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Population dynamics of the pasture leafhopper complex (Hemiptera: Cercopidae) in brachiaria and mombasa grass

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Abstract

Pasture leafhoppers are considered highly important pests in forage grasses in Brazil due to their widespread occurrence. This insect is one of the most relevant pests in pasture degradation. In order for the control of spittlebugs to be efficient, it is important to know the population behavior of the species of this insect, identify the period of greatest occurrence, as well as the climatic and environmental conditions that favor the development of the pest. Thus, this study aimed to evaluate the population dynamics of spittlebugs, at a quantitative level, in *Brachiaria decumbens* and *Panicum maximum* pastures, associating the results with meteorological data from the municipality of Conceição do Araguaia, Southeast Pará. To study the population dynamics of spittlebugs, samples were taken every two weeks, in two types of pastures aged between 5 and 7 years, kept under rotational grazing, with a stocking of 1.5 animal units. The method of monitoring nymphs and adults of leafhoppers was adopted, through walking within the observation area. The level of infestation of spittlebugs in both forage species was evaluated and all results were submitted to analysis of variance by the F test. It was found that the species *B. decumbens* had a greater number of adults and nymphs when compared to the forage species *P. maximum*. The population dynamics of spittlebugs occur gradually according to climatic conditions, and the period with not-so-high temperatures (22 ºC to 34 ºC) and good rainfall provide an infestation of this insect pest in the pasture.

Keywords: Insect-Prague. Pasture. *Brachiaria decumbens*. *Panicum maximum.*

Introduction

Pasture leafhoppers belong to the order Hemiptera and the family Cercopidae, which are considered pests of great importance in forage grasses in Brazil due to their widespread occurrence, high infestation levels, and the severe damage caused (VALÉRIO, 2009). The main species attacking pastures are *Zulia entreriana*, *Deois flavopicta*, *Deois schac, Mahanarva* spp.*,* and others that also have great economic importance (BORGHI *et al*., 2018).

Leafhoppers are insects known as one of the most critical pests associated with pasture degradation, with a suction-type mouthpiece. In the adult stage, they live in the aerial part of the host plant, and when nymphs, they protect themselves at the base of the covered plants by white foam, characteristic of those species (BORGHI *et al*., 2018).

There is no isolated method to control the leafhopper pest efficiently. Still, a set of measures is recommended (Integrated Pest Management); for example, cultural, chemical and biological control to minimize pest damage to pastures (TOWNSEND *et al*., 2001). However, to guarantee an effective and economically viable control, it is essential to know the leafhopper population behavior, identify the period of greatest occurrence, and the climatic and environmental conditions favoring the insect's development (BERNADO *et al*., 2003).

The damage caused by leafhoppers varies from each grass species, and the economic losses can be considerable depending on the location, climatic conditions, and management (BERNARDO *et al*., 2003). Several species of leafhoppers occur in pastures of Brazil, with some of them having economic relevance. Depending on the region, the predominant species may vary. Despite being morphologically similar, leafhopper species may have different preferences and damage capabilities (VALÉRIO, 2006).

As for the susceptibility of species to the leafhopper attack, grasses of the *Brachiaria* genus are preferentially attacked by these insects (BORGHI *et al*., 2018), as verified by scientific studies, such as the one carried out by Auad *et al*. (2009) and Pereira *et al*. (2018). These studies found a higher leafhopper population density in the *Brachiaria brizantha* and *Brachiaria decumbens* species, respectively. Studies showing leafhopper occurrence in species of the Panicum genus are poorly studied, justifying this work's development.

Grasses from the Brachiaria and Panicum genera constitute one of the main species making up the ruminant diet in Brazil, being the first most prevalent in the Cerrados regions, and considered the Brazilian cultivated pastures base. Also, the Panicum species are the most important for cattle production in tropical and subtropical regions (CORRÊA; SANTOS, 2003).

Leafhoppers occurrence in pastures has been one of the leading causes for pastures' degradation in Brazil (VALÉRIO, 2009). Thus, obtaining knowledge of leafhoppers' population dynamics is relevant for more efficient decision-making regarding the season and management type to be adopted in its control.

