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USE OF PESTICIDES IN THE IRRIGATION DISTRICT 075 OF NORTH SINALOA, MEXICO

Marco Arturo Arciniega-Galaviz

Universidad Autónoma de Occidente, Unidad Regional Los Mochis.

marco.arciniega@uadeo.mx

Orcid: https://orcid.org/0000-0001-8532-7130

Abstract

The state of Sinaloa is known to be a large agricultural producer in Mexico. The use of pesticides in this region is in large quantities, which affects a large number of agricultural workers due to exposure to these chemicals. The objective of this work to identify the main crops, pests and pesticides used in the Irrigation District 075 for this research work a convenience sampling was carried out and 100 surveys were applied with questions related to the pests, crops and pesticides used by the workers agriculture in this region of northwestern Mexico. According to the results, the main crops planted and harvested are corn and beans, the main pests are the fall armyworm (*Spodoptera frugiperda*) and the whitefly (*Trialeurodes vaporariorum*) and the main pesticides are Tamaron and Cypermethrin. In conclusion, agricultural workers in Irrigation District 075 use pesticides considered of medium and high toxicity and have a preference for chemical control over biological control.

Keywords *Crops, Insecticides, Health, Biological Control*

1. Introduction

In the north of the state of Sinaloa, highly technical agriculture is practiced, making it the country's breadbasket as it is the main producer of corn. As part of this intensive agriculture, the use of agrochemicals is in large quantities, always seeking the highest yield per hectare in crops and, above all, taking care of them from pest attacks. Although the pesticides used play an important role in controlling diseases in crops, some of them are considered moderately to highly dangerous due to their toxicity, which implies damage to people's health and the environment. (Del Puerto, 2014).

According to agricultural production statistics for the year 2020 from the Agricultural and Fisheries Information Service (2020), agricultural production in the state of Sinaloa represents 30% of the total at the national level, and grain corn production in the state represents 45.2%

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of the total production of this crop nationwide. To achieve these production levels, agriculture is highly technical, which also represents the use of agrochemicals in large quantities, including those used to control pests. Within the state of Sinaloa, there is Irrigation District 075 – Río Fuerte (DR-075), which includes part of the municipalities of Ahome, El Fuerte and Guasave, this district occupies first place nationally in planted area, surface harvested and production (National Water Commission [CNA], 2014).

The cultivation of grain corn is the most produced in the three municipalities followed by the cultivation of beans, in the case of Guasave 85% of the crops are grain corn and beans, in the case of El Fuerte 55% and for Ahome 56 % (Table 1). For the period 2018 - 2019, the Rio Fuerte irrigation district had the largest planted area with 222,237 hectares, followed by the Culiacán-Humaya and Guasave irrigation districts.

Tabla 1. Porcentajes de los principales cultivos en los municipios de El Fuerte, Ahome y Guasave

Crop	El Fuerte (%)	Ahome (%)	Guasave (%)
Bean	6.68	9.11	16.40
Grain corn	48.43	47.14	68.63
Potatoes	2.87	3.80	2.38
Grain sorghum	24.45	7.31	6.63
Red tomato	2.66	0.12	0.72
Green tomato	0.72	0.43	0.61
Grain wheat	1.46	15.84	0.45
Sesame	3.81	2.85	0
Green alfalfa	4.63	1.23	0.37
Soy	0	5.09	0

In 2010, production was 212,041 and in 2019 it was 222,237. On average over the last 10 years, the production of the irrigation district was 220,601 tons (Chart 1).

