Neotropical Entomology

ISSN: 1519-566X

journal homepage: www.scielo.br/ne

ECOLOGY, BEHAVIOR AND BIONOMICS

Cassava Shoot Infestation by Larvae of *Neosilba perezi* (Romero & Ruppell) (Diptera: Lonchaeidae) in São Paulo State, Brazil

L Gisloti, A P do Prado

Lab de Entomologia, Depto de Biologia Animal, Instituto de Biologia, Univ Estadual de Campinas, Campinas, SP, Brasil

Keywords
Manihot esculenta, parasitoid, shoot fly

Correspondence
Laura Gisloti, Lab de Entomologia, Depto de Biologia Animal, Instituto de Biologia, Univ Estadual de Campinas, CP 6109, 13.083-862, Campinas-SP, Brasil; lauragisloti@gmail.com

Edited by Wesley A C Godoy – ESALQ/USP

Received 22 April 2010 and accepted 06 October 2010

Abstract

Among the pests of cassava, the shoot fly, *Neosilba perezi* (Romero & Ruppell), is one of the most prevalent. It attacks mainly the terminal shoots and causes infested plants to produce lateral shoots. Reports on this species are rare or inexistent; thus, the purpose of this study was to assess three different areas for *N. perezi* infestation. The survey began in March 2008 and finished in February 2009. Fortnightly analyses were performed starting 45 days after planting, calculating the rate of infestation by *N. perezi* larvae in each study area. The areas were correlated separately for each parameter: fortnightly mean temperature, fortnightly mean rainfall, and plant age. The *N. perezi* larvae occurrence rate was higher in area 1 – which presented the highest population peaks in autumn and winter. There was only a single population peak in area 2, in winter; and area 3 presented the weakest population peak among the three, in November. The shoot fly population dynamics in the studied region is separately correlated to temperature, rainfall and plant age: temperatures above 23ºC, relatively high rainfall and older plants seem to have a negative effect on populations of this insect.

Introduction

Neosilba perezi (Romero & Ruppell) is known as the cassava shoot fly, but unlike the other species of this genus, its larvae feed exclusively on shoots of cassava (*Manihot esculenta*) (Euphorbiaceae). Females lay their eggs among the apical leaves of the shoots, or in small cavities made with the ovipositor; the white-colored larvae tunnel through the soft tissues of the plants and injure their terminal buds, which can retard normal plant growth and induce lateral budding (Bellotti & Schoonhoven 1978, King & Saunders 1984, Hogue 1993).

The cassava shoot fly is Neotropical in origin and was first reported in Brazil in the 1940s (Graner 1942, Zikan 1944), by authors who referred to it as *Lonchaea pendula* (Bezzi). Indeed, the taxonomic difficulty of distinguishing among Lonchaeidae species also applies to *N. perezi,* and many papers refer to it as *Silba pendula* (Bezzi) (Brinholi *et al* 1974, Bellotti & Kawano 1980, Montaldo 1985).

The distribution of *N. perezi* is apparently restricted to the Americas, with specimens already found in South (Hershey 1987, Bellotti *et al* 1999), Central and southern North America (McAlpine & Steyskal 1982, Saunders *et al* 1998 Fhia 2003, Bellotti 2004). Waddill & Weems (1978) believe that *N. perezi* was introduced in Florida *circa* the 1960 as a result of intense Cuban immigration to Miami, thereby providing major losses to cassava production in the region.

Despite the widespread distribution of *N. perezi* in the Neotropical region, the damage caused by its larvae to cassava crops is apparently restricted to stem production and does not impair root yield (Lozano *et al* 1981, Bellotti 2002). In Brazil, *N. perezi* is found mainly in coastal and inland São Paulo state (Lourenção *et al* 1996), and in southern Bahia (Farias *et al* 2005). The objectives of this work were to elucidate some aspects of cassava shoot infestation by *N. perezi* larvae; investigate the possibility of correlations between *N. perezi* infestation and plant age, local temperature and/or local rainfall in the southeastern São Paulo state.