Therefore, the objective was to evaluate leafhopper population dynamics, at the quantitative level, in pastures of *B. decumbens* and *P. maximum*, associating the results with meteorological data.

Material and methods

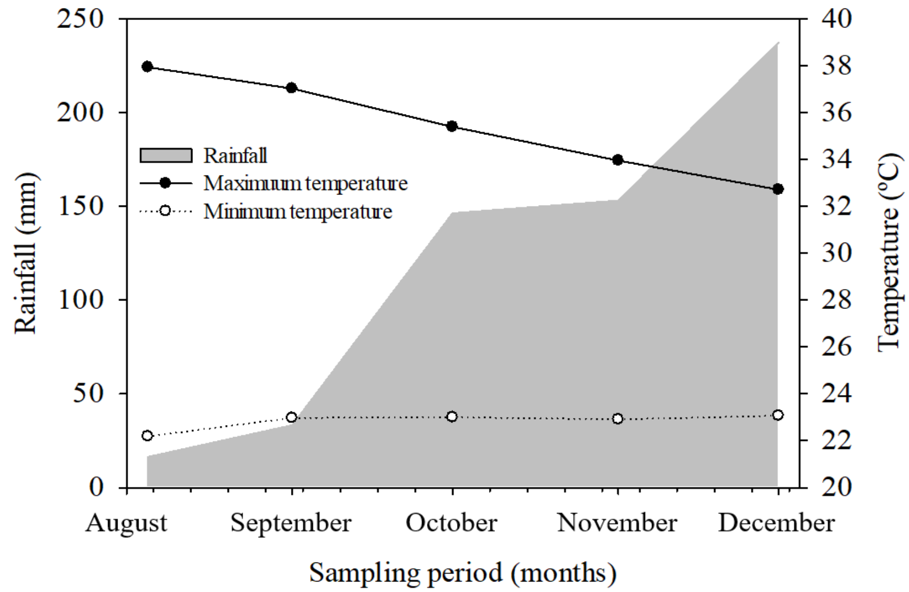
The work was carried out at the Paraíso property, located 10 kilometers from the municipality of Conceição do Araguaia, Pará, on the banks of the PA-287 road. The municipality of Conceição do Araguaia, in the State of Pará, belongs to Mesorregião Sudeste Paraense, with municipal headquarters located at 08º16'S; 49º16'W and 157 m altitude. The region's climate, classified according to Köppen-Geiger, falls under the category of dry, humid equatorial in winter, type Aw. The average annual temperature is 26.1 ºC and has an average annual rainfall of 1,734 mm.

The research started in August 2018 and ended in December of the respective year. The meteorological data for the sampling months are available in Figure 1. It was possible to observe a variation of the maximum temperature between 37.93 ºC and 32.71 ºC, while the minimum temperature varied between 23.07 ºC and 22.19 ºC. The total rainfall increased gradually from August to December, obtaining a value of 221 mm higher in the last month of sampling (December) when compared to the first month (August).

Biweekly samplings were carried out in two types of pasture, *B. decumbens* and *P. maximum* cv. Mombasa, aged 7 years and 5 years, respectively, kept under rotational grazing, with a capacity of 1.5 animal units.

The leafhopper nymphs and adults monitoring method was adopted in this study by walking inside the observation area in a zigzag form (VALÉRIO, 2005). The population survey of nymphs was carried out based on the counting of foam masses number at the foot of the plant (soil level), using as a reference a square iron frame with dimensions of 0.25 m x 0.25 m, thrown at random, for defining a sampling point (PEREIRA; BENEDETTI; ALMEIDA, 2008). After the pitch, the total number of foam masses within the square delimited area was quantified, and

Figure 1 – Climogram of rainfall, maximum and minimum temperature from August 2018 to December 2018, in Conceição do Araguaia, Pará, Brazil.



Source: Instituto Nacional de Meteorologia (2020).

the result was expressed as the foam masses' average number per square meter.

The method used for sampling adults was through scanning with entomological net, with a 40 cm diameter arc, sampling at 10 points at random, describing a random trajectory within the pasture area (LOHMANN; PIETROWSKI; BRESSAN, 2010).

