J. Entomol. Res. Soc., 27(1): 101-110, 2025 *Research Article*
Doi: 10.51963/jers.v27i1.2736 *Online ISSN:2651-3579*

Identification and Evaluation of Damage Caused by *Nicentrites testaceipes* (Champion, 1908) in Maize in the Amanalco-Valle de Bravo Basin, Mexico

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ABSTRACT

In Mexico, the main maize pests are Lepidoptera and Coleoptera. In the spring-summer cycle of 2024, damage caused by a species of the Cucurlionidae family was observed in maize crops. In this region, damage caused by this type of insects had not been observed; therefore, this work aimed to identify the specie causing the lesions and evaluate the foliar damage in maize crop. *Nicentrites testaceipes* was identified as causative of damage to maize from vegetative stages V4 to V11. Between 0.3 and 6.3 adults were observed per plant, and the percentage of damaged leaves per plant was between 63.4 and 100%, with the greatest damage occurring in plants in vegetative stages V5 and V7. In a more specific visual sampling focused on the leaf located in the third position from top to bottom, it was observed

Felipe-Victoriano, N., Bautista-Pérez, C. E., García-Ramírez, A., Delgado-Luna, C.,& Felipe-Victoriano, M. (2025). Identification and evaluation of damage caused by *Nicentrites testaceipes* (Champion, 1908) in maize in the Amanalco-Valle de Bravo basin, Mexico. *Journal of the Entomological Research Society*, 27(1), 101-110.

Received: October 02, 2024 *Accepted: February 05, 2025*

that it can cause an average damage of between 1.0 and 6.1% of the damaged leaf area, and as a minimum and maximum between 1.0 and 15.0% of the damaged leaf area, respectively. *N. testaceipes* is a little-studied corn pest because it is considered a secondary pest, but population outbreaks can occur that can significantly affect corn crops if control measures are not taken.

Keywords: Weevils, *Zea mays*, secondary pests, damage, native maize.

INTRODUCTION

Maize is the cereal produced in the largest volume in the world. Currently, Mexico is ranked as the seventh largest producer in the world, being very important in its economy, gastronomy, and culture (Arispe-Vázquez et al., 2021). It is important to note that the domestication process of this crop began in Mexico approximately 10,000 years ago, and it concentrates the greatest diversity of maize and teosintle [*Zea perennis* (Hitch) Reeves & Mangesldorf (Poales: Poaceae)] in the world, which can be found naturally and they have coexisted since remote times (Wellhausen, Roberts, Hernández, & Mangelsdorf, 1951; Wilkes, 1985; Galinat, 1995). In 2023, 6,923,000 ha were planted in Mexico, yielding 22,046,000 tons of maize, with an average yield of 4.2 tons ha^{-1} (SIAP, 2024). The main maize-producing states are Sinaloa, Jalisco, Guanajuato, Michoacán, Veracruz, Chihuahua, and Guerrero, which together contribute 69% of national production (SIAP, 2024).

In Mexico and around the world the main maize pests are the fall armyworm [(*Spodoptera frugiperda* (Smith, 1797)] and the corn earworm [*Helicoverpa zea* (Boddie, 1850)], (Lepidoptera: Noctuidae), which cause the greatest economic losses in tropical and neotropical regions (Blanco et al., 2014; Wang et al., 2020; González-Maldonado, Correa-Ramírez, & Flores-Villegas, 2023). For *S. frugiperda* alone, it is estimated that control measures can reach 10% of production costs (Jaramillo-Barrios, Varón-Devia, & Monje-Andrade, 2020). There are other pests that are not of economic importance for maize cultivation, however, they become relevant and behave as primary pests under certain conditions such as abundant food, prolonged drought, or favorable temperature, which allow accelerated growth of their populations, such as the maize flea [*Chaetocnema pulicaria* (Melsheimer, 1847) (Coleoptera: Chrysomelidae)]. Salas-Araiza, Medina-Rodríguez, Vazquez-Martínez, Sandoval, & Mendoza, (2023) mention that some other species of beetles (Coleoptera: Cucurlionidae) may be presented in maize, such as *Linogeraeus capillatus* (LeConte, 876), *L. hospes* (Casey, 1892), *Geraeus senilis* (Gyllenhal, 1836) and *Nicentrites testaceipes* (Champion, 1908), which are not considered of economic importance in maize cultivation.