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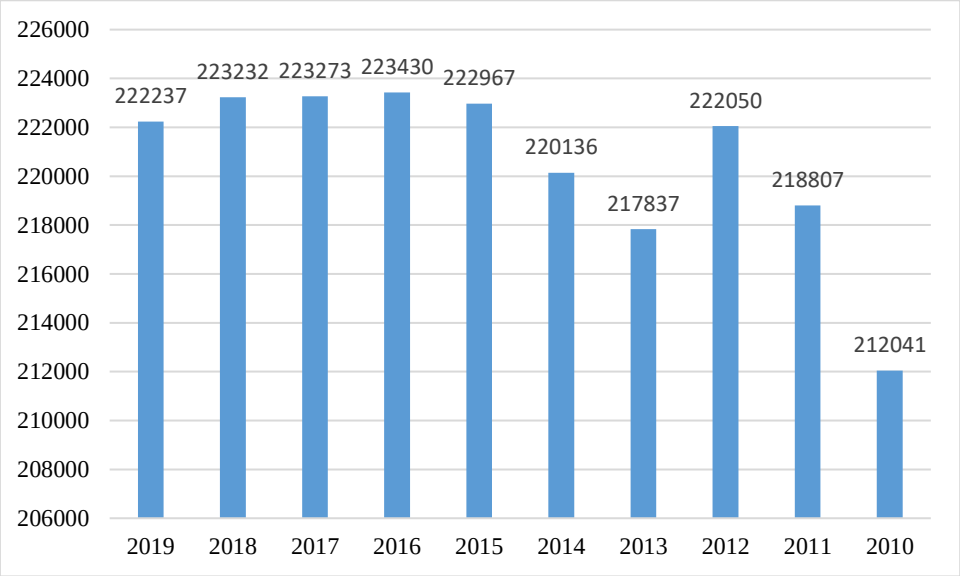

Chart 1. Hectáreas sembradas en el distrito de riego 075

Chemical fertilizers and pesticides are the most used in the state of Sinaloa, more than 60% of fertilizers, herbicides and insecticides are chemical (INEGI, 2019) (Table 2). According to INEGI (2020), the most produced pesticides are fungicides with an average of 45,290 tons in the last 14 years, followed by herbicides with an average of 31,239 tons in this same period.

Table 2. Percentage of technologies used in agriculture in the state of Sinaloa from October 2018 to September 2019.

Tecnology		**Percentage (%)**
Use of chemical fertilizers		61.49
Use of natural fertilizers		14.05
Use of herbicides	Chemicals	66.94
	Organic	4.48
Use of insecticides	Chemicals	65.73
	Organic	4.36
Use of fungicides	Chemicals	31.87
	Organic	3.16

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From 2018 to 2020 there is a tendency to decrease the use of pesticides (liquid insecticides, solid insecticides, fungicides and herbicides), for the year 2020 the number of tons of fungicides was 17,940 and herbicides 15,777. The use of chemical pesticides is a priority for farmers compared to other pest control methods that are more environmentally friendly and do not have negative effects on people's health.

According to a study carried out in the valley of Culiacán, Sinaloa, in the period from November 2011 to October 2012 by Leyva et al (2014), 97 active ingredients were identified, for the Autumn-Winter period among the most important. Mancozeb, Paraquat, Chlorothalonil are found, representing 71%, while in the Spring-Summer period Sulfur, Chlorothalonil, Paraquat and Malathion represented 59% of the total pesticides applied, these quantities were obtained by accounting for the empty containers that were collected within the cages of the clean field program. According to this research work, the pesticides most used in the region in relation to the pest they control are: fungicides (29.4%), insecticides (27.2%), nematicides (19.2%), herbicides (21.7%) and acaricides (2.5%). In this same study it was found that 45.89% were pesticides that normally do not offer danger under normal use (LD50 > 3000 mg/Kg), 38.06% were moderately dangerous (LD50 200 - 200 mg/Kg), 11.10% were slightly dangerous (LD50 2000 - 3000 mg/Kg), 4.7% were very dangerous (LD50 20 - 200 mg/Kg) and 0.2% were extremely dangerous (LD50 < 20 mg/Kg). It is very important to control the use of pesticides in Mexico by the authorities, so that prohibited and/or restricted pesticides are not used in agricultural fields and in this way reduce damage to the environment and health of agricultural workers.

In a study carried out by Hernández and Hansen (2011) in irrigation district 063, which mainly includes the area of Guasave Sinaloa, it was found that the pesticides applied to corn were Paraquat in 116,055 hectares, Abacmetina in 5,247 hectares of tomato, Chlorpyrifos in 14,523 hectares. hectares in chickpeas and Benomylo in 17,590 hectares of beans.

Although there are research works that used different methodologies that result in the main pesticides used in agriculture in the state of Sinaloa, this research work seeks to know the main crops, pests and pesticides used by agricultural workers in the Irrigation District. 075 using as research instruments the interviews and application of surveys with the agricultural workers of this irrigation district.

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2. Research Method

2.1 Study area.

This Irrigation District 075 has an area of 228,337 hectares of irrigation and a total of 21,600 producers (CONAGUA, 2016), distributed in 13 irrigation modules as follows (Table 3). Convenience sampling was applied taking into account the following characteristics of the agricultural workers surveyed: they work directly in the application of chemical pesticides, they know basic aspects about their preparation and application, they are committed to providing clear and reliable information, and they establish and work in the towns of Irrigation District 075, Sinaloa.

