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Population fluctuation of the pineapple mealybug in two pineapple (*Ananas comosus* [L.] Merr.) varieties in Huimanguillo Tabasco, Mexico

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ABSTRACT

Objective: To identify the pineapple mealybug *Dysmicoccus* spp. and determine its prevalence and seasonal distribution in Huimanguillo Tabasco, Mexico.

Design/Methodology/Approach: This study was carried out in two pineapple producing localities in the municipality of Huimanguillo, Tabasco. The varieties studied were MD2 and Cabezona. The seasonal distribution and infestation percentage was determined in both localities and for both varieties from January to June 2021. Forty plants were randomly sampled per month in a 4-ha area per locality. Roots, stems, basal leaves, and fruits were examined at the plant level.

Results: The highest abundance of pineapple mealybugs (*D. brevipes* sp.) was found in the Cabezona variety. *D. brevipes* is mainly located in 85.46 and 61.76% of the old leaves of the stem, in the Cabezona and MD2 varieties, respectively. From January to April —when the highest temperatures were recorded—, the population of *D. brevipes* was moderate, while the highest populations were recorded towards mid-June, when the rains began.

Study Limitations/Implications: Climatic variables can affect the evaluation parameters. The immature stages dynamics can limit the interpretation of results.

Conclusions: *D. brevipes* is mostly distributed in the lower parts of the plant. To determine the population fluctuation, predict the total number of insects per plant, and establish their temporal and spatial distribution, the entire production cycle must be considered, as well as the climatic parameters, in order to develop a targeted control strategy on dates of moderate abundance.

Keywords: Pineapple mealybug, seasonal distribution, Huimanguillo.

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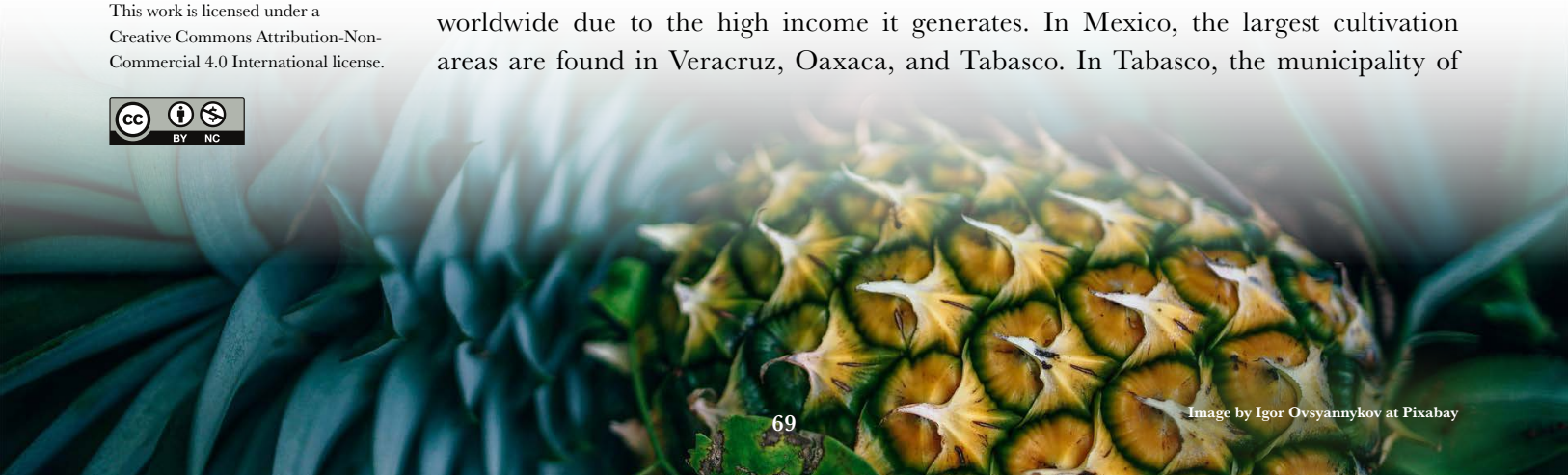
INTRODUCTION

The cultivation of pineapple (*Ananas comosus* (L.) Merr.) is of great importance worldwide due to the high income it generates. In Mexico, the largest cultivation areas are found in Veracruz, Oaxaca, and Tabasco. In Tabasco, the municipality of



