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Investigation note

Agricultural activities and use of glyphosate in the ejido of Bella Esperanza, Coatepec, Veracruz

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Abstract

Glyphosate is a broad-spectrum herbicide that has been applied to agricultural fields in more than 200 countries for 40 years. Due to recent studies that demonstrated its relationship as a carcinogen, a worldwide debate has opened about its use and prohibition. Mexico has joined the movement to ban its use in the decree issued in December 2020. Due to its constant application, residual glyphosate impacts different environmental compartments, including the soil. Therefore, the objective was to identify the agricultural practices and weed management used in the ejido of Bella Esperanza, Coatepec, Veracruz, as part of the characterization of the sampling site for the research project on the bioremediation of glyphosate with endogenous microorganisms. Through a field approach, surveys were carried out with producers in the area, where the results showed that 54% use glyphosate as their primary weed control. They do not use any protective equipment either and consider glyphosate a product harmless to the environment. In the same way, the result of this study observed that the ejido of Bella Esperanza is a suitable sampling area for studying microorganisms with possible applications in bioremediation.

Keywords:

Citrus latifolia Tanaka, glyphosate, pesticide, weeds.

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In Mexico, agriculture has a significant global presence, ranking fifth as the leading exporter of fruits and vegetables, such as avocado (*Persea* americana), lemon (*Citrus* × *aurantifolia*), strawberry (*Fragaria* × *ananassa*) and corn (*Zea mays*) (SIAP, 2021). This has been achieved by introducing different practices, technologies, and schemes of work in the field with agricultural producers. Among these, the most widely used is monoculture, which is based on the use of agrochemicals: fertilizers and pesticides, to obtain better yields each year.

Pesticides are chemical or biological formulations aiming to reduce and exterminate a particular pest. There are different classifications for pesticides, including, according to the target pest, fungicides, bactericides, herbicides, and nematicides, among others (SADER-SENASICA, 2019). In the case of herbicides, they reduce or eliminate the growth of undesirable plants called weeds, which compete for nutrients with the crops of interest and can also be vectors of pests and diseases.

Glyphosate has been the most widely used herbicide since its launch on the market in the 1970s by Monsanto® (now Bayer®), which is consumed in more than 200 countries (Valavanidis, 2018). In Mexico, it is mainly used for the production of corn (35%), citrus fruits (14%), sorghum (11%), cotton (5%), sugarcane (4%), and coffee (3%). In the economic sphere, from 1974 to 2014, about 8.6 million tonnes of glyphosate were produced in Mexico, and in the last ten years, 485 340 t were imported from the main foreign companies manufacturing these products (Syngenta®, Bayer®, Dow®, BASF®, and DuPont®) (SEMARNAT, 2019).

Nonetheless, due to its prolonged and practically monopolized use in the transgenic crop industry, glyphosate has impacted different environmental compartments, resulting in an imbalance in soil homeostasis, threatening the existence of pollinating organisms, and affecting human health. The report published by the International Agency for Research on Cancer (IARC) in 2015 placed on the international scene a reality that had been evaded despite multiple pieces of evidence from research carried out and published before this report: the consequences of glyphosate abuse (IARC, 2017).

In this regard, in response to human rights requests from different environmental groups, the government of Mexico published a decree in December 2020 with a view to eliminating the use of glyphosate, its different formulations, and transgenic seeds in a period of 4 years, of which about half of the stipulated time has elapsed (SEGOB, 2020).

The strategies that have been promoted so far to eliminate the use of glyphosate include the promotion of projects financed by the National Council of Science and Technology (CONACYT, for its acronym in Spanish) on various topics, such as the evaluation of the use of vegetation cover for the control of weeds, the promotion of the use of machinery (brush cutter, rototiller, etc.) in substitution of herbicides, use of weeds as livestock feed, among other projects.

