Chapter 5 Evaluation of the monitoring of the asian citrus psyllid, *Diaphorina citri* Kuwayama in the orange zone of Querétaro

Capítulo 5 Evaluación del monitoreo del psilido asiático de los cítricos, *Diaphorina citri* Kuwayama en la zona naranjera de Querétaro

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Abstract

The Asian citrus psyllid *Diaphorina citri* Kuwayama, in complex with the phytopathogenic bacteria *Candidatus liberibacter asiaticus*, causes Huanglongbing disease that affects citrus production in Mexico, placed among the main producers of lemon, orange and mandarin. Thus, citrus farming is in serious trouble. Associate the environmental variables and site conditions with the incidence of psyllid. 20 yellow traps were placed in five orchards of orange. The number of adults and nymphs was recorded in four shoots of 10 trees and the size was determined. Also, data collectors were placed climatic conditions. Fluctuation data population were obtained from 4 years, with significant differences between years ($p \leq 0.05$), it was observed an increase in the average capture, with 2022 being the year with the highest incidence of the psyllid in terms of captures. No monthly abundance pattern is observed in the sampling years; behavior galore changed every year; which caused the significant differences ($p \leq 0.05$). In the sampling years it was observed significant correlation between average abundance and average temperature ($p \leq 0.05$). Through a Sperman correlation, it was observed that the outbreak scales have a low correlation in relation to the abundance of nymphs and adults; However, an association of nymph abundance with the scale was observed. Of shoots 3; while adults are significantly associated with outbreaks 7.

Citricultura, Monitoreo, Plaga, Fluctuación

Resumen

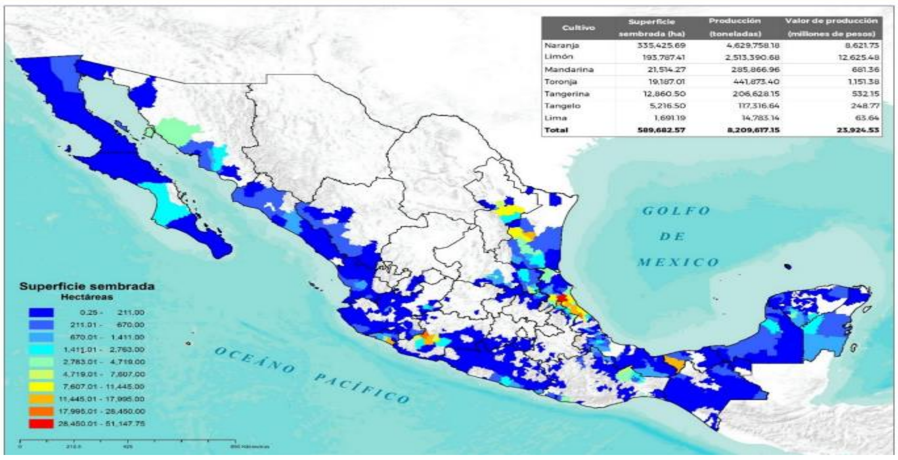
El psílido asiático de los cítricos *Diaphorina citri* Kuwayama, en complejo con la bacteria fitopatógena *Candidatus liberibacter asiaticus*, causa la enfermedad Huanglongbing que afecta la producción de cítricos en México, ubicado entre los principales productores de limón, naranja y mandarina. Así, la citricultura se encuentra en serios problemas. Asociar las variables ambientales y las condiciones del sitio con la incidencia del psílido. Se colocaron 20 trampas amarillas en cinco huertos de naranja. Se registró el número de adultos y ninfas en cuatro brotes de 10 árboles y se determinó su tamaño. También se colocaron colectores de datos sobre las condiciones climáticas. Se obtuvieron datos de fluctuación poblacional de 4 años, con diferencias significativas entre años ($p \leq 0{,}05$), se observó un incremento en la captura media, siendo 2022 el año con mayor incidencia del psílido en cuanto a capturas. No se observa un patrón de abundancia mensual en los años de muestreo; el comportamiento galore cambió cada año; lo que ocasionó las diferencias significativas ($p \leq 0{,}05$). En los años de muestreo se observó correlación significativa entre la abundancia media y la temperatura media ($p \leq 0{,}05$). A través de una correlación de Sperman, se observó que las escamas de los brotes tienen una baja correlación en relación a la abundancia de ninfas y adultos; Sin embargo, se observó una asociación de la abundancia de ninfas con la escama. De brotes 3; mientras que los adultos se asocian significativamente con los brotes 7.