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Huimanguillo has the largest area for cultivation. In many localities small producers work in areas of up to 4 ha. For their part, commercial plantations with more than 300 ha use intensive technology in a protected environment, with shade cloth and plastic mulch. The volume of Mexican pineapples exported to the US increased from 25,000 to 100,000 tons/year (Torres *et al.*, 2018). Meanwhile, various environmental and phytosanitary factors have caused a decrease in yields. The management of the negative effect of epidemic attacks caused by pests requires an appropriate solution. The pineapple mealybug (*Dysmicoccus brevipes* (Cockerell)) is one of the insects that has a high impact on the pineapple crop: not only does it cause direct damage by sucking the sap from the plant, but it also is the vector of the virus disease called mealybug wilt of pineapple, which can generate losses of up to 40% of production (Martínez *et al.*, 2006; Bertin *et al.*, 2013). This pest has a large number of hosts. In the Huimanguillo Tabasco region, the taxonomy of *Dysmicoccus* spp., its population fluctuation, and its distribution in plants have not been determined. Therefore, the present study was developed with the objective of identifying the species and to determine the population fluctuation and spatial distribution of *Dysmicoccus* spp. in two pineapple varieties grown in the municipality of Huimanguillo, Tabasco, in order to determine the bases for the agroecological management of this pest in pineapple cultivation.

MATERIALS AND METHODS

Location of the study area

The field work was carried out in two pineapple production areas in the municipality of Huimanguillo, Tabasco, Mexico, where the MD2 variety and a variety locally known as "Cabezona" are grown. Sampling was carried out for six continuous months (January-June 2021), from the beginning of sowing, although fruit samples were also collected during the harvest stage.

El Milagro. The ranch known as "El Milagro" produces pineapples with both conventional (300 hectares) and organic (20 hectares) methods. The latter area was established in 2019. This ranch is located on the way to Estación Zanapa, km 8 S/N, in Ejido Encomendero, municipality of Huimanguillo, Tabasco. It is located at a latitude of 17° 43' 15.63" and a longitude of −93° 41' 37.49", at an altitude of 20 m.a.s.l. Temperatures range from 20 °C to 37 °C, rainfall varies between 34 and 112 mm, and relative humidity fluctuates between 67 and 88% (Weatherspark, 2021). The soils of this region are Cutaneous Umbric Acrisol (Salgado *et al.*, 2017).

La Esperanza. Pineapple production of the variety locally known as "cabezona" was identified in this area. Cabezona is a triploid with fruits of up to 5 kg, large plants, and many thorns on the leaves (Bartholomew & Rohrbach, 2002). This town is located in Ejido La Esperanza, municipality of Huimanguillo, Tabasco, at a latitude of 43° 11' 43.8" and a longitude of 19° 48' 2.7", at an altitude of 24 m.a.s.l. Temperatures range from 20 °C to 37 °C, precipitation varies between 34 and 112 mm, and relative humidity fluctuates between 67% and 88% (Weatherspark, 2021). The soil belongs to the Cutaneous Umbric Acrisol type (Salgado *et al.*, 2017).

Sample processing and identification of the pineapple mealybug

Whole samples of pineapple plants with mealybug individuals were taken to the Laboratorio de Control Biológico of the Colegio de Postgraduados, Campus Tabasco, Cárdenas, Tabasco, where they were identified. The pineapple mealybug specimens were sent for their identification to Mr. Héctor González Hernández (ScD), from the Colegio de Postgraduados, Campus Montecillo, Texcoco, State of Mexico.

The pineapple mealybugs were processed following the mounting technique for scale insects (Hemiptera: Coccomorpha) developed by Kosztarab (1963). This method is an adaptation, with minor changes, of the procedure used for micro-insect mounting established by the U.S. Department of Agriculture (USDA).

H. González Hernández identified the pink pineapple mealybug, using the keys developed by Williams and Granara de Willink (1992).

Seasonal distribution of *D. brevipes* in two varieties of pineapple from two locations in Huimanguillo Tabasco, Mexico

To determine the seasonal distribution of *D. brevipes* in the two locations and two pineapple varieties, a random destructive sampling was used, in the form of a diagonal line, according to a method modified by González Hernández *et al.* (1999). This method consisted of taking 10 plants/ha, sampling one plant every 25 m, with 10 m between double rows. In total, 40 plants were sampled in the 4 ha of the study's sampling area. The mealybugs present on each uprooted plant were counted with the aid of a magnifying glass. The counts were made directly in: A) roots and underground stems, B) basal leaves of the stem at ground level, and C) fruits (Figure 1).

