Colegio de Postgraduados

Practices and perceptions of fall armyworm (*Spodoptera frugiperda* Smith) and striped grass looper (*Mocis latipes* Guenée) management in maize

Álvarez-Galicia, Alejandra[1]; Fajardo-Franco, Marja L.[1*]; Aguilar-Tlatelpa, Martin[1]; Hernández-Guzmán, Karina[1]

[1] Universidad Intercultural del Estado de Puebla. Calle Principal a Lipuntahuaca S/N, Lipuntahuaca, Huehuetla, Puebla, C.P. 73475.
* Correspondence: marjaliza.fajardo@uiep.edu.mx

ABSTRACT

Objective: To describe practices and perceptions about the fall armyworm and striped grass looper management in maize crops in La Pahua, Francisco Z. Mena, Puebla.

Design/Methodology/Approach: A descriptive study with probability sampling was performed. From April to June 2021, n=79 semi-structured interviews were conducted.

Results: The management of the fall armyworm and striped grass looper is carried out through the application of synthetic insecticides, mainly chlorpyrifos ethyl (81%). The minimal use of personal protective equipment for its application (75%) reflects the lack of knowledge of the population about health risks in the short, medium, and long term; however, producers are interested in receiving technical advice (56%) and are open to the use of alternatives, such as the use of traps (1%) and plant extracts (66%).

Study Limitations/Implications: This is a specific case study; therefore, the results are limited to descriptive statements about the study area.

Findings/Conclusions: The fall armyworm and striped grass looper are controlled with chemicals formulated with chlorpyrifos-ethyl alone or combined with permethrin. These chemicals are applied without the use of appropriate protective equipment. The population showed interest in incorporating other alternatives to synthetic insecticides, especially plant extracts and traps.

Keywords: Opinion, synthetic insecticides, *Zea mays*, bioinsecticides.

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INTRODUCTION

Mexico is the 8th largest maize producer in the global market with a production of 27,228,242 t (SIAP, 2020). This grain accounts for 89.1% of the cereal volume in the country, with an annual per capita consumption of 331.9 kg (SIAP, 2021b). The State of Puebla ranks 10th nationally with a production of 1,165,996 t of grain, out of which 29,926 t are produced in the region of Huachinango. Within this region, the municipality of Francisco Z. Mena ranks second with 3,238 t (SIAP, 2021b).

This crop is impacted by insect pests (CESAVEP, 2020) —especially the fall armyworm (*Spodoptera frugiperda*) (J. E. Smith) (Lepidoptera: Noctuidae)—, causing 30-70% losses in grain production and, consequently, economic losses for producers (Lugo-García *et al.*, 2017; Martínez-Núñez *et al.*, 2018; SENASICA, 2017).

Crops in the municipality of Francisco Z. Mena have not only been affected by the fall armyworm, but also by the striped grass looper (*Mocis latipes*) (Guenée) (Lepidoptera: Noctuidae). In order to design management strategies to control the pests that affect maize, the producers' perception and knowledge about their environment must be understood, in order to support the local and cultural wealth, as well as the environment care (Cortés-Rodríguez and Venegas-Cardoso, 2011). The objective of the study was to describe the farmer practices and perceptions in the community of La Pahua, Francisco Z. Mena, Puebla about the fall armyworm and striped grass looper management.

MATERIALS AND METHODS

The study was conducted in La Pahua, Francisco Z. Mena, Puebla. According to the Rural Medical Unit, 411 families live in the community and, based on this information, the sample size was estimated for the application of semi-structured interviews (Castañeda-Guerrero et al., 2020).

$$n = \frac{NZ^2_{\alpha/2} p_n q_n}{Nd^2 + Z^2_{\alpha/2} p_n q_n}$$

Where: n: Sample size; N: Population size = 411 families; d: accuracy = (0.10); $Z^2_{\alpha/2}$: reliability = 95% = 1.96; $p_n = 0.5$; $q_n = 0.5$.