Citricultura, Monitoreo, Plaga, Fluctuación

5 Introduction

In Mexico, citriculture is one of the most economically important fruit growing activities and also positions the country among the first places in citrus production, with a reported surface area of 526 thousand hectares of citrus, distributed in 23 states of the Mexican Republic, with a production of 6.7 million tonnes per year, and a value of more than 8 billion 50 million pesos (Martínez, 2009). In 2015, oranges ranked first with a production of almost 4 million tonnes, with the states of Veracruz, Tamaulipas and San Luis Potosí accounting for 67 % of the production harvested nationally (Ministry of Agriculture and Rural Development, 2017). However, despite the aforementioned importance, citriculture is seriously threatened by various pests, among which the Asian citrus psyllid (*Diaphorina citri*) (Baños et al., 2015) associated with the bacterium *Candidatus liberibacter* which together cause the Huanglongbing disease (HLB), one of the most important worldwide (Mora et al., 2014) and for which there is a phytosanitary campaign focused on control in all the states with citrus production (Fig. 1) (NOM-EM-047-FITO-2009).

Figure 5 Map of the main citrus producing areas in Mexico



Source: (SIAP, 2018)

Despite the control efforts that have been made to control the pest, damage to diseased trees cannot be cured and they eventually die after a few years, during which time their development capacity is reduced, they produce small, deformed and tasteless fruit, inverted ripening, seed abortion, as well as mottled leaves and the appearance of yellow shoots (Ortega et al., 2013 and SAGARPA, 2014).

In Querétaro, citriculture is under protection due to the detection of the HLB bacterium in samples of the psyllids, and together with activities such as the application of mineral oil, biological control with Tamarixia radiata Waterston and fortnightly monitoring, the population of the Asian citrus psyllid is kept low (CESAVEQ, 2021). citri, these activities are also replicated in the Concá area in order to reduce production costs in commercial orchards as well as in backyard orchards (Government of Mexico, 2021).

In the state of Querétaro there is a first record of the Asian psyllid in the municipality of Arroyo Seco, Querétaro, this report was made in April 2004, since then sampling and censuses have been carried out to delimit the presence of the pest and according to the secretary of the EPPO it is the first record in the state of Querétaro (EPPO, 2004). Although historical data on the beginning of citrus cultivation and the spread of the Asian citrus psyllid are unknown, in 2013 the citrus psyllid control campaign was initiated and 270 hectares of citrus were registered (Table 5).

Table 5 Distribution of citrus crops with phytosanitary management in the state of Querétaro

Crop	Municipality	Surface (Ha)	Production (ton)	Value of production ($)
Lemon	Jalpan de Serra	13.00	104.00	208,000.00
	Landa de Matamoros	0.75	6.00	12,000.00
Lemon	Landa de Matamoros	6.25	50.00	100,000.00
Orange	Arroyo Seco	33.75	317.25	634,500.00
	Landa de Matamoros	0.25	2.00	4000.00
Orange	Arroyo Seco	161.25	1293.36	2,586,718.64
	Pinal de Amoles	4.25	0	0.00
	Jalpan de Serra	24.50	196	392,000.00
	Total	244.00	1968.61	3,937,218.64

Source: Government of Mexico, 2013

The Asian citrus psyllid causes a great number of damages in plants of the Rutaceae family, (Ortega et al., 2013; Alemán, 2007), derived from its preference for this family, in nymph stage it feeds on the sap of the plant as well as buds and young leaves (Baños et al., 2015), while injecting the HLB bacteria (Huanglongbing) from one plant to others (Hernández, et al., 2013; García, 2013 and Díaz et al., 2014)), as well as causing dwarfing, death of vegetative shoots and even of the tree, which is why constant epidemiological surveillance is carried out in commercial and backyard orchards, as well as the elimination of HLB-positive plants (Yzquierdo et al., 2021).

5.1 Methodology

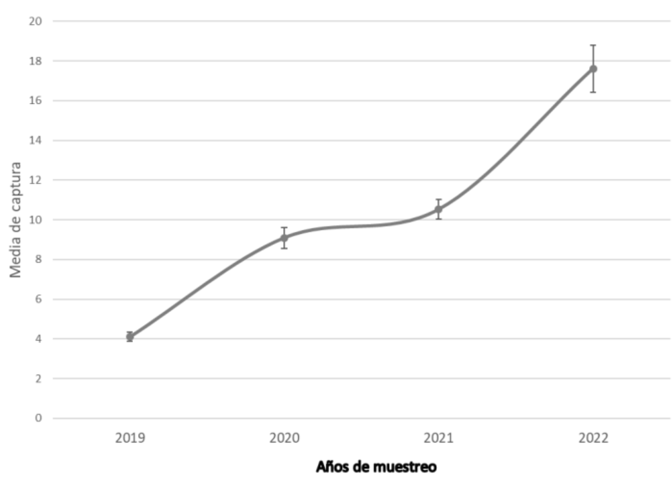
Therefore, a collaboration agreement was signed with the State Plant Health Committee of Querétaro (CESAVEQ) to evaluate the psyllid control strategy within the phytosanitary campaign for the control of the Asian citrus psyllid. The methodology proposed by CESAVEQ, 2021 in the operation manual for citrus regulatory pests was followed. In each orchard 20 yellow sticky traps were placed, gridded on both sides, measuring 12.5x17.5 cm, with a separation of 10 metres between each trap, facing north-west at a height of approximately two metres above ground level. The traps were numbered from 1 to 20 and labelled with the date of placement.