Analysis of data

To determine the incidence, distribution, and population fluctuation of the pineapple mealybugs (*D. brevipes*) found in the organs of the plants evaluated in both study areas,

Figure 1. Parts of the plants sampled A) roots and underground stems, B) stem leaves at ground level, and C) fruits.

monthly registration was carried out in Microsoft Excel. An analysis of variance was made for each of the evaluated variables, in which the locality/variety and the sampling month were considered as variation sources. Likewise, a multiple comparison test of means was carried out using Tukey's test (SAS, 2012).

RESULTS AND DISCUSSION

The mealybug species detected in the two localities with pineapple plantations in this study was *Dysmicoccus brevipes* (Cockerell) (Hemiptera: Pseudococcidae): the pink pineapple mealybug (Figure 2), a species of cosmopolitan distribution, already reported in pineapple, grasses, and agaves in Mexico (Williams & Granara de Willink, 1992).

In the case of the number of *D. brevipes* adult females in the pineapple stem basal leaves, highly significant statistical differences were found between both localities and varieties ($p<0.0001$). The highest number of pineapple mealybugs was found in Ejido La Esperanza, in the Cabezona pineapple variety, with an overall average of 84 individuals per plant during the 6 months sampled. Meanwhile, in El Milagro ranch, the MD2 variety had a lower number of individuals, with an average of 25 adults of *D. brevipes*. The highest number of pineapple mealybugs detected was 120 adult females per plant in the month of June 2021 for the La Esperanza/Cabezona combination, while the highest number of adult females was recorded with the El Milagro/MD2 combination during the

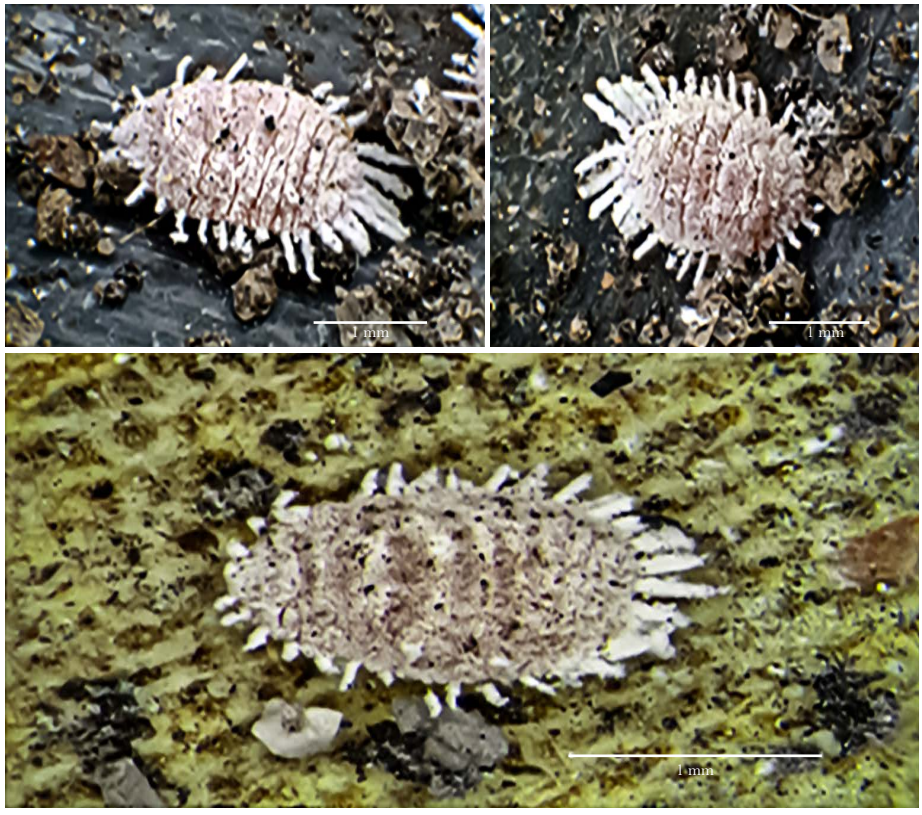

Figure 2. Adult females of *D. brevipes* (photo by H. González-Hernández, 2021).

month of May 2021 (11 pineapple mealybugs per plant); a slight increase was recorded in June (Figure 3 A).

