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PEST MANAGEMENT

Infestation of Cassava Genotypes by *Neosilba perezi* (Romero & Ruppell) (Diptera: Lonchaeidae)

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Abstract

The objectives of this work were to assess the infestation of ten genotypes of cassava by the shoot fly *Neosilba perezi* (Romero & Ruppell) and to investigate effects of plant age, temperature or precipitation on cassava plants infestation by the shoot fly. Thirty-two individuals of each cassava genotype were planted and analyzed every two weeks in order to calculate the percentage of plants infested by shoot fly larvae at each sampling event and per genotype. Infestation by the fly was different across the genotypes. Genotype IAC Caapora 105-66 and genotype IAC Cascuda were resistant to shoot fly infestation, whereas the genotype IAC 15 was the most susceptible to this insect. Plant age may have an influence on infestation by shoot flies. Advanced plant age apparently favors lower or even inexistent infestation rates. However, infestation rate does not seem to be affected by temperature or precipitation.

Introduction

The genus *Neosilba* is comprised of Neotropical fly species whose larvae are hosted by many species of commercially important plants (Fehn 1981, Strikis & Prado 2005), with larvae attacking fruits species from many plant families (Araújo & Zucchi 2002, Uchôa-Fernandes *et al* 2002, Raga *et a*. 1996, Souza *et al* 2005, Strikis & Prado 2005, 2009).

The larvae of *Neosilba perezi* (Romero & Ruppell) are shoot parasites, particularly of cassava *Manihot esculenta* (Euphorbiaceae). The species is thus known as the shoot fly or cassava fly. Shoot fly females lay eggs inside the leaves of the apical part of the shoot, or in small cavities made using their ovipositors. This characterizes the species as a primary invader of cassava shoots. The larvae chew into the soft tissue of the plant and kill its point of growth. The affected shoots present many whitish larvae which often kill the apical buds, often retarding the normal growth of young plants and inducing the production of lateral buds (Graner 1942, Boza & Waddill 1978).

The damage caused by the larvae in cassava crops seems to be restricted to stem production, without impairing root yield (Bellotti & Schoonhoven 1978, Ciat 1981, Bellotti *et al* 1999). However, there is very little literature on this particular species of *Neosilba* cassava fly and few analyses have been conducted on the potential damage caused by this species to cassava crops (Lourenção *et al* 1996).

This work therefore aims to assess the performance of ten cassava genotypes upon infestation by larvae of *N. perezi* and investigate whether there is any relation between infestation by *N. perezi* and plant age, temperature, or rainfall, ultimately aiming to better elucidate some aspects of the interactions between this fly and cassava crops.

Material and Methods

A field test was conducted on ten genotypes of cassava, *M. esculenta*: IAC Caapora 105-66, IAC 12, IAC 13, IAC 14, IAC 15, IAC 576, Fécula Branca, Clone IAC 118, IAC 90, and Cascuda, aiming to investigate the performance of these genotypes upon infestation by shoot fly larvae. The test was carried out between June 2008 and January 2009 in the experimental field, in the city of Campinas, state of São Paulo, Brazil (23°33'S 47°26'W, 635 masl), in an adjacent area to an old cassava crop that was infested by the studied insect. A statistical design was conceived where each of the ten cassava genotypes was represented by 32 replicas planted at random in an open area of 80 m^2, totaling 320 plants throughout the experiment. The cassava stems, 20 cm long, were planted on June 19, 2008. They were planted in an inclined position in pits arranged in a 0.5 x 0.5 m grid, with soil covering two thirds of their basal portions. All of the plants were identified with stakes containing the relevant genotype information to enable proper sampling.

Observations were made approximately every two weeks over a seven month period. This interval was chosen because it is the maximum time required for the complete immature development of *N. perezi*. Sampling commenced sixty days after planting, i.e., when the plant buds were fully formed and oviposition by *N. perezi* was possible. The sampling events were concluded seven months after planting, as the rate of bud infestation by the larvae at this stage of plant development was close to zero across all genotypes.

Infestation assessment per genotype

Infestation of each genotype was assessed by recording the number of plants whose buds were damaged by the presence of shoot fly larvae. Damage was assessed visually, as the attack by these larvae produces a yellowish secretion that is easily recognizable with the naked eye. At each sampling event, the infestation rate per genotype was calculated as {(%P = number of infested plants of a given genotype/ total number of plants of that genotype) x 100}. Finally, the influence of plant age on shoot fly infestation was tested separately for each genotype by determining the linear correlation between plant age and the infestation rate of each genotype.

Infestation assessment per sampling event

The mean infestation rate at each sampling event was calculated as {(%P = number of infested plants at each sampling/ total number of plants in experiment) x 100}, aiming to identify possible differences among sampling periods, disregarding any differences among genotypes. The mean percentage of cassava shoot infestation by larvae at each sampling event was correlated separately with the mean temperature and with the mean rainfall at the experiment site over the two weeks immediately preceding each sampling. The meteorological data were provided by the Center for Meteorological and Weather Research Applied to Agriculture - CEPAGRI (22°48´57"S, 47°03´33"W, 640 masl).

