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Biological Parameters and Life Table of Lipaphis pseudobrassicae (Hemiptera: Aphididae) (Davis, 1914) on Kale (Brassica oleracea L. var. acephala)

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Biological Parameters and Life Table of Lipaphis pseudobrassicae (Hemiptera: Aphididae) (Davis, 1914) on Kale (Brassica oleracea L. var. acephala)

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RESUMO: Couve folha (*Brassica oleracea* L. var. *acephala*), é uma das principais brassicaceas plantadas no Brasil. Dentre as principais pragas da cultura no Brasil destacam-se os afídeos *Brevicoryne brassicae, Myzus persicae e Lipaphis erysimi*, embora *Lipaphis pseudobrassicae* tem sido relatado em couve não existe estudos sobre sua bioecologia em couve. Para a obtenção de sucesso em tais manejos são imprescindíveis o conhecimento dos parâmetros biológicos e populacionais da espécie em questão no ambiente de ocorrência. Sendo assim objetivou-se estudar os parâmetros biológicos e populacionais de afídeo que infestam couve. Para tanto realizou-se a coleta, após a triagem confeccionou-se lâminas permanentes para identificação taxonômica, então estabeleceu-se uma criação dos afídeos para os estudos biológicos e elaboração da tabela de vida. Para a construção da tabela de vida discos foleares de couve foram infestados com duas ninfas, com 0-24 horas de idade e acompanhado todo o ciclo biológico. Os parâmetros avaliados para construção da tabela de vida calculados foram: Taxa Líquida de Reprodução (R_o); intervalo de Tempo entre cada geração (T); Inata capacidade de aumentar em número (r_m); Razão finita de aumento (λ) e Tempo para a população duplicar (TD). A única espécie coletada foi *Lipaphis pseudobrassicae* que demonstrou possuir grande potencial biótico e de crescimento populacional na cultura de *Brassica oleracea* nas condições estudadas com R_o 92,61, T de 11,32, $r_m$de 0,39 e λ de 1,49.

PALAVRA CHAVE*:* Taxonomia, bioecologia, pulgão*, Brassica oleracea*, interação inseto-planta.

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ABSTRACT: Kale (*Brassica oleracea* L. var. *acephala*) is one of the main Brassicaceae crops cultivated in Brazil. Among the major pests of this crop in the country are the aphids *Brevicoryne brassicae*, *Myzus persicae*, and *Lipaphis erysimi*. Although *Lipaphis pseudobrassicae* has been reported on kale, no studies have yet investigated its bioecology on this host. Successful pest management requires knowledge of the biological and population parameters of the species in the environment where it occurs. Therefore, the objective of this study was to evaluate the biological and population parameters of the aphid that infests kale. Aphids were collected, screened, and mounted on permanent slides for taxonomic identification. Subsequently, a laboratory colony was established for biological studies and for the construction of the life table. For the life table, kale leaf discs were infested with two nymphs (0–24 h old) and monitored throughout the biological cycle. The parameters evaluated were the net reproductive rate (R_o), mean generation time (T), intrinsic rate of increase (r_m), finite rate of increase (λ), and doubling time (DT). *Lipaphis pseudobrassicae* was the only species collected, showing a high biotic potential and population growth rate on *Brassica oleracea* under the studied conditions, with $R_o = 92.61$, $T = 11.32$, $r_m = 0.39$, and $\lambda = 1.49$.

KEYWORDS: Taxonomy, bioecology, aphid, *Brassica oleracea*, insect–plant interaction.

INTRODUCTION

Leaf kale (*Brassica oleracea* L. var. *acephala*) is one of the most widely cultivated Brassicaceae species in Brazil, and its consumption has been increasing due to its nutritional and medicinal properties (TRANI, TIVELLI, BLAT, et. al., 2015). Aphid species that become agricultural pests are generally cosmopolitan, occurring in both temperate and tropical regions (PAL, SING, 2013). This is the case for *Brevicoryne brassicae* L., 1758, and *Myzus persicae* S., 1776, which stand out as the main pests of kale in Brazil (TRANI, TIVELLI, BLAT, et. al., 2015; VALBON, MACHADO, RONDELLI, FRANZIN, 2015). Another species frequently mentioned in scientific literature as a pest of brassicas is *Lipaphis erysimi*, which is reported as one of the main pests of mustard (*Brassica juncea* L.) (PATEL, AWASTHI, TOMAR, 2004), and is also associated with other brassicas (GODOY, CIVIDANES, 2002; RANA, 2005; CAMPOS, et. al., 2011; QUEIROZ, et. al., 2012; BROGLIO et. al., 2014).