Regarding the presence of *D. brevipes* in the root zone of the pineapple plant, highly significant statistical differences were also found between both locations/varieties ($p<0.0001$), although the population of pineapple mealybugs at the base of the stem was very small compared to the above results. The highest number of *D. brevipes* was recorded by the La Esperanza/Cabezona combination (up to 4 individuals per plant), while the El Milagro/MD2 combination registered the highest number of individuals in May 2021, with an average of 2 pineapple mealybugs (Figure 3 B).

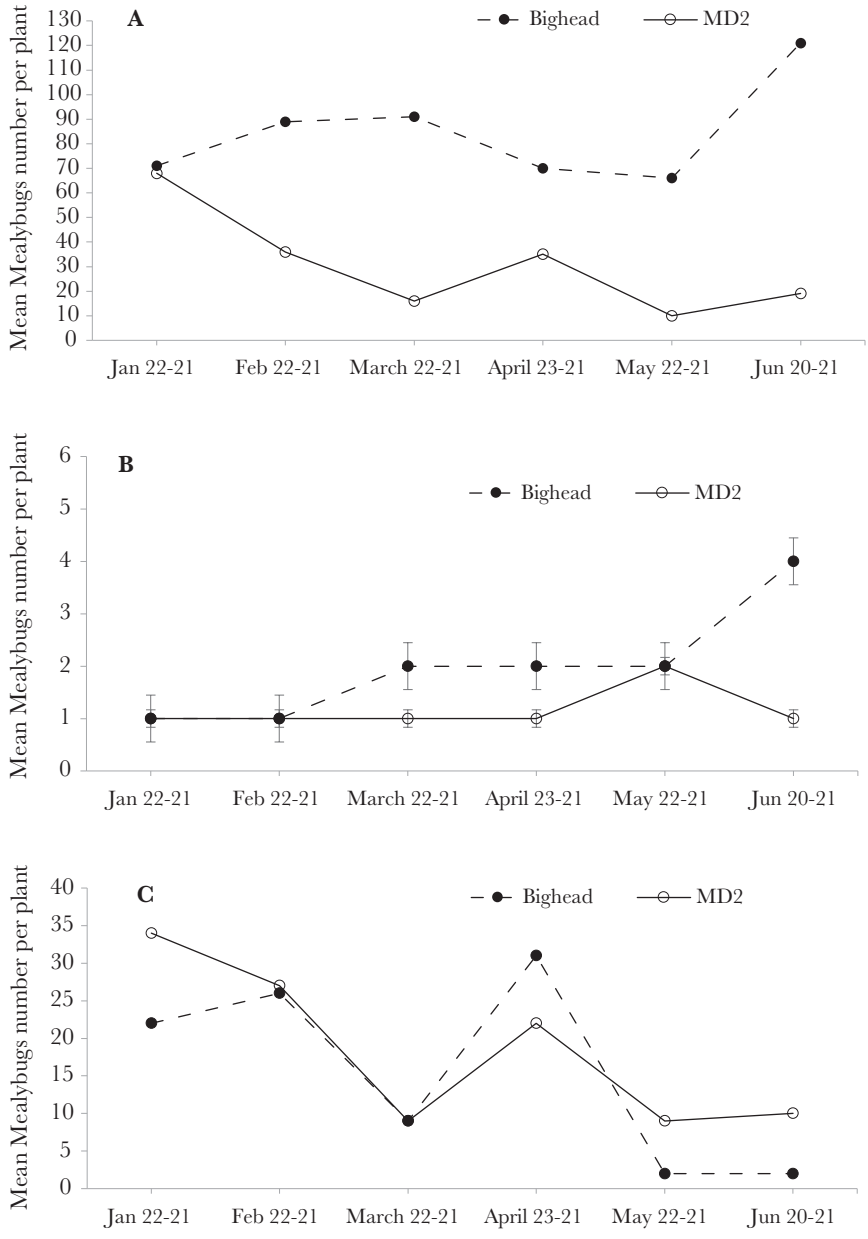

Figure 3. Prevalence of *D. brevipes* in A: Stem and basal leaves, B) roots and C) fruits of pineapple, from January 22, to June 20, 2021, in two areas and varieties in Huimanguillo Tabasco, Mexico.