Material and Methods

This study was conducted from May 2008 to February 2009 in three cassava organic production areas of the State of São Paulo, using variety IAC 576-70. The first (Area 1) is located on SP 340 Highway, km 144, in the municipality of Jaguariúna, (22°40'20'' S 46°59'09'' W, mean altitude 584 m). The second property (Area 2) is located on SP 147 Highway, km 49.6, in the municipality of Mogi Mirim (22°25'55''S, 46°57'28''W, mean altitude 588 m) and the third property (Area 3) is located on SP 340 Highway, km 138, also in the municipality of Jaguariúna. Area 1 is located 6 km away from Area 3 and roughly 40 km from Area 2.

According to Setzer (1976), the regions are inserted in a climatic transition between very humid subtropical with marked dry seasons (Mu-Cw), with mean temperatures around 24°C and minimum temperatures around 16°C in the summer. Mean annual precipitation is about 1,300 mm/year and the predominant soil type in the studied areas is Latosol with good aeration, permeability and drainage.

The assessments began in May in area 1, June in area 2, and August in area 3, forty-five days after planting each one, in order to guarantee that shoots would be susceptible to *N. perezi* oviposition. The three cassava plantations were set up similarly, with plants spaced approximately 0.5 m apart along rows which were, in turn, 0.90 m from each other. Plant density was approximately 1,000 plants in all areas.

Sampling by total count was performed in each area at fortnightly intervals, upon which the number of plants with shoots damaged by the larvae was recorded. Infestation damage to the cassava plants from *N. perezi* larvae was determined from visual symptoms, because its larva causes a yellowish secretion on shoots.

Infestation rate in each cassava crop area was estimated as the number of plants infested by the *N. perezi* larva divided by the number of plants in the respective study area, multiplied by 100 {(%P = number of plants with parasite in the plantation / total number of plants in the plantation) X 100}, from the 45th to the 300th day after planting. After this period, the plants were no longer assessed as it was almost harvest time and the infestation rate was approximately zero.

Infestation rate in each area was separately correlated with the following factors: local mean temperature (Cº), local mean precipitation (mm) and plant age. The meteorological data were provided by the Centro Integrado de Informações Agrometeorológicas (CIIAGRO - Jaguariúna 22°40' S, 46°59'W) and by the meteorological station installed in Mogi Mirim (Agritempo, 22°43' S, 46°95' W). The climate data used in this study were the mean values in the 15 days prior to each sampling event, based on the daily records obtained from the meteorological stations in each area. The area 1 is located about 0.6 km of CIIAGRO, the area 2 is located about 3 km of the meteorological station installed in Mogi Mirim, and the area 3 is located about 3 km of CIIAGRO.

Variance testing was applied to the infestation rate data and the total number of emerged parasitoids from each area. The Kolmogorov-Smirnov (Lilliefors) test was used to check for normality, and samples that presented normal distribution and equal variances were submitted to ANOVA testing. Tukey tests were applied to the data that produced significant ANOVA results, in order to specify which groups were different between themselves. The correlations for each area were calculated separately for each parameter (temperature, precipitation and plant age) using Pearson's correlation coefficient (Zar 1999). The software used to process and analyze the data was BioEstat v5.0, set to a 5% significance level (Ayres *et al* 2007). All specimens are deposited in the Coleção Entomológica do Departmento de Biologia Animal, Universidade Estadual de Campinas (Unicamp).

Results and Discussion

Similarly to the work of Lourenção *et al* (1996), larvae of *N. perezi* were found on all months at the three different properties, with several peaks, mainly during the vegetative growth, but at much lower frequencies when the plants were close to harvesting. There was no statistical difference among the three areas in terms of mean infestation rate during the analyzed period ($P > 0.05$), but area 3 presented the smallest population peak compared to the other two.