Every 15 days the traps were replaced and the number of adult psyllids collected in each trap was counted, then the number of adults captured and the phenological stage of the trees was recorded using the SIMDIA-Mobile (Smartphone) application (Diaphorina monitoring system), the replaced traps were transferred in a cooler to the laboratory of Management and Conservation of Natural Resources CIDAF-UAQ where the adults stuck and captured in the traps were detached with the help of a brush dipped in 96% alcohol and preserved in bottles with 70% alcohol for corroboration of the identification and subsequent assembly. For the association of the developmental stages of the psyllid and the phenological stages of the shoots, the number of adults and nymphs was recorded in four shoots in 10 trees and the size of each shoot was determined according to the scale proposed by INIFAP and climatic data collectors were placed. The climatic data were obtained by data logger in each of the orchards.

5.2 Results and discussion

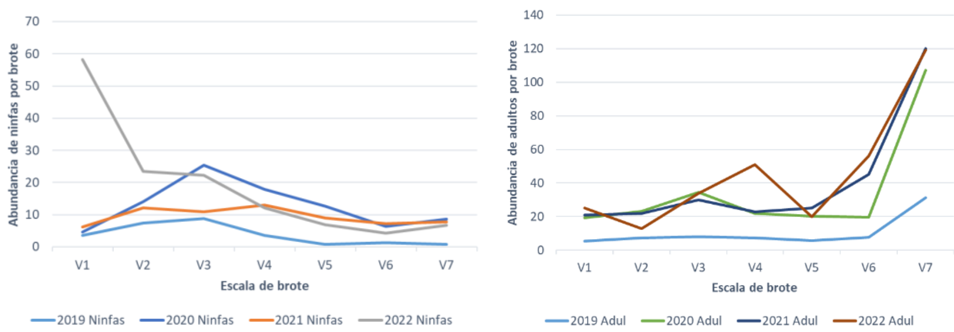
Sampling was carried out from 2019 to 2022, with significant differences between years ($p = <0.05$), (Fig. 5.1). An increase in the mean number of captures was observed, with 2022 being the year with the highest incidence of the psyllid in terms of captures. No monthly abundance pattern was observed in the sampling years, the behaviour in terms of abundance changed each year with significant differences ($p = < 0.05$). In 2019 two abundance peaks were observed in July and September, in 2020 the highest abundance was recorded in March, for 2021 May was the month with the highest average abundance, and April recorded the highest averages of psilids in 2022. Significant correlation between average abundance and average temperature was observed in the sampling years ($p = <0.05$). These data show that the fluctuation of *D. citri* is not homogeneous and depends on environmental factors and orchard conditions.

Figure 5.1 *D. citri* sampling years in the orange-growing area of Querétaro



Temperature is an environmental factor that favours high incidences of the psyllid in the sampled orchards. On the other hand, an important correlation was observed between stage 2 and 3 nymphs with category 3 outbreaks, while adults were perfectly associated with category 7 outbreaks (Fig. 5.2).

Figure 5.2 Association of nymphs and adults in relation to outbreak scale.



D. citri is present all year round, it is possible that its multivoltine biology allows it to have several generations per year and therefore to be present all year round. The year 2022 was the year with the highest abundance of the psyllid, however, in 2019 two population peaks were observed. From 2020 to 2022, population peaks were observed in March, April and May, contrary to what was reported by Luna-Cruz et. al., 2018. However, this behaviour is reported by García-Garduzca et. al., 2013. There is a significant correlation with temperature, coinciding with that reported by Hernández-Fuentes et. al., 2022. An association was observed between scale 7 shoots with adults and scale 1 and 3 tender shoots with *D. citri* nymphs. More precise statistics are needed and the phenology of the plant needs to be taken into account.

5.3 Conclusions

It was observed that Diaphorina citri does not have a pattern of population fluctuation, possibly due to its multivoltine biology, in addition the populations of the psyllid have increased notably in recent years and finally an association was determined between the tender vegetative shoots and the nymphal stages, possibly due to the type of feeding that the psyllid has, likewise the adults are associated with mature shoots, possibly occupying them as breeding sites.

5.4 Acknowledgements

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