Table 3. Irrigation modules of Irrigation District 075.

Module	Producers
Guasave	2,519
Río Fuerte	1,562
Leyva Solano	658
Ruíz Cortines	1,639
Batequis	976
Santa Rosa A.C.	3,011
Taxtes	2,418
Sevelbampo	1,838
Pascola	1,854
Mavari	2,048
Cahuinahua	1,000
Juncos	1,097
Nohme	980
TOTAL	21,600

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2.2 Survey and interview design.

The survey and interviews with agricultural workers were used as research instruments. The survey was structured with multiple choice and open questions. In total, each survey consisted of 11 questions: irrigation module to which it belongs, age, education, daily hours of work. work, age at which they began to work in the crops, number of hectares worked, main crops, main pests, pesticides used in pest control, stage of agricultural activity in which pesticides are applied and use of biological control. The research instruments were applied in the months of September to February, which corresponds to the autumn-winter crop cycle. The visits made to the communities of Irrigation District 075 for the application of the surveys and interviews were in the afternoon with the objective of being able to find the agricultural laborers in their homes.Tamaño y distribución de la muestra.

To determine the number of surveys to be applied, the population of the number of agricultural producers in Irrigation District 075 was taken as a basis, which according to the CNA is approximately 21,600.

According to López (2004), a formula to determine the number of surveys in qualitative research is:

$$n = \frac{N}{(N-1)(\mathrm{K})^2 + 1}$$

Dónde:

N = Tamaño de la población

n = Tamaño de la muestra

K = Margen de error

For a population size of 21,600 agricultural producers, and a margin of error of 10%, a sample size of 100 was obtained, distributed in the 13 modules.

2.3 Information collection.

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Some considerations that were taken into account for the interview stage in which the questionnaire was applied are the following:

• First, the reasons for the interview were explained, and it was clarified that the information provided was exclusively for research work, on the main pests and pesticides in irrigation district 075.

• It was also emphasized that the information is handled confidentially, even the name of the people interviewed was not requested, this gave greater confidence to the interviewees to freely answer the questions asked.

• The interview was ensured that it was in a place without noise and without distractions, in the same way that other people who wanted to intervene in the answers were not physically present or that the respondent did not feel free to answer.

• In the case of open questions, the interviewee's response was recorded faithfully, even when the answers were very absurd. The interviewee was not corrected or induced to give an answer, they were quick and concrete. If the question was not understood by the interviewee, the question was repeated.

• The questions were written in a simple way, without very technical terms, in which they did not have to make mental effort and/or calculations. They were also written in an objective and concrete way so as not to give rise to different interpretations**.**

2.4 Analysis of the data obtained.

To prepare the database and its analysis, the EXCEL 2013 program was used, each of the survey responses were captured, for each variable (question) the frequencies of the responses were added in order to identify the prevalence of these. . Likewise, bar or pie graphs were made to represent the prevalence of the responses of the variables.

The design used in the research was exploratory, transversal and descriptive, since information was collected at a single moment.

The information obtained in the interviews was coded in the following codes:

- Causes of the presence of pests in crops.

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- What are the reasons for preference for certain pesticides?

- Training in the use of biological controls

The research was complemented by consulting official documents from the Ministry of Labor and Social Security (STPS), the Ministry of the Environment and Natural Resources (SEMARNAT) and the guide to good practices for the land application of pesticides from the United Nations Organization for Agriculture and Food (FAO).

3. Results and Discussion

3.1 Ages and education

The ages of the agricultural workers surveyed range between 46 and 60 years of age (46%), 8% are people under 30 years old and 7% are over 70 years old. In relation to the academic level, 16% of the agricultural workers surveyed have a bachelor's degree and 28% have a high school level, 99% of all respondents have the ability to read and write.

3.2 Hours per day working with pesticides

The hours per day that they work with pesticides, 34% of those surveyed apply 4 hours a day, mainly in the early hours of the morning, to avoid the strong wind that occurs in the middle of the morning, in the same way to prevent the sun from quickly evaporating the solutions. applied and finally avoid inclement weather.

Regarding the number of hectares that the respondents work, 68% are plots of less than 40 hectares (Chart 2).