During the spring-summer cycle of 2024, in the region that includes the Amanalco-Valle de Bravo basin, plants of maize crops with foliar lesions similar to those caused by early-stage larvae of *S. frugiperda* were observed. Upon careful observation, the presence of an insect belonging to the cucurlionidae family was observed. It is important to highlight that in this region, according to field technicians, this type of lesion caused by this specific pest had not been previously observed. Therefore, the objective of this work was to identify the specie causing the lesions and evaluate the foliar damage it can cause in maize crops.

MATERIALS AND METHODS

Identification of the pest in maize

The sampling and collection of the specimens was carried out during the spring-summer cycle of 2024 in two maize fields with an area of one hectare each. The first located in the town called Lomas de San Sebastián el Grande, at the geographic coordinates 19º 18' 08.53'' north latitude and 100º 03' 04.38'' west longitude at 2700 masl; and the second located in the Ejido de San Mateo, at the coordinates 19º 18' 14.44'' north latitude and 100º 02' 46.78'' west longitude at 2711 masl, both locations belong to the municipality of Amanalco, State of Mexico. Identification of the specimens was carried out at the Campo Experimental Las Huastecas (CEHUAS), belonging to the Instituto Nacional de Investigaciones Forestales, Agrícolas, y Pecuarias (INIFAP), located in the Municipality of Altamira, Tamaulipas, Mexico.

In the maize field located in the town of Lomas de San Sebastián el Grande, the weevil sampling was carried out in the MS-RS maize variety that is tolerant to drought, the sampling was carried in the vegetative stage V4-V7. In the maize field located in the Ejido San Mateo, the sampling was carried out on a plantation of native maize Blanco-San Mateo (MNB-SM), between the vegetative stages V7-V11.

Infestation and damage caused by weevils in maize

In the sampled crops, maize plants were found at different stages of development because the rainy season was unstable. To determine the damage, sampling was carried out in the two plots, at five points within the plot, the four ends, and the central part (Santana, Flores, & Domínguez, 2016; Ochoa-Guzmán et al., 2024). At each sampling point, the number of healthy leaves and damaged leaves was counted in 20 randomly selected plants, therefore for each locality, a total of 100 plants were sampled; with the above, the percentage of damaged leaves was estimated using the following formula: % damaged leaves per plant = (damaged leaves / total leaves) x 100. In addition, the number of weevils per plant, the stage of development of the maize plant, and the percentage visual damage on the third position leaf located from top to bottom were counted (the percentage of damage is assigned to each leaf based on the damage it presented). To identify the species, 250 specimens were collected, which were placed in 70% ethanol. The identification was carried out with the key for weevil species in maize proposed by Salas-Araiza et al. (2023). A one-way analysis of variance (ANOVA) was performed with the collected data, variables that presented statistical significance were subjected to a Tukey mean comparison test (α=0.05) in the InfoStat statistical software (2023).

RESULTS AND DISCUSSION

Identification of the pest in maize

According to the taxonomic key proposed by Salas-Araiza et al. (2023), *N. testaceipes* were identified as the cause of damage to maize crops (Fig. 1); 100% of the collected specimens belong to this species. The specimens used for identification

presented an average size of 3.5 mm (n=10); dark rostrum in the basal part that changes to brown towards the distal part, the rostrum does not reach the anterior coxae; the scape, funiculus, and club of the antennae are brown similar to the rostrum, the scape can be seen in a darker color. The head, thorax, and abdomen are black with abundant scales arranged on well-defined lines on the elytra, which give the appearance of having a yellowish-white or light gray color. Coxae and trochanter dark brown, femur, tibia, and tarsi lighter brown (Fig. 1). In the male genitalia, in dorsal view the aedeagus can be observed with the middle lobe truncated in the distal region, being wider in the middle part; while in lateral view the distal part is observed slightly curved downwards (Fig. 2), the above agrees with the description made by Salas-Araiza et al. (2023).

