djabla, J. M., Z, O. D., Kouadio, Y. A. (2018). Diseases and pests associated to tomato cultivation in the locality of Daloa (Côte d'Ivoire). *Journal of Advances in Agriculture*, 9, 2349-0837. https://doi.org/10.24297/jaa.v9i0.7935