At each sampling point, 10 sweeps were carried out with the net, and the insects obtained at each sampling point were packed in plastic bags and sent to the Entomology Laboratory of the IFPA - Conceição do Araguaia Campus, where the species were screened, selecting the insect species of interest (leafhoppers). The leafhopper species identification was carried out with the aid of a binocular stereomicroscope with LED (light-emitting diode) model DI-224, to visualize the insects' structures and the use of identification keys.

The experimental units had 100 square meters, and the experimental design adopted was randomized blocks, with two treatments and ten repetitions. The treatments consisted of the study area (forage species) and the periods (time of monitoring), considering each monitoring performed as a repetition. The meteorological data (precipitation, average daily maximum and minimum temperature) were obtained through the National Institute of Meteorology database, Automatic Station of Conceição do Araguaia (INMET, 2018).

The level of infestation of leafhoppers in both forage species was evaluated. All results were subjected to analysis of variance by the F test. The averages of the forage species and monitoring time and their interaction were compared by the Tukey test at the level of 5 % probability. When there was an interaction between the factors studied, Pearson's correlation analysis was performed. The statistical analysis and plotting of the graphs were performed with the software Sisvar 5.4 (FERREIRA, 2011) and SigmaPlot 10.0 aid (SYSTAT SOFTWARE, 2006).

Results and discussion

The analysis of variance (TABLE 1) demonstrated a significant interaction for the factors of forage species and sampling times when observing the number of adult leafhopper infestations. The number of foams per square meter was significant only for the sole factor of forage species.

According to the averages test for forage species, it was noted that *B. decumbens* had a higher number of adults and nymphs compared to the *P. maximum* forage species. The sampling time showing the highest adult number was December, followed by November. The other months did not differ statistically from each other by the Tukey test, just as there was no statistical difference for the foam number (TABLE 1).

Table 1 – Analysis of variance and test of means for the number of leafhoppers adults and number of foams as a function of forage species and sampling time.

Source of variation	Mean squares	
	Number of adults	Number of foams m^{-2}
Forage species (FS)	1685.50 **	1513.80 **
Sampling period (SP)	180120.20 **	21.5750 ^{NS}
FS x SP	1448.70 **	9.425 ^{NS}
CV (%)	9.95	22.12
	Averages for forage species	
Brachiaria decumbens	235.40 ± 36.75 a	23.6 ± 3.69 a
Panicum maximum	45.60 ± 9.09 b	6.20 ± 2.93 b
	Averages for the sampling period	
August	124.25 ± 91.10 b	17.75 ± 9.36 a
September	126.25 ± 84.51 b	13.00 ± 9.97 a
October	134.25 ± 90.08 b	12.75 ± 6.87 a
November	143.00 ± 82.97 ab	14.00 ± 8.15 a
December	174.75 ± 128.41 a	17.00 ± 10.56 a

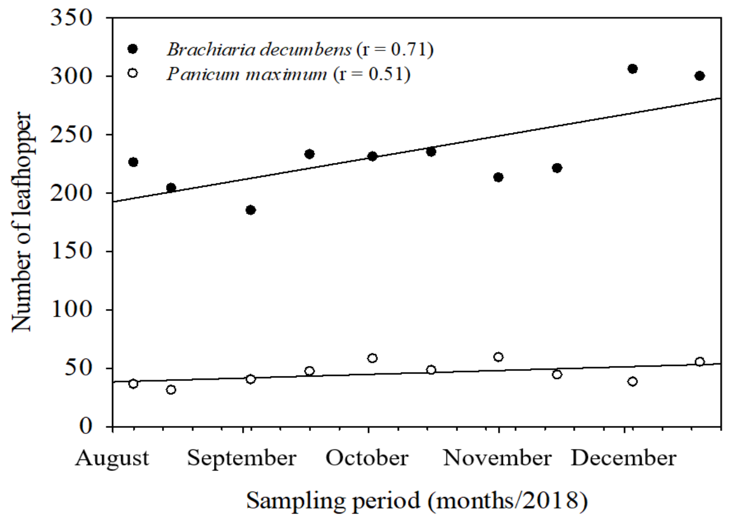
CV = Coefficient of variation. ns = not significant, ** = significant by F test at 1 % probability. Means followed by the same letter in the columns are statistically equal by the Tukey test at 5 % probability.