Figure 1. Adult of *N. testaceipes* collected on maize crop, a) lateral head and face, b) lateral view, c) dorsal view.

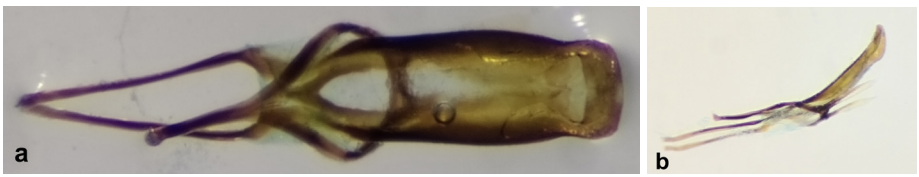

Figure 2. Genitalia of *N. testaceipes*, a) dorsal view, b) lateral views.

Infestation and damage caused by weevils in maize

The damage caused by *N. testaceipes* was observed in different locations in the municipalities of Donato Guerra and Villa Victoria State of Mexico, in maize from vegetative state (V5) to reproductive state (R1), although infestation and damage sampling were not carried out in these. In the maize field located in the town of Lomas de San Sebastián el Grande, it was observed that the greatest damage was presented by the plants that were larger at that time and were in the vegetative stage (V5 to V7), with respect to the plants that were in vegetative stage younger to V5. The damage was observed on the leaf as irregular white lesions parallel to the leaf veins, without completely piercing the leaf blade. These lesions had a white hue when they were recent and changed to a brown hue in old lesions; the size of the lesions was variable, small lesions of 0.1 cm were observed up to large lesions of 9.0 cm long (n=50 lesions) and 0.03 to 0.5 cm wide (n=50 lesions); this is observed in Figure 3. The above agrees with what was described by Ortega, (1987) who mentions that *N. testaceipes* in maize, causes irregular white foliar lesions without perforating it, he also mentions that the lesions can merge when there are serious infestations causing lesions of a larger size.

Figure 3. Maize plants with leaf damage caused by *N. testaceipes*, a) adult feeding on maize leaf, b-c) maize plants in vegetative stage V5-V7 with visible lesions in a horizontal position and on the upper part of the leaf blade.

N. testaceipes in maize is considered a secondary pest, and it is mentioned that it can sometimes cause serious damage during the first 60 days of cultivation in late maize if control measures are not taken (Pérez, Villareal, & Herrera, 2011; Ramírez, 2021). During the evaluations, *N. testaceipes* was only observed in the adult stage, however, it is mentioned that in maize plants with a well-developed stem, females can lay about 200 eggs. The larvae have been observed feeding on the stem and fibrous roots where they can also spend their pupal stage. Due to the above, in crops with high infestations of this pest**,** a greater number of plants with stem and/or root lodging are observed. It is also mentioned that in the pupal stage, it can remain in hibernation within the pupal cell during the winter (Pérez, 1984; Ortega, 1987; De la Torre, 1990).

From random sampling in the maize field of the town of Lomas de San Sebastián el Grande, for the variable number of adult weevils per plant, statistical differences were found ($p<0.0001$) between the plants sampled at different points of the crop. On average, between 0.3 and 6.3 individuals per maize plant were observed depending on the sampling point. Likewise, it was visually observed that the highest number of weevils was found in the largest plants that were between vegetative stage V5 and V7, where a maximum of 22 weevils were counted per plant, the latter being a high infestation of this pest. In the maize field located in the Ejido de San Mateo, the average number of weevils was 0 and 0.2 weevils per sampled maize plant; the plants that had weevils had one and a maximum of two adult weevils per plant.

Table 1. Number of *N. testaceipes* per plant, percentage of damaged leaves, and visual damage on the third position leaf located from top to bottom in maize planted in spring-summer 2024 in the Municipality of Amanalco.