They also include the adoption of the model of peasant agriculture of integrated knowledge and integrated management of induced crops (ACCI-MICI, for its acronym in Spanish), which is characterized by the interaction of scientific knowledge with the knowledge of farmers and producers. On the issue of legality, an initiative was presented where priority is given to agricultural products from agroecological strategies for export as a way to encourage the use of these technological alternatives (CONACYT, 2022).

However, despite the information presented by the institutions and secretariats involved, there is no data or reports that show the actual progress of these strategies and programs. Likewise, there is a lack of sufficient information on the practices and uses of glyphosate in the state of Veracruz that would serve as a basis for subsequent projects, such as the use of endogenous microorganisms from crop fields for the bioremediation of soils contaminated with glyphosate.

The concentration of glyphosate and AMPA has been determined in different water, soil, and sediment matrices, finding concentrations ranging from 0.1 mg L^{-1} to 48.5 mg L^{-1} in all of them. Similarly, glyphosate has a high affinity for iron oxides that are mainly found in clays from acidic soils,

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so they are adsorbed into the surface, increasing their residence time, which leads to the production by the microbial activity of the secondary metabolite aminomethylphosphonic acid (AMPA), which is more toxic than glyphosate.

In agricultural practice, the dosage and frequency indicated by the supplier are not always followed, coupled with its continuous and prolonged use in the last forty years. For this reason, bioremediation is an attractive technological process for this pollutant since it uses glyphosate-resistant microorganisms capable of degrading it and converting it into less harmful compounds.

Therefore, this study aims to identify the agricultural practices and weed management used in the ejido of Bella Esperanza, Coatepec, Veracruz as part of the characterization of the sampling site for the research project on the bioremediation of glyphosate with endogenous microorganisms. The municipality of Coatepec has agriculture as its main economic activity, with the main crops being coffee (*Coffea arabica*), sugarcane (*Saccharum officinarum*), beans (*Phaseolus vulgaris*), corn (*Zea mays*), and Persian lime (*Citrus latifolia* Tanaka).

The ejido of Bella Esperanza is located within the municipality of Coatepec in the state of Veracruz, located 10 km from Coatepec at 1 000 masl, at the coordinates longitude (dec): -96.866667, latitude (dec): 1. The population density of the town of Bella Esperanza, according to the National Institute of Statistics and Geography (INEGI, for its acronym in Spanish), is 1 618 inhabitants. It is considered a rural area due to the number of inhabitants, where the main productive activity is agriculture (90%), with coffee, corn, and Persian lime predominating (INEGI, 2009).

The research was carried out through fieldwork with a non-experimental cross-sectional descriptive study design. The selected tool was a semi-structured exploratory survey with multiple-choice and open-ended questions. The variables of interest are the type of crops, pesticides used, herbicide application practices, and weed management. Due to the COVID-19 pandemic, the instrument was applied once a week during the months of October-November 2020 and January-February 2021 to avoid overexposure to the virus.

The locality was divided into four quadrants, resulting in a total of 37 respondents because most of them were working in the field or showed distrust and refused to participate in the activity. In the first section of the interview, personal data, data on the health status of the interviewee and those of close immediate family members, were collected. In the second section, information was collected regarding the type of crops grown in the area, management practices, and fertilizer use. The third section focused on pest management and pesticide use.

The results showed that agriculture in the ejido is still predominant for the male gender, as only 5% were women. All of the interviewees were within an age range of 30 to 60 years, of which 24 farmers sowed more than one crop or rotated between sugarcane, corn, and beans, and 13 cultivated Persian lime (Figure 1).