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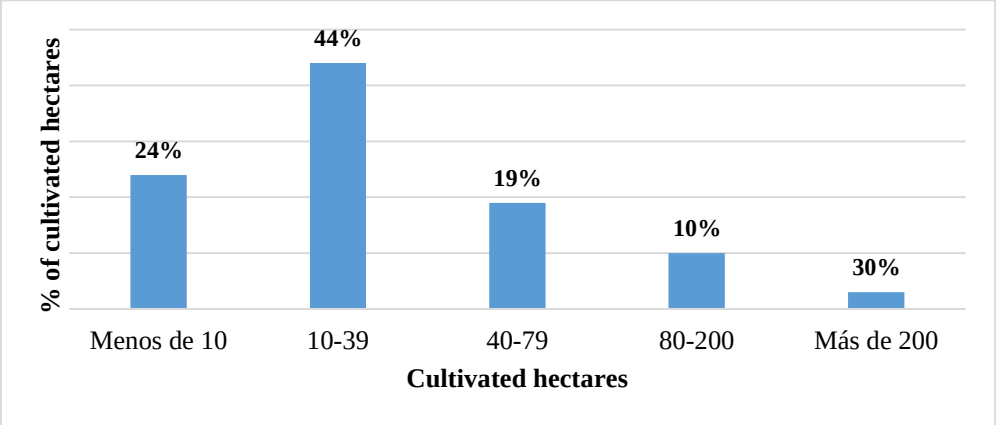

Chart 2. Percentages of the number of hectares cultivated by agricultural workers.

3.3 Main crops

Of the agricultural workers surveyed, 57% plant only corn, 13% plant corn and beans, and 13% of them plant beans (Chart 3). The planting of corn predominates, since farmers state that its sale in the market is safer, and in which they can obtain greater profits.

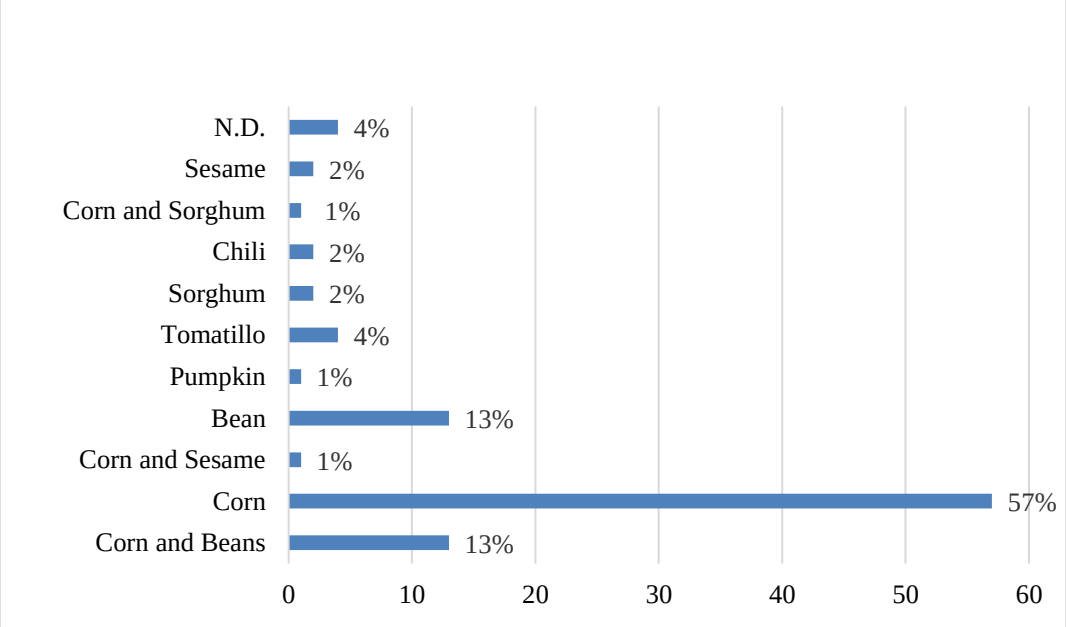

Chart 3. Percentage of main crops in Irrigation District 075.

Agricultural workers do not risk planting other types of crops because they do not know if there will be demand for the product in the market or because they do not know its price. Corn, being the predominant crop and the only one for many farmers, becomes a monoculture practice, so insects find constant food, few predators and reproduce intensely, thus becoming a pest.