Sampling point	Sampling in the town of Lomas de San Sebastián el Grande			Sampling in the Ejido of San Mateo		
	N. testaceipes per plant	No leaves damaged per plant (%)	Damage 3rd leaf up-down (%)	*N. testaceipes* per plant	No leaves damaged per plant (%)	Damage 3rd leaf up-down (%)
1	6.3 (±1.0)A	100 (±0.0*)AΩ	6.1 (±0.9)A	0.1 (±0.07)A	93.6 (±2.4)A	1.6 (±0.22)A
2	3.2 (±0.5)B	100 (±0.0)A	4.8 (±0.7)AB	0.2 (±0.09)A	90.1 (±2.4)A	1.4 (±0.47)A
3	2.9 (±0.4)B	100 (±0.0)A	4.5 (±0.7)AB	0.0 (±0.00)A	69.8 (±5.0)B	0.7 (±0.11)A
4	2.1 (±0.5)BC	100 (±0.0)A	3.1 (±0.5)BC	0.1 (±0.07)A	69.2 (±6.7)B	1.0 (±0.21)A
5	0.3 (±0.1)C	95 (±3.4)A	1.3 (±0.2)C	0.2 (0±.14)A	63.4 (±7.2)B	1.1 (±0.14)A
Pr>F	<0.0001	0.0854	<0.0001	0.4388	0.0001	0.1047

Ω Different literals between columns indicate statistical differences between sampling points within the plot (one-way ANOVA, Tukey <0.05), *(±n) standard error.

There is very little information regarding the infestation and damage that *N. testaceipes* can cause in maize. De la Paz et al. (2009) mention that in a time-based sampling (one minute of searching) in maize, *N. testaceipes* presents an abundance of 3.6%, after *Rhopalosiphum maidis* (Fitch, 1856) (Hemiptera: Aphididae) with an abundance of 85%; while in a sampling by plant looking at stem and leaves the abundance of *N. testaceipes* is 1.4%, being below *R. maidis* and *Frankliniella* sp (Karny, 1910) (Thysanoptera: Thripidae) which presented an abundance of 79.4% and 15.1% respectively. The above highlights the status of *N. testaceipes* as a secondary pest in maize. However, it is important to highlight that the insects with which they are compared in these investigations are highly prolific; they present high rates of individual development, along with a very short life cycle, which allows them to quickly colonize crops. For example, *R. maidis* can increase their populations by 12% per day, which is why they are considered major pests in various crops (López, Cortez-Mondaca, & Valenzuela-Hernández, 2023).

In other research in Tlaxcala, Mexico, it is reported that on average there may be between 2.5 and 4.0 individuals of *N. testaceipes* for each maize plant (Pérez-Constantino, 2015); and more recently, Salas-Araiza et al. (2023) in Guanajuato, Mexico, they mention that high populations of this insect can be found at vegetative stage V5 and these decrease in more developed stages of the crop. The above is possibly due to the fact that *N. testaceipes* according to Pérez, Villareal, & Herrera, (2011) and Ortega, (1987) they prefer to feed of young leaves in maize, which is why the greatest damage caused by this pest occurs in the first 60 days of the crop, nevertheless, this pest can be found even in the reproductive stages of maize where it can be observed feeding on the stigmata and spikes, as observed in this investigation.

Besides Mexico Ardjanhar, Muis, & Nonci (2008) mention that in Indonesia, in the province of Central Sulawesi, in the Palolo District, *N. testaceipes* is ranked as the third pest in economic importance after *Dalbulus maidis* (De Long, 1923) (Hemiptera: Cicadellidae) and *Ostrinia furnacalis* (Guenee, 1854) (Lepidoptera: Crambidae) in maize crops.