However, both locations/varieties also show significant statistical differences ($p<0.05$) regarding the number of *D. brevipes* individuals in the fruit. Contrary to what happens in the root and stem leaves, in MD2 fruits sampled at the El Milagro ranch, the highest number of *D. brevipes* was found in January, with up to 34 individuals of the pineapple mealybugs (Figure 1 C)

Regarding the distribution of *D. brevipes* among the sampled parts of the pineapple plant, a higher percentage of infestation was observed in stem leaves (85.98%), fruit (13.71%), and root (0.013%) of the Cabezona variety in La Esperanza. Meanwhile in El Milagro, the percentage infestation of MD2 was higher in stem leaves (61.76%), fruits (37.55%), and root (0.68%) (Figure 4).

Regarding the seasonal distribution and the infestation percentage by *D. brevipes*, the results indicate that there were significant differences ($p<0.0001$) between the locations/varieties of pineapple: the infestation percentage of the Cabezona variety was higher in Ejido La Esperanza.

The Cabezona variety cultivated in approximately 200 ha of Ejido La Esperanza has a minimal agronomic management, especially regarding *D. brevipes*. In some cases, this management is completely deficient, as a consequence of several criteria, including scarce knowledge of the producer about these problems. For example, pineapple mealybugs and their associated ants are exclusively managed applying insecticides (such as diazinon and chlorpyrifos) once or twice per crop cycle. Insecticides are applied at the beginning of sowing (November-December) and in the middle of the cycle (July-August). Consequently, an increasing trend of *D. brevipes* is observed from February to June in the Cabezona variety. The areas harvested and awaiting destruction for subsequent pineapple plantations lack an adequate management; therefore, they are sources of *D. brevipes* reproduction (Mau and Martín, 1992). Likewise, the edges of the plantations are totally infested with weeds, which could be reservoirs of this pest (Martínez *et al.*, 2006, García De la Cruz *et al.*, 2021).

Meanwhile, the lower abundance of *D. brevipes* in the MD2 variety can be explained in part by aspects of agronomic management. This study was also carried out in the Agrícola San Pablo company. The plantations of this company (including El Milagro ranch) grow

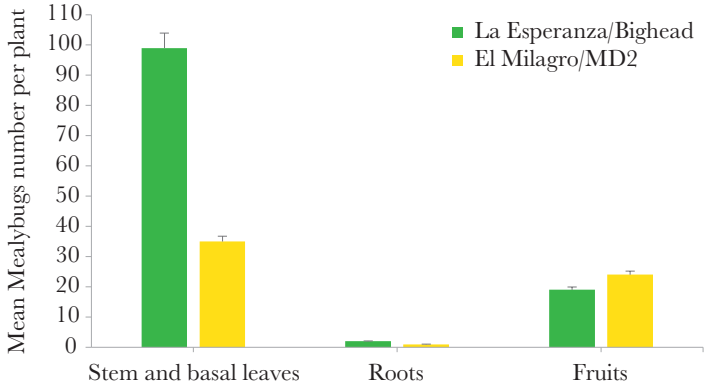

Figure 4. Prevalence and overall distribution of *D. brevipes* in pineapple plants from January to June 2021, in two locations/varieties of Huimanguillo Tabasco, Mexico.

commercial MD2 pineapple and Persian lime. This variety is grown in approximately 287.24 ha. Currently, the company owns 48 plantations more where MD2 pineapple production is carried out in more than 300 ha. Those pineapples are in different stages: development, production, and nurseries. In this ranch, the agronomic management of the plantations is done in a planned and intensive manner, making use of high-tech, since the production is frequently exported. To manage *D. brevipes*, the company carries out sanitation pruning after harvest, applies herbicides such as Paraquat to finish the crop, and destroys and incorporates harvest residues. It also carries out a chemical control program based on class 1B organophosphate insecticides Diazol 50 EW® (diazinon) and class 3B pyrethroids (cypermethrin). These products are applied bimonthly, together with other chemicals; they are regularly applied in the foliar area using a boom sprayer. However, this type of pest management could lead to a scenario where pineapple mealybug becomes resistant to constantly applied insecticides (Venkatesan *et al.*, 2016). Pineapple production will continue to increase in the future and, therefore, looking for eco-friendly management strategies (such as the use of more selective products with low impact on beneficial fauna) must be a priority, within a comprehensive pest management arrangement. These strategies would allow producers to sustainably manage this pest.