A total of n=79 interviews were conducted and each one included three sections: 1) general data, 2) main pest control strategies in maize crops, with emphasis on the fall armyworm and striped grass looper, and 3) knowledge about plants with potential as insecticides. The taxonomic identification of the aforementioned plant species with potential bioinsecticide properties was based on their botanical characteristics. Subsequently, herborized specimens were transferred to the XAL herbarium of INECOL (Institute of Ecology) where their identity was corroborated. The information collected was systematized in a database and then analyzed by descriptive statistics.

RESULTS AND DISCUSSION

Characteristics of maize producers

Interviewees were between 20 and 80 years old. Ninety-five percent were men and 5% were women. The predominant language was Spanish (95%), while 5% said they spoke Totonac. While 95% of the interviewees were farmers, 5% are homemakers who also work the land. Regarding their education level, 6% are illiterate, 5% have not completed elementary school, 40% have completed elementary school, 29% have completed junior high school, and 20% have completed high school.

Management of the fall armyworm and striped grass looper

Maize pest management in the study area is done by chemical control. Accordingly, the insecticide mostly used in the La Pahua community to control the fall armyworm and the striped grass looper is Foley® (81%), while the less used are Lorsban® (10%) and Foley Rey® (9%). The latter is applied with a 10-20 ml dose dissolved in 20 L of water (capacity of a backpack sprayer), every 15 days during the first 30 days of growth of the maize seedling and once a month thereafter.

Most farmers either do not wear personal protective equipment when handling or applying insecticides (68%) (Figure 1a) or the equipment they wear is incomplete —*i.e.*, it is limited to only gloves, masks or goggles—, mainly due to lack of economic resources (25%) (Figure 1b). The use of sprinklers in poor condition was also identified. FAO has reported that 99% of agricultural workers are exposed to acute intoxications by direct and indirect contact and by the lack of appropriate protective equipment for handling and application (Guzmán-Plazola *et al.*, 2016). Farmers in the community even mix pesticides (*e.g.*, chlorpyrifos-ethyl with permethrin), assuming that this increases their potential.

Risks of poisoning are latent in these practices. The handling of insecticides can have harmful effects on health, especially on the respiratory tract, digestive system, skin, and eyes —either as a consequence of potential spills on the skin, accidental splashes on the face, or inhalation—, causing symptoms such as vomit, nausea, weakness, headaches, drowsiness, and behavioral alterations, among others (Nava-Pérez *et al.*, 2012). Medium and long-term health repercussions may include cancer, Parkinson's disease, Hodgkin's disease, Alzheimer's disease, endocrine alterations (sterility, diabetes, immunosuppression, kidney impairment, etc.), and hepatotoxic and mutagenic effects, as well as neurocognitive problems (Nava-Pérez *et al.*, 2012) (Díaz-Vallejo *et al.*, 2021).

Likewise, a lack of training was identified: 99% of the interviewees mentioned that they do not receive technical advice for pest management (Figure 1c). They are also unaware about the toxicity and health damage caused by agrochemicals and, just like in other rural regions of Mexico, they have a low perception of risk (62%) (Figure 1d and Figure 1c) (Herrera-Moreno *et al.*, 2018; Ordoñez-Beltrán *et al.*, 2019; Gómez-González, 2017).

Therefore, the following measures should be applied: promoting the use of personal protective equipment; training and advice for the proper handling of pesticides; and raising awareness about the environmental and human health damages caused by the improper handling of agrochemicals.

In addition, 9% of the interviewees declared that they are willing to incorporate other alternatives for the control of the fall armyworm and the striped grass looper (Figure 2a) and 64% are also willing to use other management alternatives, such as traps and plant extracts (Figure 2b).