Source: Elaborated by authors (2021).

The interaction between the factors of forage species and sampling time is illustrated in Pearson's correlation in Figure 2. There was a notable increase in the leafhopper infestation level as the period approached December, mainly in the pasture composed by *B. decumbens* species, presenting the highest absolute value of the determination coefficient (r = 0.71). On the other hand, *P. maximum* grass showed little influence of the sampling period on the leafhopper infestation level (r = 0.51).

It is worth mentioning that December, whose infestation of this insect pest was more accentuated, coincides with the period that occurred the highest total rainfall (237.3 mm) and average maximum and minimum temperatures of 32.71 ºC and 23.07 ºC, respectively (FIGURE 1). Thus, it is possible to infer those environmental factors influence the leafhopper population dynamics and their reproductive potential, with temperature and humidity being the most relevant climatic parameters in this context (GARCIA *et al*., 2011; TEIXEIRA; SÁ, 2010).

Figure 2 – Pearson linear correlation for the number of leafhoppers adults as a function of the sampling period.



Source: Elaborated by authors (2021).

This information corroborates the current work compared with the abiotic parameters (precipitation and temperature). Townsend *et al*. (2001) declared a greater leafhopper population occurrence in the State of Rondônia between December and February, justifying the climatic conditions corresponding to the region's rainy period.

Regarding climatic and environmental factors, the leafhopper attacks can occur with greater severity in the greater precipitation and higher temperatures period compared to others when the conditions were not so favorable (period of drought), a fact which is directly related to the largest population of this insect whose climatic conditions are ideal (DIAS-FILHO, 2017).

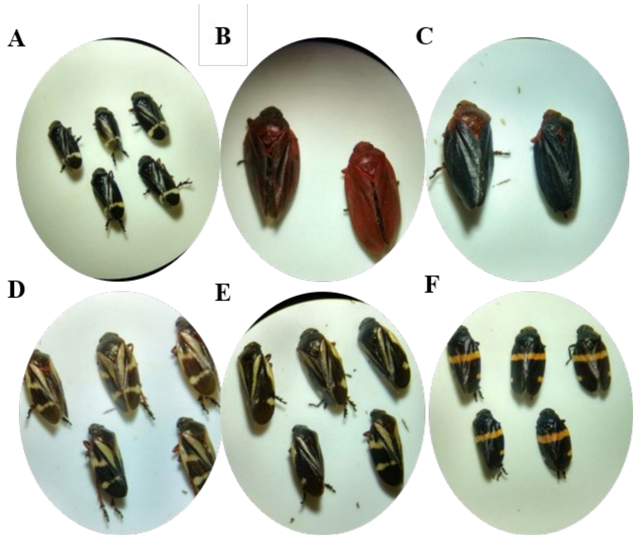
It is noteworthy that the beginning of the rainy season favors the infestation of leafhoppers, due to its mild temperatures and high humidity. In unsuitable conditions, the pasture leafhopper eggs may not hatch, causing diapause (acquiescence). It corresponds to a rest period and may remain like that until the end of the dry period, showing a dependence on climatic conditions for good performance of its biological cycle (SANTOS; SARAIVA, 2019).

The species that occurred in both sampled pastures are shown in Figure 3. The identification in the laboratory demonstrated the presence of *Notozulia entreriana*, *Mahanarva* sp., *D. flavopicta*, *Deois incompleta,* and *Aeneolamia colon*. The identified species agree with those reported in the literature regarding the main occurring leafhopper species in Brazil, namely: *Z. entreriana*, *D. flavopicta*, *D. incompleta*, *D schach*, and *Mahanarva fimbriolata* (TOWNSEND *et al*., 2001).