The population dynamic of *N. perezi* larvae from May 2008 to January 2009 in Area 1 showed three peaks during the autumn and winter, with the first appearing in June 2008 (%P = 44.1), the second in July (%P = 46.2) and the third in early September (%P = 37.0). After September, there was a drastic reduction in the rate of infestation by *N. perezi* larvae, due to the dry period. In area 2, there was only one population peak, in winter (%P = 35.0 in August); infestation rate drastically declined after September, as in the other areas. Area 3 presented the smallest population peak (%P = 33.4 in November), which declined considerably after December until the last evaluations (Fig 1). This low rate of *N. perezi* larva occurrence in area 3 may be associated with a forest fragment near the area. This fact should be verified in further studies, to determine the hypothesis of available plant hosts,

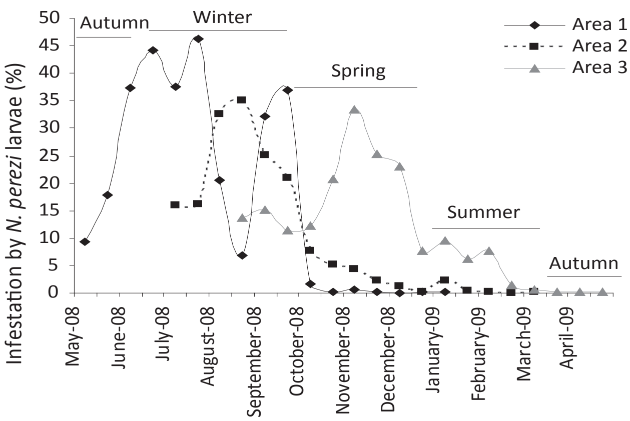

Fig 1 Infestation by *Neosilba perezi* as measured by the percentage of cassava plants infested with the larvae in three cassava crop areas in southeastern São Paulo State, Brazil, from May 2008 to April 2009.

migration or occurrence of natural enemies.

Our results in terms of population peaks in the three areas clearly showed a considerable similarity to those reported by Waddill (1978), who observed highest infestation peaks in the autumn months when studying an *N. perezi* population in Florida. However, that same author verified that lower temperatures caused by a cold winter in Florida were responsible for a drastic reduction in North American *N. perezi* populations.

On the other hand, Lourenção *et al* (1996) obtained the highest infestation rates by *N. perezi* in cassava experiments during the rain period (December, January and February). Our results differ from those of Waddill (1978), probably because the high temperatures (above 23°C) caused infestation rate reduction by *N. perezi*. Pearson's correlation test revealed a strong negative correlation between infestation rate by *N. perezi* larvae and temperature in areas 1 and 2 ($r = -0.70$ and $P = 0.001$; $r = -0.86$ and $P < 0.0001$, respectively); thus, low infestation rates by this fly seem to be strongly correlated with temperatures higher than 23°C (Fig 2). In area 3, however, such correlation was not observed ($r = -0.21$ and $p = 0.41$), but higher temperatures than 23°C had a negative influence on the population growth of *N. perezi* larvae in that area. However, it is important to take into account that area 3 had the highest mean temperature (22.8ºC) over the experiment period. This confirms the idea that high temperatures may have a negative influence on *N. perezi* population growth, considering that area 3 was also the study site with the smallest population peak. Accordingly, area 1 presented the lowest mean temperature (20.3°C) during the experiment and was the area with the highest infestation rates, once again confirming the influence of temperature on the dynamics of this *N. perezi* population.

Likewise as temperature, local precipitation may influence the population dynamics of *N. perezi* because a negative correlation was found between infestation rate and mean fortnightly rainfall in the study region at the three study areas ($r = -0.50$ and $P = 0.03$; $r = -0.54$ and $P = 0.02$; $r= -0.48$ and $P = 0.04$; respectively for areas 1, 2 and 3) (Fig 3). This correlation indicates that the highest *N. perezi* population peaks appear during dry periods. Indeed, we observed the highest population peaks in autumn and winter, seasons which are characterized by lower mean temperature and rainfall. This is consistent with the results found in this work, where higher infestation was observed when mean temperatures were below 23ºC and there was less rainfall.