Lipaphis pseudobrassicae Davis, 1914, was first recorded in Brazil in 2006, associated with kale (RESENDE et. al., 2006). This aphid is considered one of the main pests of Indian mustard (*Brassica juncea* L.) and also uses wild host plants in Europe and Africa (AHUJA et. al., 2009). Despite being cited in several scientific publications as associated with brassicas (RESENDE et. al., 2006; AHUJA et. al., 2009; SAMPAIO, KORNDORFER, VILLAR, et.al. 2017; MARSARO JÚNIOR, et. al., 2021), it has not yet been listed in Brazilian technical literature as an important pest of these crops.

For this reason, obtaining data and information on the biological parameters of the species is essential, as there are still no records of its occurrence in the state of Piauí. Therefore,

the purpose of this study was to conduct biological observations and construct the life and fertility table of *Lipaphis pseudobrassicae*, which was identified by the author as the main aphid associated with kale (*Brassica oleracea*).

MATERIALS AND METHODS

The study was carried out at the Phytosanitary Laboratory, located at the Socopo Campus of the Federal University of Piauí (UFPI), Department of Crop Science, Center for Agricultural Sciences (CCA). It was divided into two stages: the first involved collecting aphids from urban vegetable gardens, identifying them at the species level, and establishing an initial laboratory colony; the second involved conducting experiments to obtain biological data, which were then used to construct the life and fertility table.

Urban community vegetable gardens in Teresina, Piauí, were visited, where kale plants infested with aphids were collected. Ten random sampling points were established, following a zigzag path through the gardens. At each point, one infested leaf was collected and placed in a paper bag, separated according to the collection point. Samples were then taken to the entomology laboratory for screening and taxonomic identification. Subsequently, the selected aphids were mounted on permanent slides and sent to Dr. Regina Célia Zonta de Carvalho, from the "Marcos Enrietti" Diagnostic Center, Plant Parasitology and Entomology Laboratory, Federal University of Paraná, for species confirmation.

Once the species was confirmed, the initial colony was established according to the methodology adapted from Oliveira et al. (2010). Kale plants (*Brassica oleracea* L. var. *acephala*) were cultivated in 5 L pots containing substrate and maintained inside cages (1.0 m^2) covered with anti-aphid mesh. When the plants had four true leaves, they were infested with aphids previously identified from the field, using a fine brush. Every 30 days, ten new pots were

planted, which were infested in due time when the previous plants showed signs of deterioration.

For the study of biological parameters, kale leaf discs (N = 100), 5 cm in diameter, were cut, washed under running water, and placed in a 1% sodium hypochlorite solution for five minutes for disinfection. They were then rinsed twice with distilled water and placed abaxial side up in plastic Petri dishes (8.5 cm in diameter) containing a 5 mm layer of 1% agar-water to maintain leaf turgidity. Three apterous adult females were placed on each leaf/disc. The dishes were sealed with lids containing a central 4 cm opening covered with voile fabric. After 24 hours, the adults were removed, and two nymphs were selected to evaluate the biological parameters (adapted from VALENTE et al., 2014). Daily observations were carried out under a stereomicroscope. The following parameters were recorded: duration of the nymphal and reproductive periods, total life cycle, nymph viability, daily and total fecundity per female, and daily mortality. The presence of exuviae was used to determine molting, and exuviae were removed daily after counting. The experimental design was completely randomized, consisting of one treatment with 50 replicates (dishes). The plates were kept in climate-controlled chambers set to 25 ± 1 °C, 70 ± 10% relative humidity, and a 12-hour photophase.

The biological data were used to construct the life and fertility table. The population growth parameters estimated were: mean generation time (T), net reproductive rate (R_o), intrinsic rate of increase (r_m), and finite rate of increase (λ), using the Bootstrap method implemented in the software TWOSEX-MSChart (CHI, YOU, ATLIHAN et.al., 2020).

