Investigation note

# Diversity of leafhoppers (Homoptera: Cicadellidae) collected in chili parcels in northern-central Mexico

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## Abstract

The chili for drying (*Capsicum annuum* L.) is an important crop in northern central Mexico where viral and bacterial diseases transmitted by leafhoppers are emerging; however, very little is known about the presence and composition of the populations of leafhoppers in the chili plots, therefore, the purpose of this work was to identify the genders of leafhoppers in the commercial chili parcels in the states of Aguascalientes, Durango and Zacatecas. Leafhoppers were captured through an entomological network in 57 commercial plots of the mentioned states. The 86% of the plots sampled were found. Individuals belonging to the genders *Aceratagallia* spp., *Acinopterus* spp., *Balclutha* spp., *Carneocephala* spp., *Circulifer* spp., *Cuerna* spp., *Dalbulus* spp., *Draeculacephala* spp., *Empoasca* spp., *Exitianus* spp., *Graminella* spp., *Graphocephala* spp., *Hordnia* spp., *Ollerianus* spp., *Scaphytopius* spp., *Stirellus* spp. and *Texananus* spp., were identified in the chili parcels.

**Keywords:** *Capsicum annuum* L., Aguascalientes, Durango, vectors, Zacatecas.

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The state of Zacatecas is the main producer of chili for drying (*Capsicum annuum* L.) in the north central region of Mexico; around 38 000 hectares are planted each year (Zegbe *et al.*, 2012). A considerably smaller area is occupied with this vegetable in the states of Aguascalientes with an area of 1 124 ha and Durango with 3 213 ha in 2017 (SIAP 2017). The chili production for drying in this region is affected by the occurrence of viral and bacterial diseases such as *Beet mild curly top virus* and *Candidatus* Phytoplasma trifolii, respectively (Velásquez-Valle *et al.*, 2008; Mauricio-Castillo *et al.*, 2015); both pathogens are transmitted in Zacatecas by the beet leafhopper *Circulifer tenellus* Baker (Homoptera: Cicadellidae).

Additionally, there are reports not completely confirmed on the ability of other leafhoppers (*Aceratagallia* spp., *Dalbulus* spp., *Empoasca* spp. and *Graminella* spp.) to transmit phytoplasmas in the same region (Mercado-Arteaga *et al.*, 2013; Dávila-Berumen *et al.*, 2013). Recently, the presence in Aguascalientes and Zacatecas of some genders of leafhoppers during the winter season was confirmed (Velásquez-Valle *et al.*, 2017), the survival of these insects during the winter is important since it can assure that the potential vectors and transmitted pathogens are available to infect the chili seedlings in the following spring.

On the other hand, very little is known about the presence of leafhoppers in the chili plots in northern central Mexico during the summer, so the purpose of this work was to identify the genders of leafhoppers present in commercial plots of chili in the Mexican states of Aguascalientes, Durango and Zacatecas. The collection of leafhoppers was carried out between June and September 2016 in randomly selected plots of chili. Most of the plots had types of chili for drying (Mirasol, Ancho, Pasilla or Puya) although plots were also included with types of chili for fresh consumption (Jalapeño or Bell). The leafhoppers were captured using an entomological striking net (four series of 100 strokes at four points in each plot).

The content of the network was transferred to a plastic bag which was stored at -20 °C until the separation of the species of cicadellides in the laboratory. The leafhoppers were identified using the taxonomic keys proposed by Nielson (1968). The Jaccard Index was used to know the similarity between the genus of leafhoppers trapped in the plots with different types of chili.

In addition, the Shannon-Wiener diversity index (ISW) was calculated according to the methodology used by Reyes and Torres-Florez (2009). Leafhoppers were found in 49 out of 57 chili plots regardless of geographic location or type of chili. It is identified 17 genders of leafhoppers: *Aceratagallia* spp., *Acinopterus* spp., *Balclutha* spp., *Carneocephala* spp., *Circulifer* spp., *Cuerna* spp., *Dalbulus* spp., *Draeculacephala* spp., *Empoasca* spp., *Exitianus* spp., *Graminella* spp., *Graphocephala* spp., *Hordnia* spp., *Ollerianus* spp., *Scaphytopius* spp., *Stirellus* spp., and *Texananus* spp. The total number of leafhoppers captured was 313, adults belonging to the genus *Balclutha* spp. were the most frequently caught (36.4%) followed by those of *Circulifer* spp., *Empoasca* spp., *Aceratagallia* spp. and *Graminella* spp. (22, 17.6, 7.9 and 5.1% respectively).

On the contrary, the genders *Carneocephala* spp. and *Texananus* spp. were the least frequently trapped genders (0.3% each). Without taking into account the geographical location or the type of chili, the adults of *Circulifer* spp. they were the most widely dispersed; 57.1% of the 49 plots sampled that were positive to the presence of cicadellides were found; individuals of the genders

*Aceratagallia* spp. and *Empoasca* spp. they were also caught in high numbers in the plots of chili (38.8% each), adults of *Graminella* spp. they were captured in a high percentage (22.4%) in the chili parcels. The dispersion of the genders *Aceratagallia* spp., *Empoasca* spp., and *Graminella* spp. since they have been mentioned as possible vectors of phytoplasmas in this region (Mercado-Arteaga *et al.*, 2013; Dávila-Berumen *et al.*, 2013).