The monthly temperature data recorded for the municipality of Huimanguillo from January to June 2021 was 26, 30, 29, 33, 37, 34 °C, respectively (Figure 5). It is inferred that these conditions favor the proper development of *D. brevipes*, since its population does not undergo dramatic changes. Bertín *et al.* (2019) mention that a total of 678.4 degree-days are required to complete the development from the first nymphal instar to the adult stage and that the most favorable temperature for the optimal development of *D. brevipes* is 30 °C.

Regarding the seasonal distribution and the percentage of *D. brevipes* infestation, the results indicate that there were significant differences ($p<0.0001$) between the pineapple varieties. The infestation percentage was higher in the Cabezona variety. This variety shows a vigorous growth and has very large plants and high Fe content in its leaves (Murillo *et al.*, 2019); consequently, the lower parts of the plant (basal stems, old leaves and roots)

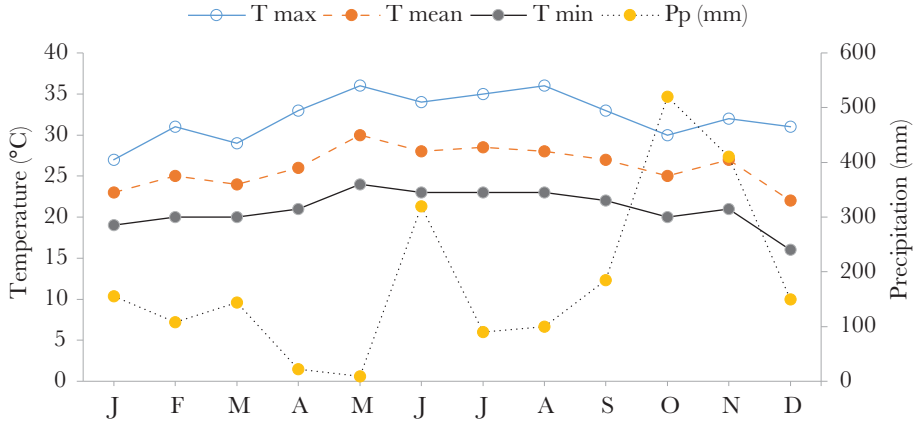

Figure 5. Fluctuation in temperature and rainfall (monthly mean) during 2021, around pineapple fields in Huimanguillo, Tabasco.

receive less light and are more susceptible to pests, which find better conditions for their development (Valdes *et al.*, 2019). The lower parts of the plants have a greater number of colonies; the curvature of the old basal leaves protects pineapple mealybugs from light or natural enemies. It also reduces the efficiency of the chemical products applied to control them (Valdes, 2019; Hernández and Peña, 2009). According to Mau and Martín (1992), Ciesla (2000), and Cermeli *et al.* (2002), mealybugs have been detected sucking the sap of any part of the plant; they prefer to attack the base of the leaves of smaller plants. Meanwhile, in older plants, the infestation passes through the stems until it reaches the fruit. This study shows that *D. brevipes* attacks various parts of the plant and the fruit of both varieties. It has medium impact on the MD2 variety, because it can lead to its rejection as an export fruit.

Our findings match those of Valdes *et al.* (2019), who showed that *D. brevipes* feeds on any external part of the plant and that, undoubtedly, prefers to attack the base of the stem and leaves in the semi-underground part, where ant colonies are also found. The seasonal distribution varies notably according to the time of year since, according to Valdés *et al.*, (2019), pineapple mealybugs are generally located in the lowest stratum of the pineapple plant during the dry season, while in the rainy season they tend to be found in the axils of intermediate leaves.

CONCLUSIONS

Dysmicoccus brevipes (Cockerell) is found in both localities, both in the MD2 and in the Cabezona varieties. The population of this mealybug species tends to increase towards the beginning of the rainy season, starting in June. This insect feeds on various parts of the plant, with special preference for the lower parts (stem and basal leaves), at the semi-subterranean level. Based on these data, we can infer that the sanitary management aspects of this pest must be directed from the beginning of the plantation, using healthy propagation materials and sustainable agroecological management programs, according to the population levels detected in this study.

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