With respect to plant age in relation to infestation rate, a strong negative correlation was confirmed at all study sites ($r = -0.65$ and $P = 0.003$, $r = -0.79$ and $P = 0.0001$, and $r = -0.69$ and $P = 0.002$; respectively for areas 1, 2 and 3), with considerable reduction in *N. perezi* larval population as of the fourth month after planting in area 2 and as of the sixth month after planting in areas 1 and 3. Accordingly, the studied areas presented almost no infestation as the plants became older (Fig 4). This correlation suggests that advanced plant age seems to

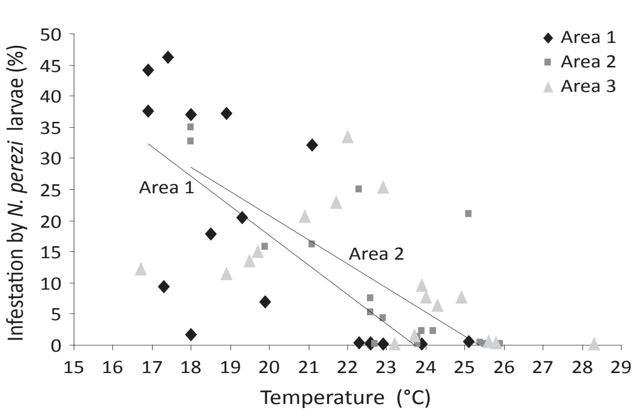

Fig 2 Temperature (fortnightly mean) *vs.*infestation by *Neosilba perezi* larvae (percent) in study areas 1, 2 and 3 in southeastern São Paulo state, from May 2008 to April 2009.

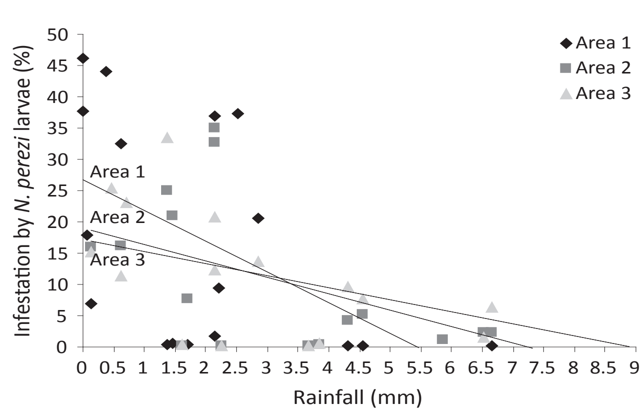

Fig 3 Infestation by *Neosilba perezi* larvae (%) *vs.* rainfall (fortnightly mean) in three cassava crop areas in southeastern São Paulo state, from May 2008 to April 2009.

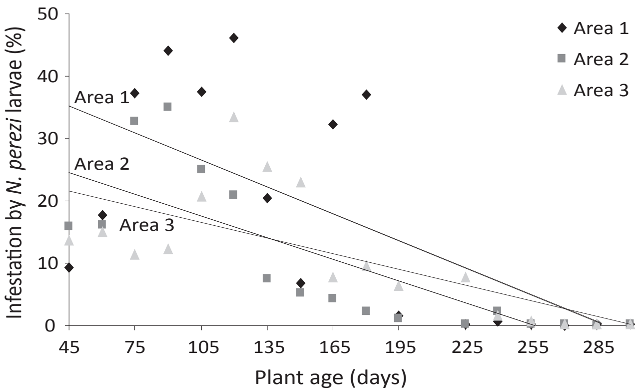

Fig 4 Infestation by *Neosilba perezi* larvae *vs.* plant age in three cassava crop areas in southeastern São Paulo state, from May 2008 to April 2009.

have a negative influence on *N. perezi* larval population growth in cassava shoots, as verified by Boza & Waddill (1978), who also observed higher rates of immature stages of the insect in younger plants.

The tissues of young cassava plants are softer than those of older plants, therefore such preference could be easily explained by the easier penetration of *N. perezi* larvae into younger shoots. Besides, semiochemicals produced by vegetative growth of cassava may significantly influence the plant attractiveness to adults in the field.

Acknowledgments

To the owners of the rural areas for field assistance; and to Prof Dr Arício Xavier Linhares for reviewing the statistic analyses.

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