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Agriculture teaches us that plant diseases, insect pests and weeds became more severe with the development of monoculture (Altieri, 1994), which implies the use of more concentrated pesticides and in greater quantities to control them.

3.4 Main pests

The main pest that attacks corn is the fall armyworm (Spodoptera frugiperda) (Chart 4), which when found in the larva (worm) stage causes damage to the cornfields. The fall armyworm in its larval state feeds mainly on the buds of corn, which when the leaves spread appear with perforations like rows. (Negrete and Ángulo, 2000).

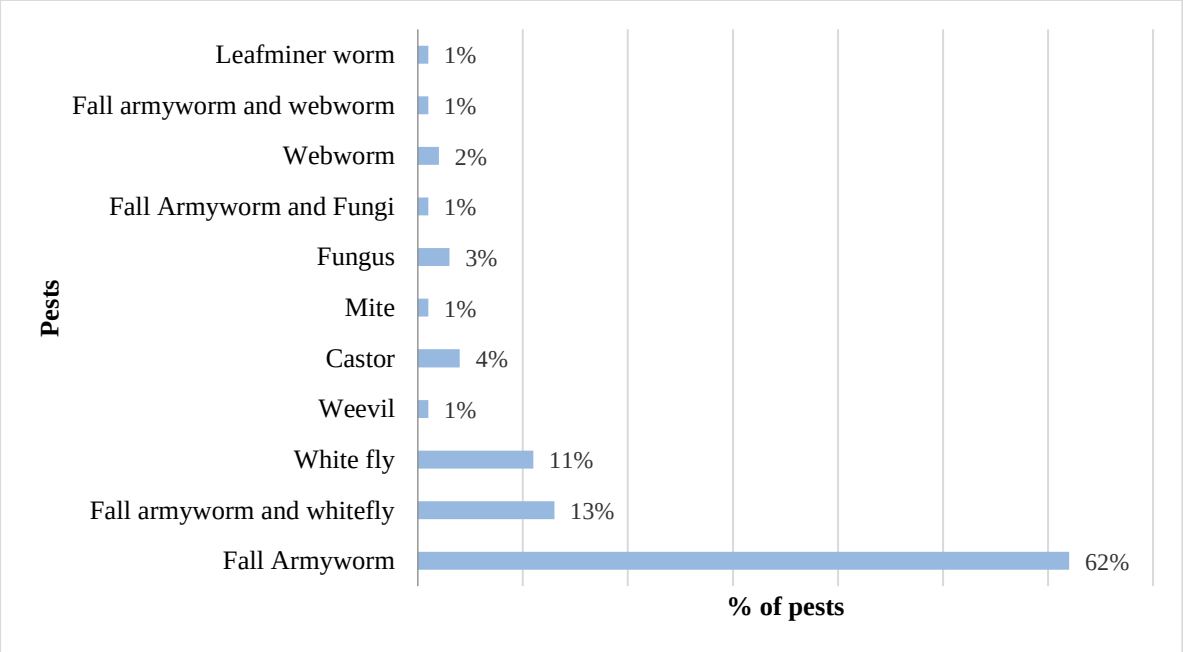

Chart 4. Percentages of the main pests in crops.

The fall armyworm, “It is the most voracious pest of corn crops since the worms are located in the buds of the plants. The early attack promotes a delay in development, and also causes damage to the tissues that form the cob” State Plant Health Committee of Guanajuato (CESAVEG, 2007). The main pests that attack the crops of Irrigation District 075 are presented in Table 5.

Table 5. Main crop pests in Irrigation District 075.

Crop	Main pest	Scientific name

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Corn	Fall Armyworm	*Spodoptera frugiperda*
Corn	Armyworm	*Mythimna unipuncta*
Corn	Cutworm	*Agrotis ípsilon*
Bean	White Mosquito	*Trialeurodes vaporariorum*
Sorghum	Fall Armyworm	*Spodoptera frugiperda*
Sesame	Webworm	*Amorbia cuneana*
Pumpkin	Screwworm	*Elasmopalpus angustellus*
Tomatillo	Mining Worm	*Amauromyza maculosa*
Potatoes	Aphid	*Aphididae*
Chili	Weevil	*Rhynchophorus ferrugineus*

3.5 Main pesticides used in Irrigation District 075.

The main pesticides used to control the corn pest are Cypermethrin (48%), Tamaron (18%) and Lorsban (15%) (Chart 5).