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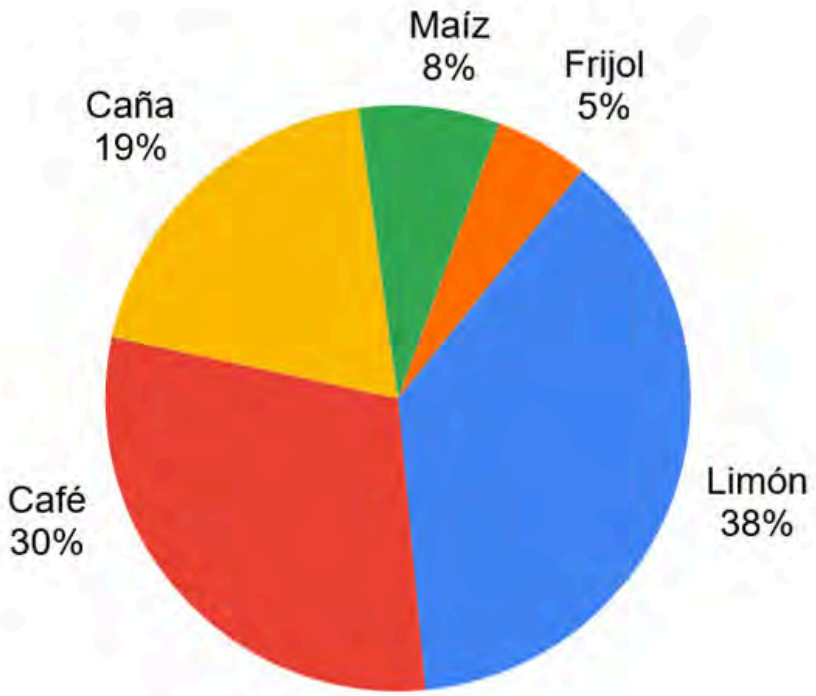
Figure 1. Crops predominating in the ejido of Bella Esperanza, Coatepec, Veracruz.



The preference for lemons over coffee in this group of respondents is due to the fall in coffee costs due to the coffee crises (which occurred between 1989 and1994) and the phytosanitary problems with pests such as rust and nematodes that generate considerable losses, or that mean additional expenses to improve efficiency (SIAP, 2021).

Likewise, although sugarcane is a crop of national importance, the ejidatarios (shareholders of communal land) commented that they only produce it because of the support they receive since the profit is not enough. On the other hand, in the case of sowing beans and corn, it is exclusively for self-consumption or due to family tradition. In contrast to coffee and sugarcane, at the international level, Mexico ranks second in lemon production, which is a product in high demand, and, in the case of the Persian lime, Veracruz is the first producing state of this citrus fruit, which is a sector to exploit with greater interest from producers (SIAP, 2021).

Farmers responded that the main pests and diseases are weeds (100%), gummosis (78.4%), tristeza virus (67.6%), and citrus leafminer (40.5%) in lemon, while for coffee, the main ones are rust (59.5%), coffee berry borer (37.8%), and nematodes (27%).

The phytosanitary control coincides with the crops predominating in the area and of economic interest, and because the requirements of lemon cultivation include the absence of other plants and trees that can compete for nutrients or that can be vectors of pests and diseases, producers focus the inspection on the elimination of these as a preventive and maintenance control.

Even though all respondents mentioned having pest and disease problems, 67.5% use pesticides, among which the following stand out: glyphosate (56.0%) as the main pesticide, copper oxychloride (22%), chlorpyrifos (6%), abamectin (5%), ametrine + atrazine (5%), 2.4-D (3.0%) and paraquat (3%).

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On the other hand, regarding the handling and applications of chemical controls, they mention that they do not use any special equipment for the application; although the label mentions that it requires it, they consider that it is not necessary. This statement is shared even by those who presented symptoms of intoxication such as headache and nausea (7.5%) during applications.

Regarding weed control, 54% of respondents use glyphosate, and 46% do not use chemicals but mechanical maintenance and manual macheting. The reason why herbicides such as glyphosate and 2.4-D continue to be used is because they are cheaper and more effective for weed control, even though both are subject to international regulation or are banned in some countries.

When asked the reason why they selected this herbicide on their plot, 40% said it was on the recommendation of another producer in the community, 12.5% chose it on the recommendation of the agrochemical seller, 2.5% for the economy, 2.5% for the functionality of the product and 42.5% abstained from answering. It is interesting to note that the public policies that are intended to be implemented can use this route of recommendation by members of the community, which would mean an approach to the application of the methodologies and verification of their functionality, which would mean a positive recommendation and appropriation of the new practices.