Given these results, it is relevant to motivate and make the population aware about the integration of environmentally friendly alternatives into their pest control practices (*e.g.*, the use of plant extracts), due to their safer and low-cost bioactives (Rodríguez-Montero *et al.*, 2020). In addition, this type of biopesticides is characterized by metabolites that quickly degrade in the environment. About 1,600 plant species with insecticidal, attractant, and repellent properties have been reported (Cerna-Chávez *et al.*, 2020).

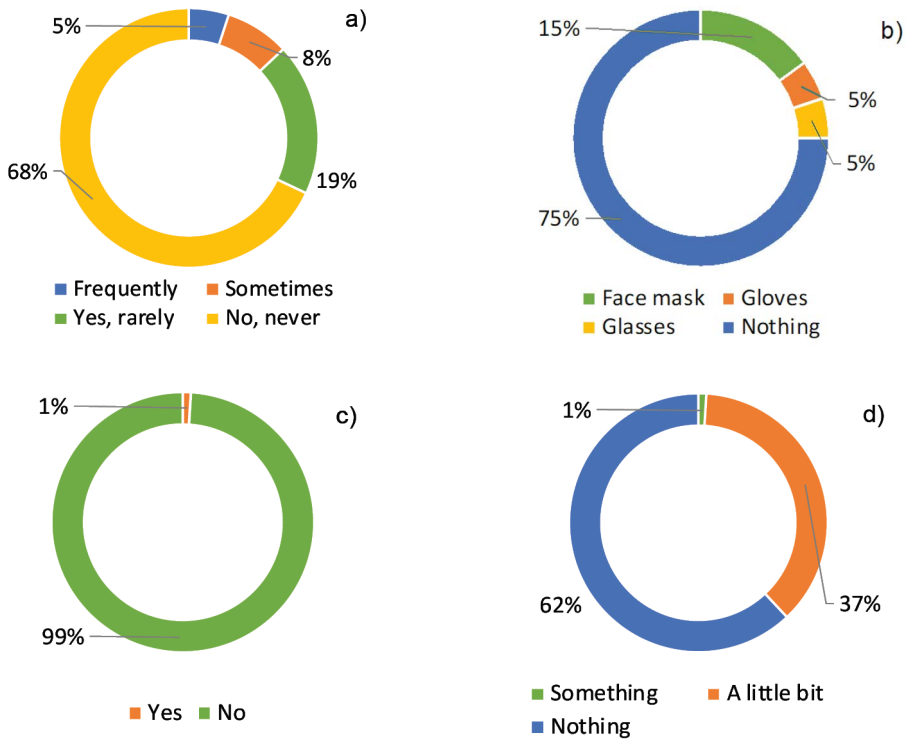

Figure 1. Characteristics and opinions on the control of the fall armyworm and striped grass looper in La Pahua, Francisco Z. Mena. a) Use of protective equipment, b) Type of protective equipment, c) Technical advice, d) Knowledge about health impacts of the use of synthetic insecticides.

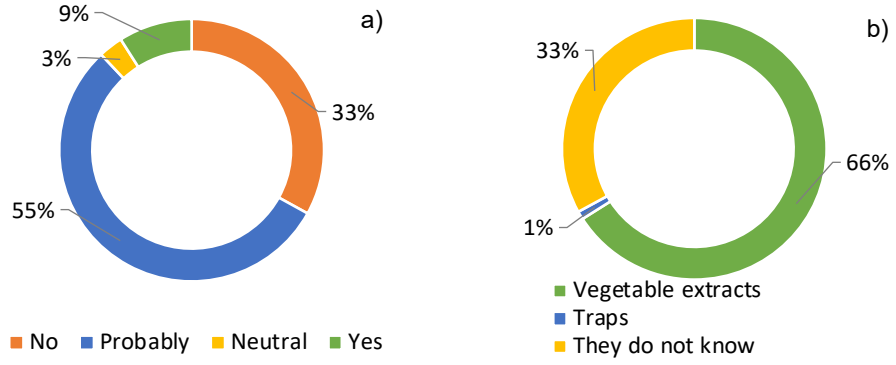

Figure 2. Opinions of maize producers from Francisco Z. Mena about alternatives for the management of fall armyworn and striped grass looper. a) Willingness to incorporate management alternatives in their practices, b) Alternatives that could be incorporated.