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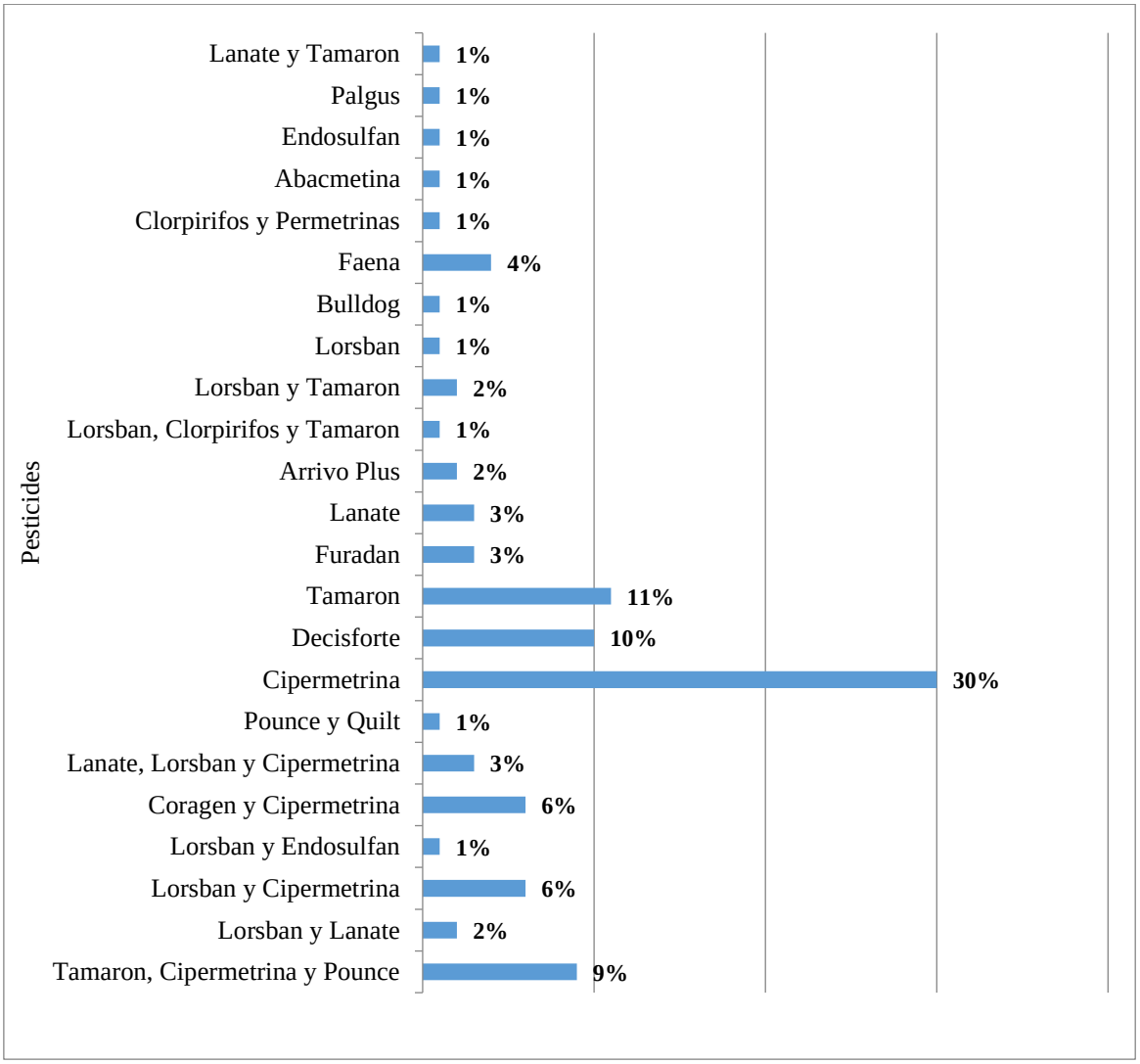

Chart 5. Percentages of the pesticides most used by agricultural workers.

It is important to mention that Cypermethrin and Lorsban are moderately toxic, the pesticides Tamaron and Lanate are considered highly toxic.

According to NOM-003-STPS-1999, only phytosanitary inputs or pesticides and plant nutrition inputs or fertilizers with current registration with COFEPRIS may be applied, in the recommended doses, without mixing incompatible products and in the permitted crops, as established in the label and in the safety data sheet. It is worth mentioning that the aforementioned pesticides are registered in COFEPRIS.