It is important to note that, despite representing a third of the total number of leafhoppers captured at work, individuals of the genus *Balclutha* spp. only 24.5% of the positive plots were found in the presence of leafhoppers. The genus *Circulifer* spp., has been reported in Mexico since 1954 (Young and Frazier, 1954); however, its role as a vector of viruses, phytoplasma and spiroplasmas in the north of the country has only recently been recognized (Velásquez-Valle *et al.*, 2008; Mauricio-Castillo *et al.*, 2015; Swisher *et al.*, 2016). Mixed populations of *Aceratagallia* spp., *Circulifer* spp., *Empoasca* spp., and *Graminella* spp., considered important for their quality as vectors or potential vectors, were detected in 26 chili plots.

Specimens of *Circulifer* spp. Were identified in 20 of these 26 plots, which underscores the importance of this genus as vector of viruses and bacteria. In the plots of the most economically important types of chili for drying in this region (Mirasol, Ancho and Pasilla), 303 leafhoppers were captured, equivalent to 96.8% of the total of captured cicadellids, with the number of genders captured in each variable plot (Table 1).

**Table 1. Relative percentage and total percentage of leafhopper genders caught in plots with three types of chili for drying in the states of Aguascalientes, Durango and Zacatecas.**

| Genus | Chili Mirasol | | Chili Ancho | | Chili Pasilla | |
|---|---|---|---|---|---|---|
| | Relative[1] | Total[2] | Relative | Total | Relative | Total |
| *Aceratagallia* spp. | 8.1 | 5.6 | 4.9 | 0.9 | 12.5 | 1.3 |
| *Acinopterus* spp. | 0.5 | 0.3 | 1.6 | 0.3 | 0 | 0 |
| *Balclutha* spp. | 41.9 | 29 | 39.3 | 7.9 | 6.2 | 0.7 |
| *Carneocephala* spp. | 0.5 | 0.3 | 0 | 0 | 0 | 0 |
| *Circulifer* spp. | 21.4 | 14.8 | 18 | 3.6 | 40.6 | 4.3 |
| *Cuerna* spp. | 0.5 | 0.3 | 1.6 | 0.3 | 0 | 0 |
| *Dalbulus* spp. | 1.9 | 1.3 | 0 | 0 | 0 | 0 |
| *Draeculacephala* spp. | 2.8 | 1.9 | 3.3 | 0.7 | 0 | 0 |
| *Empoasca* spp. | 15.2 | 10.6 | 13.1 | 2.6 | 25 | 2.6 |
| *Exitianus* spp. | 0.5 | 0.3 | 3.3 | 0.7 | 0 | 0 |
| *Graminella* spp. | 3.8 | 2.6 | 9.8 | 1.9 | 3.1 | 0.3 |
| *Graphocephala* spp. | 0.5 | 0.3 | 1.6 | 0.3 | 0 | 0 |
| *Hordnia* spp. | 0.5 | 0.3 | 1.6 | 0.3 | 0 | 0 |
| *Ollerianus* spp. | 0 | 0 | 0 | 0 | 3.1 | 0.3 |
| *Scaphytopius* spp. | 0 | 0 | 0 | 0 | 9.4 | 0.9 |
| *Stirellus* spp. | 1.4 | 0.9 | 1.6 | 0.3 | 0 | 0 |
| *Texananus* spp. | 0.5 | 0.3 | 0 | 0 | 0 | 0 |

[1]= According to the number of individuals captured within a specific type of chili; [2]= According to the number of individuals caught in the three types of chilli for drying.

The genus *Balclutha* spp., has been found in grasslands of China (Lu *et al.*, 2013) as well as in Canadian vineyards where the population of this genus represented less than 10% of the total captured (Saguez *et al.*, 2014) in contrast, in the current work, the percentage of individuals belonging to this gender was close to 36%. On the other hand, a species of this genus, *B. rubrostriata* (Melichar) is capable of transmitting a phytoplasma, causal agent of the disease called white leaf of sugarcane in the North American states of Texas and Louisiana (Morgan *et al.*, 2013) so the activity of *Balclutha* spp. in the chili plots it must be carefully evaluated. Relative percentage (related to the total number of leafhoppers trapped by type of chili) of the genders *Circulifer* spp. and *Empoasca* spp. it represented 22.7 and 15.2% of the total number of leafhoppers caught (Table 1).

The Jaccard Index values showed that the similarity in the composition of the leafhopper genders among types of chilli for drying was greater (0.75) between the Ancho and Mirasol types than between the Ancho and Pasilla types (0.33) or Mirasol and Pasilla (0.29). Most of the ISW values in the Mirasol type plots were lower than 3.5, with a range of 1.1 to 6.4; on the other hand, the range of ISW for the width type plots expressed values between 1.5 and 3.4 and between 1.7 and 4.9 for the plots with Pasilla type chili. The wider ISW range in Mirasol-type chili plots could suggest a greater diversity of leafhoppers in those plots.

## Conclusions

In plots of chili from the states of Aguascalientes, Durango and Zacatecas, chicharritas belonging to the genders were identified *Aceratagallia* spp., *Acinopterus* spp., *Balclutha* spp., *Carneocephala* spp., *Circulifer* spp., *Cuerna* spp., *Dalbulus* spp., *Draeculacephala* spp., *Empoasca* spp., *Exitianus* spp., *Graminella* spp., *Graphocephala* spp., *Hordnia* spp., *Ollerianus* spp., *Scaphytopius* spp., *Stirellus* spp. y *Texananus* spp.

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