Local lore about plants with insecticidal potential

Regarding their knowledge of plants with pest control potential, 81% of the participants mentioned that they do not know plants with insecticidal effect, while 19% mentioned knowing little about the matter; therefore, recovering this type of knowledge could make a significant contribution to a greener agricultural production, which involves less health risks to producers and the general population.

The interviewees consider that some of the plants that grow in La Pahua could be used to make insecticides from plant extracts, including the following: castor oil bean (*Ricinus communis* L.) from the Euphorbiaceae family, Angel's trumpets (*Datura metel* L.) from the Solanaceae family, arrowhead vine (*Syngonium neglectum*) from the Araceae family, parthenium weed (*Parthenium hysterophorus* L.) from the Asteraceae family, cacahuananche (*Gliricidia sepium*) from the Fabaceae family, Aztec marigold (*Tagetes erecta* L.) from the Asteraceae family, and neem (*Azadirachta indica*) from the Meliaceae family (Figure 3).

P. hysterophorus and *G. sepium*, as well as *S. neglectum*, *D. metel*, *R. communis*, *T. erecta*, and *A. indica* have been documented to have insecticidal properties. They have been used to control insect pests and, in some cases, Lepidoptera (Al-Snafi, 2017; Aragón-García *et al.*, 2015; Gahukar, 2014; Ortiz-García *et al.*, 2018; Rodríguez-Rodríguez *et al.*, 2016; UNAM, 2022; Villate-Gómez *et al.*, 2008).