In the sampling carried out in the maize field located in the location of Lomas de San Sebastian el Grande, damage of between 95 and 100% in the leaves of maize was observed. For this variable, no significant statistical differences were found between the sampling points, indicating that the damage was uniform throughout the surface of the sampled crop. Regarding the percentage of visual damage to the leaf located in the third position from top to bottom, an average damage of between 1.3 and 6.1% was observed, with a minimum of one and a maximum of 15% of the leaf blade affected by *N. testaceipes*. It is important to note that the greatest damage was observed in the most developed plants, which were located at points one and two at the time of sampling (Table 1). In the maize field located in the Ejido de San Mateo, the percentage of damaged leaves showed significant statistical differences between the sampling points, which ranged from 63.4 to 93.6%. This may be because the weevils began the infestation at the most damaged points and over time they can homogenize the damage throughout the crop. Regarding the percentage of visual damage to the

leaf located in the third position from top to bottom, no statistical differences were found between the sampling points; leaf damage was observed between 0.7 and 1.6% (Table 1). The different races of native maize can present a certain tolerance to pests due to the coevolutionary process, in this regard authors such as Pérez-Constantino, Sánchez-Escudero, Pérez-Panduro, Garza-García, & Ramírez-Alarcón (2018), they mention that native black maize has a greater tolerance to *N. testaceipes*, compared to native white, blue, and wide-grain maize, such as cacahuacintle. This resistance can be due to mechanism such as antixenosis, which can manifest itself through mechanical resistance (physical barrier such as trichomes, serosity) or through photochemical repellents (phenolic compounds, volatiles, secondary metabolites or pigmentation) which will limit the feeding of insects, as well as oviposition on plants (Fan et al., 2022)

As mentioned above, there are very few works related to *N. testaceipes* and so far no scientific publication has been found that mentions the damage it can cause to maize foliage. In published theses and manuscripts, it is only mentioned as a secondary or occasional pest. Several recent investigations indicate that the weevils can be a pest of economic importance in various agricultural and forestry crops, for example in the Las Huastecas region in the states of Tamaulipas, Veracruz and San Luis Potosí, there are two species of economic importance, the chili weevil [*Anthonomus eugenii* (Cano, 1894) (Coleoptera: Curculionidae)] and the Mexican soybean weevil [(*Rhyssomatus nigerrimus* (Fahraeus, 1837) (Coleoptera: Curculionidae)], which represent a potential threat to soybean and various types of chili production areas (López-Guillén, 2012; Sparks et al., 2022; Guillén & López, 2023; Adeleye, Seal, Martini, Meru, & Liburd, 2024). Recently Tulli, Martiarena, Divita, Inchauspei, & Carmona (2022) reported the weevil [*Listroderes foveatus* (Lea, 1928) (Coleoptera: Curculionidae)] affecting sunflower seedlings at the collar level, significantly affecting plant density in this crop. In forest trees, *Aegorhinus nodipennis* (Hope, 1834) (Coleoptera: Curculionidae) has been reported on birch [*Betula pendula* (Roth, 1788) (Fagales: Betulaceae)], elm [*Ulmus minor* (Mill., 1768) (Rosales: Ulmaceae)], and willow [*Salix* spp. (L. 1764) (Malpighiales: Salicaceae)] (Lencinas, Zamora, & Martínez Pastur, 2021) and in fruit trees such as avocado [*Persea americana* (Mill., 1768) (Laurales: Lauraceae)] the weevils (Coleoptera: Curculionidae) *Macrocopturus aguacatae* (Kissinger, 1957) and *Copturomimus hustachei* (Kissinger, 1957) are mentioned as pests of economic importance (Durán-Peralta et al., 2022; Moreno-Gaviria, Díaz-Grisales, & Carabalí-Muñoz, 2023).

CONCLUSIONS

N. testaceipes was identified as the causative of damage to maize crops in the Amanalco-Valle de Bravo basin region, Mexico. This insect can be found in maize from vegetative stage (V4) to the reproductive stages, but it causes the greatest damage to plants in the stages of development between vegetative stage V5 and V7. This pest has not been studied because it is considered a secondary pest, but it can cause population outbreaks that can significantly affect maize crops if control measures are not taken.

ACKNOWLEDGMENTS

The authors are profusely thankful the producers who allowed us to conduct this research on their crops, as well as the maize field technicians.

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