The occurrence of species was higher in the pasture with *B. decumbens* (POE = 6) than in *P. maximum* (POE = 4) (FIGURES 4A and 4B). Note that the leafhopper species *D. incompleta* and *A. colon* had the highest number of individuals in the pastures of *B. decumbens* and *P. maximum*, respectively, with an occurrence percentage per species of 55.41 % for *D. incompleta* and 81.37 % for *A. colon* (FIGURE 4).

This greater occurrence in a forage species is related to grass susceptibility. According to Townsend *et al*. (2001), *B. decumbens* has a high leafhopper infestation susceptibility compared to *P. maximum*, which is considered resistant to the pest attack. For that reason, pasture diversification becomes essential to minimize insect pest severity.

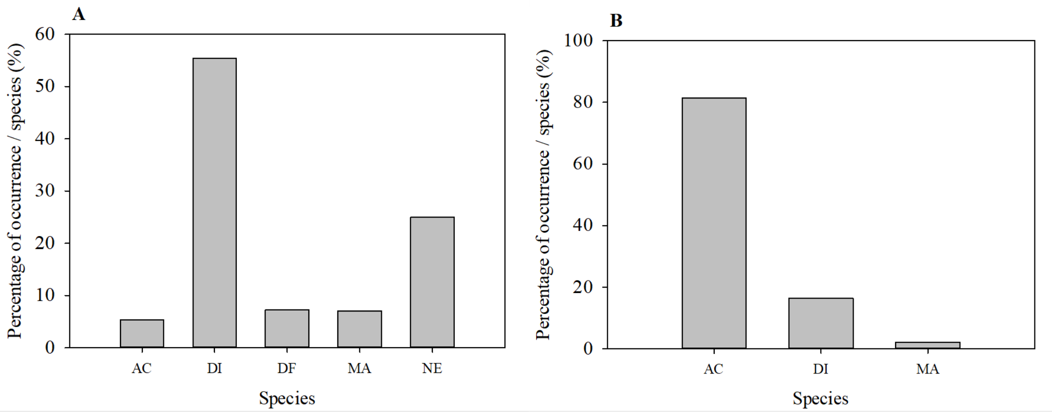
Figure 3 – Species of leafhoppers cataloged in the forages *Brachiaria decumbens* and *Panicum maximum* in Southeast Pará.



A = *Notozulia entreriana*, B = *Mahanarva* sp., C = *Mahanarva* sp., D = *Deois flavopicta*, E = *Deois incompleta* and F = *Aeneolamia colon*.

Source: Elaborated by authors (2021).

Figure 4 – Percentage of occurrence by species (POE) of leafhoppers in *Brachiaria decumbens* (A) and *Panicum maximum* (B).



AC = *Aeneolamia colon*, DI = *Deois incompleta*, DF = *Deois flavopicta*, MA = *Mahanarva* sp. and NE = *Notozulia entreriana*.

Source: Elaborated by the authors (2021).

It is worth mentioning the isolated occurrence of the leafhopper species *D. flavopicta* and *N. entreriana* in the grass *B. decumbens*, not being found in the *P. maximum* pasture. These same species were also observed in pastures of *B. decumbens* and *B. humidicola* in the mid-north of Mato Grosso (BERNARDO *et al*., 2003). Therefore, a preferential habit for grasses of the *Brachiaria* genus is visible, corroborating Borghi *et al*. (2018). It is more susceptible to forage species of the *Brachiaria* genus. It is related to the planting area intensification with *B. decumbens* and *B. humidicula* in a short time, causing biological imbalance.

Conclusions

The leafhopper population dynamics occur gradually according to the climatic conditions; periods with not-so-high temperatures (22 ºC to 34 ºC) and good rainfall provide an infestation of this insect pest in the pasture.

Brachiaria decumbens are more susceptible to the leafhopper attack than *Panicum maximum*, and some leafhopper species prefer attacking *B. decumbens*, such as *Deois flavopicta* and *Notozulia entreriana*.

Further studies are recommended, under the edaphoclimatic conditions in which this work was conducted, to assess the population dynamics of these insect pests during longer sampling periods and correlate the results with the pasture management type and different forage species.

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