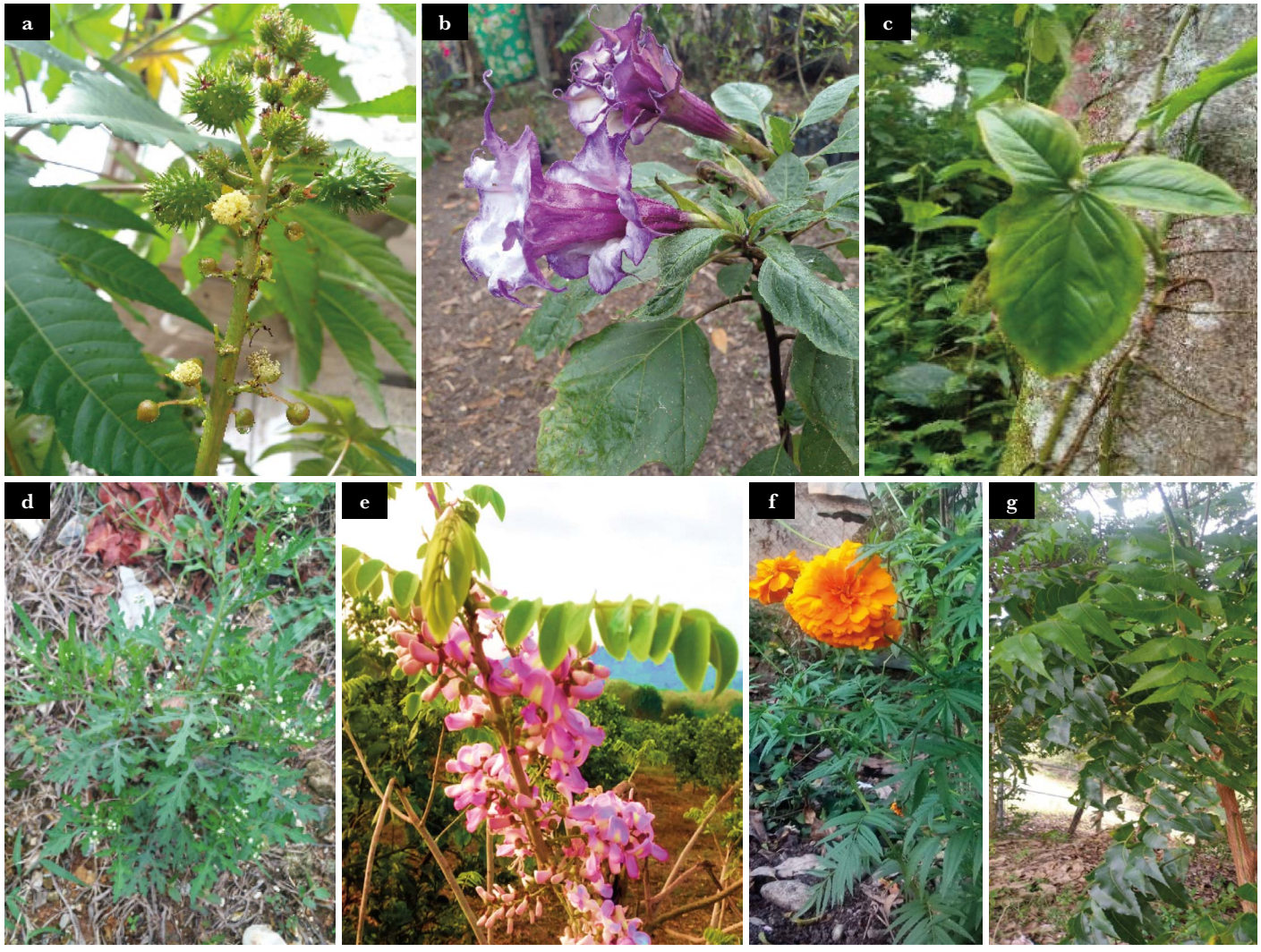

Figure 3. Plants with insecticidal potential according to the inhabitants of La Pahua, Francisco Z. Mena community a) castor oil bean (*R. communis*), b) angel's trumpets (*Datura metel*), c) arrowhead vine (*Syngonium neglectum*), Gliricidia (*Gliricidia sepium*), d) parthenium weed (*Parthenium hysterophorus*), e) and f) Aztec marigold (*Tagetes erecta*), and g) neem (*Azadirachta indica*) (personal file).

CONCLUSIONS

Maize producers from La Pahua, Francisco Z. Mena community, use synthetic insecticides formulated with chlorpyrifos-ethyl (alone or combined with permethrin) to control fall armyworm and striped grass looper in their crops; however, the minimal use of protective equipment reflects their lack of knowledge about the short, medium, and long-term health damage that these chemicals can have. However, the population is open to incorporate the use of plant extracts and traps into pest management practices, including the use of bioinsecticides made from local plant species.

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REFERENCES

Al-Snafi, A. E. (2017). Medical importance of *Datura fastuosa* (Syn: *Datura metel*) and *Datura stramonium*. *IOSR Journal of Pharmac, 7*(2), 43–58. https://doi.org/DOI:10.9790/3013-0702014358

Aragón-García, A., Pérez-Torres, C., Aragón-Sánchez, M., Cuate-Mozo, V. A., Juárez-Ramón, D., & Hernández-Loma, R. (2015). Manejo agroecológico de insectos que dañan el follaje de jamaica (*Hibiscus sabadariffa* L.) (Malvaceae) en el sur de Puebla, México. *Acta Agrícola y Pecuaria, 1*(1), 24–28. https://dialnet.unirioja.es/descarga/articulo/6201343.pdf

Castañeda-Guerrero, I., Aliphat-Fernández, M.M., Caso-Barrera, L., Lira-Saade, R., Martínez-Carrera, D.C. (2020). Conocimiento tradicional y composición de los huertos familiares totonacas de Caxhuacan, Puebla, México. *Polibotánica* 49:184-217 https://doi.org/10.18387/polibotanica.49.13