Pesticides from the pyrethroid family (Cypermethrin, Permethrins, Tetramethrin) are the most used pesticides (49%) by agricultural workers in Irrigation District 075. These pesticides have

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effects on the central nervous system, if ingested they can cause tingling. in the body and tremors, it does not have mutagenic, teratogenic or carcinogenic potential, as well as its chemical formula, chemical family and toxicity according to the WHO classification (2008) (Table 6).

Table 6. Pesticides used in Irrigation District 075

Pesticide	**Chemical family**	**Toxicity**
Tamaron	Organophosphate	Highly Toxic
Cipermetrina	Pyrethroids	Moderately Toxic
Pounce	Pyrethroids	Moderately Toxic
Lorsban	Organophosphate	Moderately Toxic
Lanate	Carbamates	Highly Toxic

3.6 Biologic control

73% of agricultural workers surveyed do not use biological control; for them, chemical control is more efficient, and this gives them more security and confidence to obtain high production in their crops. 27% of them sometimes use Trichogramma spp. which is provided by the Local Plant Health Board of Valle Del Fuerte. Farmers who do apply biological control do so when the pest is not very strong, or at the beginning when the pest is not much, but the priority is to use chemical control. None of the respondents use 100% biological control, the use is occasional, that is, when the Local Plant Health Board provides it.

According to FAO (2001), the decision to use pesticides should be made only when other alternatives have already been taken into account or considered.

3.7 Biological control by irrigation module of irrigation district 075

In most irrigation modules they do not apply biological control, they are based on chemical pesticides, biological control is not their priority, since they apply it when they are provided, even if they apply biological control, they apply chemical pesticides as their main pest control

method. Although studies have shown that well-applied biological control can control pests efficiently, the culture of farmers, the promotion of chemical pesticides by agrochemical commercial houses, the lack of dissemination by authorities competent in the matter, causes pest control by chemical substances to predominate in Sinaloa (95.8% of chemical insecticides and 91.5% of chemical herbicides), (Chart 6).

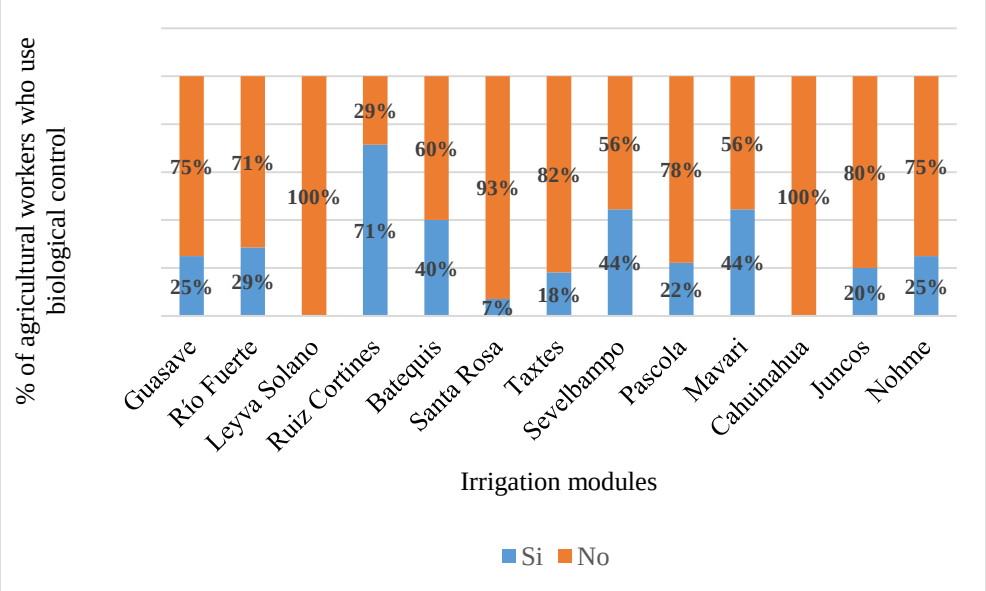

Chart 6. Analysis by irrigation modules. Use of biological control.

4. Conclusion

The pesticides used in irrigation district 075 are not within the group of pesticides prohibited in Mexico according to the 2016 COFEPRIS pesticide catalog, and comply with the regulations for their use in Mexico.