Statistical analysis

Kolmogorov-Smirnov (Lilliefors) test was applied in order to assess data normality. Tukey's test was performed in order to compare the mean infestation rates (in percent) of the different cassava genotypes, as well as the mean infestation rates of each sampling event. The correlations were calculated using Pearson's correlation coefficient (Zar 1999). *The* software used to process and analyze the data was BioEstat version 5.0, using significance levels of 5% (Ayres *et al* 2007). All specimens are deposited in the Coleção Entomológica do Departamento de Biologia Animal, Universidade Estadual de Campinas – Unicamp.

Results and Discussion

Infestation assessment per genotype

The population of shoot flies at the experiment site immediately infested all of the genotypes planted in the field, enabling the experiment to be based on natural infestation. There was a significant difference in the percentage of infested plants per genotype. Genotype IAC 15 was the most susceptible to shoot fly infestation, with the highest mean infestation rate (54.2%), as compared to IAC Caapora 105-66 and IAC Cascuda ($P < 0.05$), which had the lowest mean infestation rates (8.3% and 16.7%, respectively). There was no significant difference among the remaining genotypes, but their respective mean rates were fairly different (Fig 1).

However, it should be taken into account that the genotype which showed the highest infestation rates

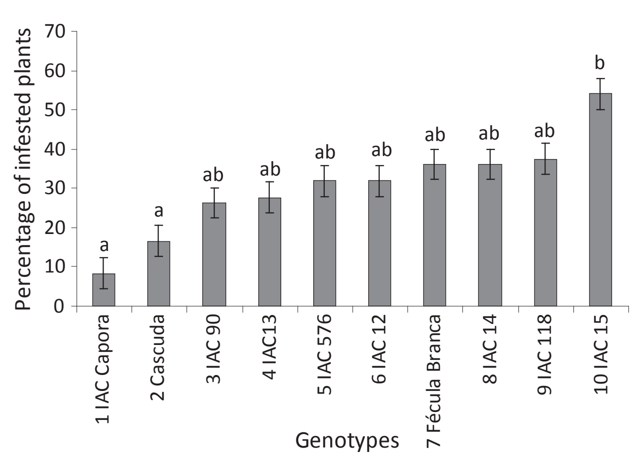

Fig 1 Percentage of plants of each genotype of cassava *Manihot esculenta* infested by larvae of *Neosilba perezi* (mean ± standard error), between September 2008 and January 2009, Campinas, SP, 2009. (Histograms followed by the same letter are not significantly different per Tukey's testing at $P < 0.05$).

is one of the most promising varieties produced by the Instituto Agronômico de Campinas – IAC. IAC 15 is promoted as a solution for weed-infested areas. It also provides excellent productivity and is indicated as the best alternative for the cassava flour and cassava starch industries (Lorenzi 2001). In light of this, a thorough analysis of the damage caused by shoot fly infestation should be applied to this genotype, given that it appears to be the most attractive to this insect.

The high infestation rates found in the large majority of genotypes analyzed in this study suggest that the damage caused by *N. perezi* to cassava may be more considerable than previously reported. In other words, if the insect infests all genotypes studied to this date and remains present in cassava fields during extended phenological periods of the plants, as verified by Gisloti & Prado (2011), it is fairly apparent that infestation by shoot fly larvae will have a detrimental effect on cassava plant development based on the fact that the larvae kill the growing part of the plants.

Correlation between plant age and infestation rate was analyzed separately for each genotype. The genotype IAC Caapora 105-66 presented the only significant result ($r = -0.77$ and $P = 0.01$). This negative correlation reveals that the attractiveness of this genotype to shoot flies decreases as plant age advances. The same correlation was not found for other genotypes, but in the final two sampling events, i.e., when the plants were older, most of the studied genotypes showed either zero infestation or a smaller rate than in previous samplings (Fig 2). Gisloti & Prado (2011) reported preferential infestation of younger plants by immatures of this insect. This suggests that advanced plant age apparently has a negative effect on cassava plant infestation by *N. perezi*, which may reject older plants because shoot fly females select soft, malleable buds in which to oviposit, so as to enable their larvae to pierce the plant tissue more successfully. However, the genotype most susceptible to infestation – namely IAC 15 – showed relatively high infestation rates throughout all of the sampling events, including the final samplings (Fig 3).

Previous tests on infestation by *N. perezi* identified genotype IAC 14 as the most resistant (Brinholi *et al* 1974, Samways 1979), but in this study, that same genotype showed a relatively high rate of infestation (36.1%).

Infestation assessment per sampling event

There were significant differences in mean infestation rates among the fortnightly sampling events ($P < 0.05$), disregarding any differences among the genotypes. At the fifth sampling in late October, with 4.5 mo-old plants, 60% of the plants were infested by shoot fly larvae, a significantly different rate from the second (18.7%), fourth (26.2%), eighth (11.2%) and ninth (11.4%) sampling events. The sixth sampling event, by mid-May/2008, with five mo-old plants, also showed a high infestation rate that was statistically different from the eighth (11.2%, mid-December 2008) and ninth (early January 2009) samplings. The latter two events showed the lowest infestation rates (Table 2). After the peak infestation rate observed in October, with 4.5 mo-old plants, mean infestation declined gradually to the low values observed in the latter two sampling events, once again confirming the negative influence of advanced plant age in infestation by shoot flies (Fig 2).