Cerna-Chávez, E., de Lira-Ramos, K. V., Ochoa-Fuentes, Y. M., Delgado-Ortiz, J. C., Cepeda-Siller, M., & González-Gaona, E. (2020). Actividad de extractos de plantas y hongos entomopatógenos para el control del picudo de la guayaba (*Conotrachelus dimidiatus* Champion) Coleóptera: Curculionidae. *Revista de Ciencias Biológicas y de La Salud, 23*(1), 70–76. https://doi.org/https://doi.org/10.18633/biotecnia.v23i1.1335

CESAVEP. (2020). Programa de Sanidad e Inocuidad Agroalimentaria 2020. Comité Estatal de Sanidad Vegetal del Estado de Puebla. http://www.cesavep.org/descargas/Informes2020/MAIZ/2.%20M.F.%20Ap.%20Maiz%20feb20.pdf.

Cortés-Rodríguez, E. A., & Venegas-Cardoso, F. R. (2011). Conocimiento tradicional y la conservación de la flora medicinal en la comunidad indígena de Santa Catarina, B. C, México. *Revista Científica de Sociedad, Cultura y Desarrollo Sostenible, 7*(1), 117–122. http://www.redalyc.org/articulo.oa?id=46116742011

Díaz-Vallejo, J., Barraza-Villarreal, A., Yáñez-Estrada, L., & Hernández-Cadena, L. (2021). Plaguicidas en alimentos: Riesgo a la salud y marco regulatorio en Veracruz, México. *Salud Publica de México, 63*(4), 486–497. https://doi.org/10.21149/12297

Gahukar, R. T. (2014). Factors affecting content and bioefficacy of neem (*Azadirachta indica* A. Juss.) phytochemicals used in agricultural pest control: A review. *Crop Protection, 62*(1), 93–99. https://doi.org/10.1016/j.cropro.2014.04.014

Gómez-González, I. (2017). Los Plaguicidas Altamente Peligrosos en México. El uso de plaguicidas altamente peligrosos en la península de Yucatán.: Vol. 1a edición. www.pmrmexico.org.mx

Guzmán-Plazola, P., Guevara-Gutiérrez, R. D., Olguín-López, J. L., & Mancilla-Villa, O. R. (2016). Perspectiva campesina, intoxicaciones por plaguicidas y uso de agroquímicos. *Revista de Agricultura en Zonas Áridas, 34*(3), 69–80. https://doi.org/http://dx.doi.org/10.4067/S0718-34292016000300009

Herrera-Moreno, J. F., Benitez-Trinidad, A. B., Xotlanihua-Gervacio, M. D. C., Bernal-Hernández, Y. Y., Medina-Díaz, I. M., Barrón-Vivanco, B. S., González-Arias, C. A., Pérez-Herrera, N. E., & Rojas-García, A. E. (2018). Factores de riesgo de exposición durante el manejo y uso de plaguicidas en fumigadores urbanos. *Revista Internacional de Contaminación Ambiental, 34*(1), 33–44. https://doi.org/10.20937/RICA.2018.34.ESP02.03

Lugo-García, G. A., Ángel Morón, M., Aragón-Sánchez, M., Reyes-Olivas, Á., Sánchez-Soto, B. H., & Sauceda-Acosta, P. C. (2017). Especies de "gallina ciega" (Coleoptera: Melolonthidae) en el cultivo de

ajonjolí (*Sesamun indicum* L.) en Sinaloa, México. *Agrociencia, 51*(1), 799-811. http://www.scielo.org.mx/pdf/agro/v51n7/1405-3195-agro-51-07-00799-en.pdf.