As for the application doses of glyphosate, they were grouped into three types of use: 1) maximum recommended dose (6 L ha^{-1}); 2) medium recommended dose (4 L ha^{-1}), and 3) minimum recommended dose (2 L ha^{-1}); it should be noted that the concentration is variable according to the brand and presentation acquired by the producer. Finally, 32.5% of the ejidatarios surveyed have used glyphosate for a period between 10 and 15 years, 17.5% between 5 and 10 years, 7.5% between 1 and 5 years, and 42.5% of farmers refused to answer how long they have been applying it to their crops.

According to the Environmental Protection Agency (EPA, 2019), glyphosate is not persistent or toxic to the environment or humans as long as it is used in the doses and frequencies stated on the packaging. Nevertheless, neither the formulations nor the effect of their derivatives and secondary metabolites are considered. In agricultural practice, the dosage and frequency indicated by the supplier are not always followed, as we can see in the survey results. Therefore, due to the nature of glyphosate and the type of soil, its permanence in the ecosystem will be longer than indicated in the data sheets.

Conclusions

Coffee producers in the ejido of Bella Esperanza are opting for Persian lime cultivation because they receive a greater economic return. This leads to a change in the activities carried out in the area, as well as the predominant pests and diseases and the agrochemicals that are used. Glyphosate has been applied as an herbicide for more than 15 years in the area; this coincides with the arrival of citrus cultivation and is a practice perceived positively by the ejidatarios. In addition, there is a notorious lack of knowledge regarding the new policies applied since pesticides such as paraquat and 2.4-D, which are restricted in the country, are still used.

This may be due to a lack of information on the part of the institutions in charge, a lack of rigidity in compliance with the rules, or a lack of control of the products sold on the market. Eradicating the use of glyphosate, as proposed by the Government of Mexico by 2024, is not a goal that is grounded in the real panorama of the Mexican countryside. It is necessary to opt for alternatives that manage to cushion the effect of this pollutant, such as bioremediation, until a change in practices and customs around the issue of weeds is achieved.

On the other hand, the results obtained from this study allow us to infer the existence of residual glyphosate in the soil due to the time and dose of application used. These conditions can lead to the development of herbicide-tolerant microorganisms, which can be used in other studies of interest, such as bioremediation.

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Bibliography

1 CONACYT. 2022. Consejo Nacional de Ciencia y Tecnología. Manejo ecológico integral de arvenses en México, sí hay alternativas al glifosato. Gaceta informativa núm. 9.

2 EPA. 2019. Enviromental Agency Protection. Glyphosate update. pesticide program dialogue committee meeting. NEPIS.1-2 pp.

3 IARC. 2017. International Agency Research for Cancer. IARC monographs on the evaluation of carcinogenic risks to humans: some organophosphate insecticides and herbicides. Lyon. World Health Organization. WHO Press. 112 p.

4 SADER. 2019. Secretaría de Agricultura y Desarrollo Rural. Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria (SENASICA). Manual para el buen uso y manejo de plaguicidas en campo. 1ra. Ed. SADER. México, DF. 80 p.

5 SEGOB. 2020. Secretaría de Gobernación. Decreto para sustituir gradualmente el uso del glifosato y derivados en México. Diario Oficial de la Federación (DOF). México, DF. DOF:31/12/2020.

6 SEMARNAT. 2019. Secretaría de Medio Ambiente y Recursos Naturales. Niega Semarnat importación de mil toneladas de glifosato, bajo el principio precautorio para la prevención de riesgos. México, DF.

7 SIAP. 2021. Servicio de Información Agroalimentaria y Pesquería. Panorama Agroalimentario, 2021. Ed. 2021. México, DF.

8 Valavanidis, A. 2018. Glyphosate, the Most Widely Used Herbicide. Health and safety issues. Why scientists differ in their evaluation of its adverse health effects. Scientific Reviews.1 11-40 pp.

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