RESULTS AND DISCUSSION

Lipaphis pseudobrassicae was the only species collected from kale crops in urban vegetable gardens in Teresina, Piauí. *Brevicoryne brassicae* and *Myzus persicae* are considered

126 the main aphid pests of brassicas in Brazil (VALBON, MACHADO, RONDELLI et.al. 2015;
127 l, GUIMARÃES, SILVA et.al., 2019). *L. pseudobrassicae* has often been confused with *B.*
128 *brassicae* and *L. erysimi*, but can be distinguished through chromosomal and detailed
129 morphological analyses. *L. erysimi* has ten chromosomes, whereas *L. pseudobrassicae* has eight
130 or nine. It is now widely accepted that *L. erysimi* is restricted to Europe, and that records under
131 this name in other regions of the world likely correspond to *L. pseudobrassicae* (NAFRÍA,
132 2016; BLACKMAN & EASTOP, 2017).

133 *Lipaphis pseudobrassicae* underwent four instars during its nymphal period, which
134 lasted 5.87 days, and had a reproductive period of 16.48 days (Table 1). On *B. campestris* and
135 *B. juncea* at 20°C, the nymphal period of *L. pseudobrassicae* was reported as 7.0 ± 0.211 and
136 7.98 ± 0.171 days, respectively, and the reproductive period as 9.60 ± 1.392 and 13.80 ± 1.289
137 days (AGARWALA, KALPANA DAS, RAYCHOUDHURY, 2009). These results
138 demonstrate that both the host plant and temperature influence insect development, particularly
139 their life cycle duration, longevity, and fecundity.

140 The reproductive period of *L. pseudobrassicae* was 16.48 days, with an average daily
141 fecundity of 5.56 nymphs per female per day (Table 1). Aphids, in general, are r-strategists,
142 characterized by high fecundity rates that enable rapid population growth (ILHARCO, 1992).
143 For instance, *Lipaphis erysimi*, under similar conditions, exhibited an average daily fecundity
144 (ADF) of 2.5 nymphs/female/day and a total fecundity (TF) of 47.9 nymphs/female (GODOY
145 E CIVIDANES, 2002). The reproductive period of *L. erysimi* begins immediately after the
146 fourth molt, when it becomes adult, and lasts for about 34 days (GODOY E CIVIDANES,
147 2002).

148 Thus, it is evident that under the warm and humid climatic conditions of *B. oleracea*, *L.*
149 *pseudobrassicae* exhibits a longer juvenile phase, a shorter reproductive period, and higher

fecundity, resulting in greater reproductive potential and an increased number of generations within the crop cycle.

Daily fecundity and total fecundity are key parameters in population assessment, as they directly affect the fertility curve. In this study, the reproductive period of *L. pseudobrassicae* began, on average, on the 5th day of life and lasted until death at approximately 32 days of age. The reproductive peak occurred between the 10th and 14th days, and the maximum rate of increase was observed on the 14th day of life (Figure 1), when the highest number of nymphs per female per day was recorded.

Biological parameters provide valuable insights into the life cycle of an insect; however, constructing a life table based on these data is even more informative, as it is the best tool for comparing the growth potential of two or more populations.

The life table of *L. pseudobrassicae* was calculated (n = 51) based on the biological data (Table 2). *Lipaphis erysimi*, feeding on *Brassica oleracea* under similar conditions, exhibited the following life table parameters: $R_o = 38.29$, $r_m = 0.28$, $\lambda = 1.33$, and T = 12.81 (GODOY e CIVIDANES, 2002). When compared to the present results, *L. pseudobrassicae* showed a greater biological potential to become a pest, as all life table parameters were higher — particularly R_o and r_m, which were 2.42 and 1.39 times higher, respectively (Table 2).

Brevicoryne brassicae and *M. persicae* are considered the main aphid pests of *B. oleracea*. At similar temperatures (25°C), their life table parameters are as follows: for *B. brassicae* — $R_o = 14.65$, T = 14.94, $r_m = 0.18$, $\lambda = 1.19$; and for *M. persicae* — $R_o = 26.33$, T = 14.59, $r_m = 0.22$, $\lambda = 1.25$ (CIVIDANES, 2002; CIVIDANES e SOUZA, 2003). Compared to the values obtained for *L. pseudobrassicae*, although the experimental conditions were not identical, the markedly higher values observed in this study indicate that *L. pseudobrassicae* possesses a superior biotic potential. This suggests that the species may reach population disequilibrium more easily and cause significant economic damage to *B. oleracea* crops.

CONCLUSION

Lipaphis pseudobrassicae demonstrated a high potential to reach population disequilibrium and cause economic damage to Brassica oleracea L. var. *acephala*.

Brassica oleracea L. var. *acephala* proved to be a suitable host for *L. pseudobrassicae* under the experimental conditions evaluated.