Martínez-Núñez, B., Tadeo-Robledo, M., Espinosa-Calderón, A., García-Zavala, J. J., Silva-Rojas, H. v, Aguilar-Rincón, V. H., & Miranda-Colín, S. (2018). Rendimiento de grano y resistencia a tizón foliar (*Exserohilum turcicum*) de híbridos fértiles y androestériles de maíz. *Agrociencia, 53*(1). https://agrociencia-colpos.mx/index.php/agrociencia/article/download/1752/1752/1741

Nava-Pérez, E., García-Gutiérrez, C., Camacho-Báez, J.R., Vázquez-Montoya, E.L. (2012). Bioplaguicidas: una opción para el control biológico de plagas. *Revista de Sociedad, Cultura y Desarrollo Sustentable, 8*(3), 17-29. https://www.redalyc.org/pdf/461/46125177003.pdf

Ordoñez-Beltrán, V., Frías-Moreno, M. N., Parra-Acosta, H., & Martínez-Tapia, M. E. (2019). Estudio sobre el uso de plaguicidas y su posible relación con daños a la salud. *Revista de Toxicología, 36*(2), 148–162. https://www.redalyc.org/articulo.oa?id=91967023011

Ortiz-García, K. P., Aragón-García, A., Pérez-Torres, B. C., Juárez-Ramón, D., & López-Olguín, J. F. (2018). Efecto de extractos vegetales y hongos entomopatogenos para el control de *Spodoptera frugiperda*, Smith (Lepidoptera: Noctuidae) en cultivo de maíz. *Entomología Mexicana, 5*(1), 136–140.

Rodríguez-Montero, L., Berrocal-Jiménez, A., Campos-Rodríguez, R., & Madriz-Martínez, M. (2020). Determinación de la actividad biocida de extractos vegetales para el combate de la mosca blanca *Bemisia tabaci* (Hemíptera: Aleyrodidae). *Revista Tecnología En Marcha, 33*(3), 117-128. https://doi.org/10.18845/tm.v33i3.4373

Rodríguez-Rodríguez, J. F., Cerna-Chávez, E., Ochoa-Fuentes, Y. M., & Hernández-Bautista, O. (2016). Evaluación de extractos vegetales sobre pulgón amarillo (*Melanaphis sacchari*) (Hemíptera: Aphididae) en sorgo en Guanajuato. *Revista de Ciencias Naturales y Agropecuarias, 3*(7), 18-24. www.ecorfan.org,revista@ecorfan.org.

SENASICA. (2017). Programa de trabajo de manejo fitosanitario del maíz, del incentivo de prevención de plagas fitosanitarias reglamentadas del programa de sanidad e inocuidad agroalimentaria 2017, en el Estado de Puebla. http://www.cesavep.org/descargas/ptas/PTA_2017%20MF%20Maiz%20f.firmas.pdf

SIAP. (2020). Sistema de Información Agroalimentaria y Pesquera. Panorama Agroalimentario. consulta https://nube.siap.gob.mx/panorama_siap/pag/2020/Atlas-Agroalimentario-2020

SIAP. (2021a). Sistema de Información Agroalimentaria y Pesquera. Producción agrícola de maíz. Consulta https://nube.siap.gob.mx/avance_agricola/

SIAP. (2021b). Sistema de Información Agroalimentaria y Pesquera. Servicio de información agroalimentaria y pesquera. Consulta https://nube.siap.gob.mx/panorama_siap/pag/2021/Panorama-Agroalimentario-2021

UNAM. (2022c). Syngonium neglectum. UNAM. Consulta .http://www.medicinatradicionalmexicana.unam.mx/apmtm/termino.php?l=3&t=syngonium-podophyllum

Villate-Gómez, M., Vento-Díaz, D., Mederos-Mederos, D., Rodríguez-Guerra, Y., Morales-Chala, S. (2008). Influencia biológica de algunas alternativas en el control de *Spodoptera frugiperda* J. E. Smith en condiciones de campo. *Centro Agrícola, 35*(1), 75-78. http://cagricola.uclv.edu.cu/descargas/pdf/V35-Numero_2/cag132081610.pdf