Pearson's coefficient did not identify any correlation between local temperature or rainfall and mean infestation rate ($P > 0.05$). The highest observed total infestation – i.e., at the fifth sampling (60%) – preceded the highest mean temperature at the experiment site (24.9°C); however, the prevailing climate conditions at the

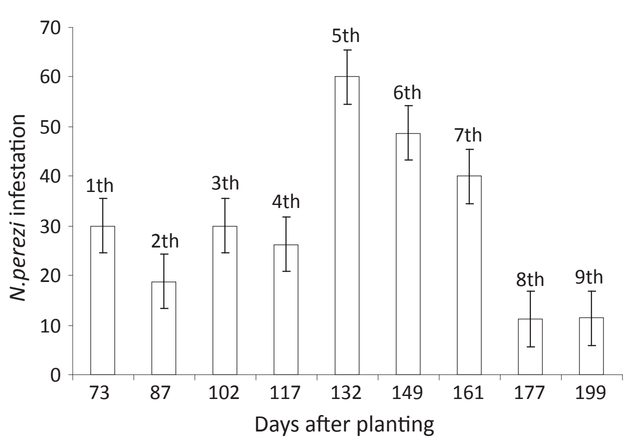

Fig 2 Infestation of cassava (*Manihot esculenta*) by *Neosilba perezi* larvae (mean % ± standard error) at each fortnightly sampling between September 2008 and January 2009, Campinas, SP, 2009.

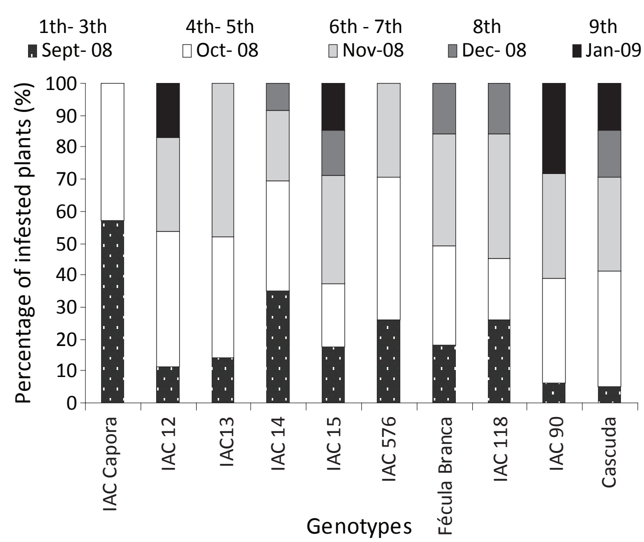

Fig 3 Distribution of infestation rate of *Neosilba perezi* larvae (monthly mean) on genotypes of cassava *Manihot esculenta*, Campinas, SP, 2009. Note that the infestation rates at the final sampling events were often equal to zero.

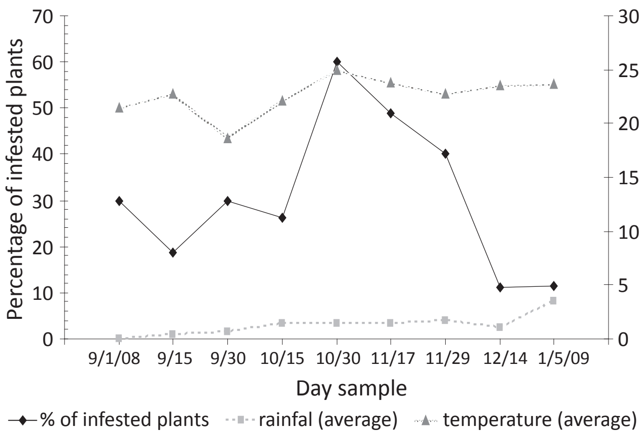

Fig 4 Percentage of plants infested by larvae of *Neosilba perezi* (mean of sampling event), temperature (mean of 15 day period prior to sampling) and rainfall (mean of 15 day period prior to sampling), at each sampling event between September 2008 and January 2009, Campinas, SP.

site varied little throughout the experiment. This might explain the absence of correlation between these climate parameters and infestation by *N. perezi* (Fig 4).

Our results showed that genotype IAC 15 appears to be the most susceptible to shoot fly infestation. Plant age seems to influence the rate of infestation by shoot flies. Advanced plant age apparently favors lower or even inexistent infestation rates. However, local temperature and rainfall do not appear to influence infestation of cassava shoots by this insect. Finally, it is extremely important that a thorough investigation be performed to assess the real damage caused by this insect to cassava crops, given that all of the analyzed genotypes showed relatively high rates of infestation. This would be particularly important because the genotype with highest attractiveness to *N. perezi* was a variety deemed very promising by the cassava industry.

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