Lipaphis pseudobrassicae can therefore be considered an important aphid species associated with the cultivation of *Brassica oleracea* L. var. *acephala* in the state of Piauí, with the potential to cause greater damage than *Lipaphis erysimi*, *Brevicoryne brassicae*, and *Myzus persicae*.

AUTHORSHIP CONTRIBUTION (CONTRIBUIÇÃO DE AUTORIA)

Melo Júnior, Luiz

Investigation; Methodology; Writing - original draft; Writing - review & editing

Ramalho Silva, Paulo

Project administration; Supervision; Writing - review & editing

França, Solange

Methodology (Supporting); Validation (Supporting); Writing - review & editing (Supporting)

Portela, Gilson Lages

Investigation; Methodology; Writing - original draft; Writing - review & editing

AVAILABILITY OF DATA AND MATERIAL (declaração de disponibilidade de dados de pesquisa)

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

FUNDING

Not applicable.

CONFLICTS OF INTEREST

All authors declare that they have no conflict of interest.

ETHICAL APPROVAL

Not applicable.

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Table 1. Biological parameters of *L. pseudobrassicae* feeding on kale (*Brassica oleracea* L. var. *acephala*) under no-choice test conditions. Temperature: 25°C, RH: 70 ± 10%, and photophase: 12 h.

Biological parameters	Mean ± SE
Nymphal period (days)	5.87 ± 0.121
Pre-reproductive period (days)	1.10 ± 0.057
Reproductive period (days)	16.48 ± 0.521
Post-reproductive period (days)	5.43 ± 0.566
Longevity (days)	20.96 ± 0.727
Biological cycle (days)	26.83 ± 0.724
Average daily fecundity (ADF)	5.56 ± 0.192
Total fecundity (TF)	91.58 ± 3.176

315 Table 2. Population parameters of *L. pseudobrassicae* feeding on *B. oleracea* L. var. *acephala*
316 under no-choice test conditions. Temperature: 25°C, RH: 70 ± 10%, and photophase: 12 h.

Analyzed parameters	Mean ± SE
Net reproductive rate (R_o)	92.61 ± 3.212
Mean generation time (T)	11.32 ± 0.167
Intrinsic rate of increase (r_m)	0.39 ± 0.00754
Finite rate of increase (λ)	1.49 ± 0.0112

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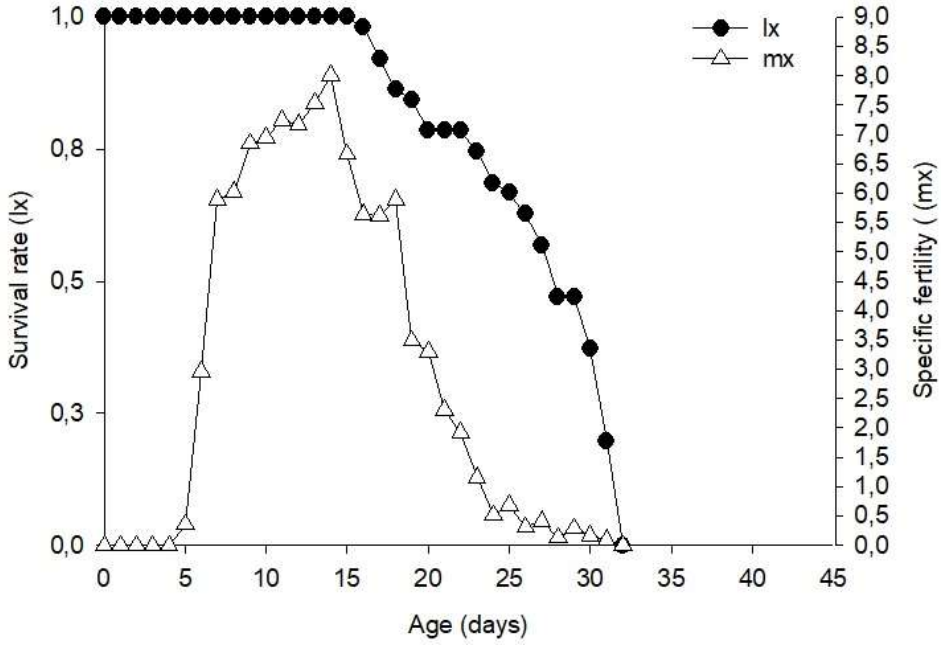

Figure 1. Survival rate (l_x) and number of offspring per female per day (m_x) of Lipaphis pseudobrassicae on cabbage leaves.

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