On the other hand, the main pesticides that are frequently used in Irrigation District 075 by agricultural workers are agrochemicals considered of medium and high toxicity, thus increasing the risks of damage to health and environmental contamination.

The agricultural worker uses the agrochemical with the objective and hope that it is effective, that it guarantees the control of pests, regardless of the degree of toxicity and the risk it represents to his health, as well as to the environment. Occasionally they use Trichogramma spp. As a biological control, chemical control is the one that predominates with 73% within the District.

It is important that the government encourages the use of biological control, trains farmers and facilitates this type of control, in this way they will be able to recognize the effectiveness in pest control, well-being in their health, economy and protection of the environment. environment.

The weak inspection and surveillance by the authorities is evident, since, although the employer has responsibilities regarding safety and hygiene with the workers, there are no sanctions for not complying with the Official Mexican Standards. The lack of education, legislation enforcement programs and culture in the correct handling of pesticides among agricultural workers in Irrigation District 075 surveyed causes bodies of water, atmosphere, soil and subsoil to be affected.

REFERENCES

[1] Altieri, M.A. (1994). Biodiversity and pest management in agroecosystems. Edition: Third Publisher: The Haworth Press, Binghamton, New York 13904-1580, 236 pages. https://books.google.com.mx/books?id

[2] Comité Estatal de Sanidad vegetal de Guanajuato CESAVEG. (2007). Folleto Maíz. Recuperado de: http://www.cesaveg.org.mx/html/plabplaguicidasysusresiduos.htm.

[3] Comisión Nacional del Agua. (2014). Estadísticas agrícolas de los distritos de riego Año agrícola 2013-2014. http://www.conagua.gob.mx /CONAGUA07/Publicaciones/ Publicaciones/SGIH-6-15.pdf

[4] Comisión Nacional del Agua (2016). Socios que integran esta Sociedad de Responsabilidad Limitada. Recuperado de http://www.conagua.gob.mx/atlas/mapa/32 /index_svg.html

[5] Del Puerto, A. M., Suárez S., y Palacio, D. E. (2014). Efectos de los plaguicidas sobre el ambiente y la salud. Revista Cubana de Higiene y Epidemiología. 3, 372-387.

[6] Hernández A.-Antonio y Hansen A. M. (2011) Uso de plaguicidas en dos zonas agrícolas de méxico y evaluación de la contaminación de agua y sedimentos. Rev. Int. Contam. Ambie. 27 (2) 115-127, 2011

[7] Instituto Nacional de Estadística y Geografía, Encuesta Mensual de la Industria Manufacturera EMIM, https://www.inegi.org.mx/programas/emim/ 2013/default.html#Tabulados, 23-09-2020.

Technium Sustainability
Vol. 7, pp 90-105 (2024)
ISSN: 2810-2991
www.techniumscience.com

[8] Instituto Nacional de Estadística y Geografía, Encuesta Nacional Agropecuaria ENA, https://www.inegi.org.mx/programas/ena/2019/, 2019.

[9] Leyva, J. B., García, L. M., Martínez, I. E., Bastidas, P. J., Astorga, J. E., Bejarano, J. y Betancourt, M. (2014). Consideraciones toxicológicas sobre el uso de plaguicidas en un valle agrícola del noroeste de México. Pacífico Mexicano. Contaminación e impacto ambiental: Diagnóstico y tendencias. *30*(3), 101-118

[10] López, P., L. (2004). Población, muestra y muestreo. *Punto Cero. 9*(8), 69-73.

[11] Negrete, F., Ángulo, J. M. (2000). Manejo del Gusano cogollero del maíz utilizando extractos de plantas. Cooperación Técnica CORPOICA, Universidad del Sinú, Colombia. Recuperado de: http://bibliotecadigital.agronet.gov.co.

[12] Organization Mundial de la Salud. (2008). Acute pesticide poisoning: a proposed classification tool. http://www.who.int/bulletin/volumes/86/3/07-041814/en/.

[13] Organización de las Naciones Unidas para la Agricultura y la Alimentación. (2001). Buenas prácticas para la aplicación terrestre de plaguicidas. http://www.fao.org/tempref/docrep/fao/005/y2766S/y2766S00.pdf.

[14] Servicio de Información Agroalimentaria y Pesquera 2020. Estadística de Producción Agrícola. http://infosiap.siap.gob.mx/gobmx/datosAbiertos.php, 2020