Biology of *Corythucha gossypii* Fabricius, 1794 (Hemiptera: Tingidae) in *Ricinus communis* at different temperatures and thermal requirements

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(With 1 figure)

Abstract

We studied the biology of *Corythucha gossypii* in *Ricinus communis* under different temperatures in climatic chambers adjusted at 20, 23, 25, and 28 °C, 60 ± 10% relative humidity, and a 12-h photoperiod. The development period and viability of eggs, the development period and survival rate of nymphs, and egg-adult cycle of *C. gossypii* as well as the adult longevity and fecundity were estimated. The thermal requirements (K) and temperature-base (Tb) were estimated for each of the immature stages and for the eggs-adults period. The duration of the eggs and nymphs phases and the egg-adult cycle of *C. gossypii* on castor bean leaves at 20-28 °C were 7.6-17 days, 10.2-27.5 days, and 16.9-44.5 days, respectively. The lower temperature inhibited the oviposition of *C. gossypii*, whereas the higher temperatures were most favorable for its development. The municipalities of the Bahia state of Brumado, Irecê, Itaberaba, Jacobina, and Senhor do Bonfim were estimated to have a high potential for the population growth of *C. gossypii*. However, a greater number of generations per year of *C. gossypii* were observed in the municipalities of Brumado and Itaberaba.

Keywords: castor bean, development time, lace bug, thermal threshold.

1. Introduction

Brazil is the world’s third-largest producer of castor bean (*Ricinus communis* L., Malpighiales: Euphorbiaceae) after China and India. The estimated castor production for 2015-2016 harvest in Brazil was 97,300 tons in 125,100-ha area, representing 52.4% growth in the national acreage as compared to the data from the previous year (CONAB, 2016). The northeast region comprises of >99% of the planted area, with a production of 96,800 tons in the
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2. Material and Methods

2.1. Insects and plant

This study was conducted in the Laboratory of Entomology, Embrapa Cotton, Campina Grande, Paraíba, and Brazil (7°13’50”S, 35°52’52”W).

The specimens of castor bean cultivar “BRS Paraguaçu” were first planted in 4-L-plastic pots filled with soil collected from the experimental field, which was classified as a mixture of entisol eutrophic and manure (3:1 ratio), as recommended by the Soils Laboratory of the Embrapa Cotton. The plants were kept in the greenhouse until 55 days of age and then transferred to the laboratory for evaluate tingids infestation.

The C. gossypii specimens used in the experiment were collected from castor bean plants attacked in the Embrapa Cotton field. A total of 30 specimens (20 females and 10 males) of the lace bugs were collected using a brush, transferred to dry glass jars, and sent to Dr. Luiz Antônio Alves Costa (National Museum of the Federal University of Rio de Janeiro in Rio de Janeiro State, Brazil) for identification. These specimens were identified based almost exclusively on external morphology, because genital traits are not usually described (Monte, 1941) and deposited at the National Museum. For each temperature condition, two leaves of a castor plant were infested with 40 C. gossypii females, which continued laying eggs for 24 h. The infested leaves were wrapped with voile to prevent the insects’ escape. At the end of this period, the females were removed and their positions were marked with black paint to facilitate stereoscopic microscope inspections until the emergence of the nymphs.

2.2. Biology and thermal time bioassays

A castor bean plant containing 250 newly laid eggs inside the leaves by C. gossypii females were maintained in the biochemical oxygen demand (BOD) chambers adjusted at 20, 23, 25, and 28 °C under a relative humidity of 60 ±10% for a 12-h photoperiod. The eggs were observed daily. The total number of eggs hatched at each temperature and the duration of each egg development (incubation period) was recorded.

To evaluate the nympha stage at each temperature, the newly emerged first-instar nymphs were kept individually in rearing units consisting of 25-mL, transparent, plastic containers (3 × 4 cm). Inside these units, a filter paper disk measuring 3.0 cm in diameter was placed and moistened with distilled water. On this disk, a disk of a castor bean leaf was placed, with the ventral side facing upward. Then, the rearing units were covered with a transparent plastic film and maintained at a given temperature until the insects emerged as adults. The castor bean leaf disks were replaced every 2 days, and the filter paper was moistened on a daily basis.

The development time and viability of eggs and the survival of nymphs and adults of C. gossypii as well as the adult longevity and fecundity were estimated. The longevity of males and females was determined by considering the couples. To determine the fertility and the sex ratio of the offspring at each temperature condition, the adults were divided into couples, and the newly emerged males were transferred separately to new arenas containing newly emerged female. The eggs laid in these areas were quantified daily by two observations made at 08:00 AM and 04:00 PM.

2.3. Data analysis

The differences in the development periods between C. gossypii males and females were compared by F test at 5% probability using the System of Statistical Analysis and
Genetics (SAEG) (Ribeiro Júnior, 2001). The threshold temperature \((T_b)\) and thermal constant \((K)\) were estimated by the hyperbole method (Haddad et al., 1999) based on the duration of the immature stages and the life cycle (egg-adult) of \(C.\) gossypii. The annual accumulation of degree-days and the likely number of generations \((NG)\) of the lace bug in five castor-producing municipalities of Bahia state were calculated based on the thermal constant (Wilson and Barnett, 1983). The \(NG\) was calculated using the following Equation 1:

\[
NG = T \left( T_m - T_b \right) / K
\]

where: \(K = \) thermal constant; \(T_m = \) average temperature for each location studied; \(T_b = \) lower temperature threshold; and \(T = \) time (in days).

3. Results

The insect was identified as \(C.\) gossypii (Figures 1A-C). The viability of \(C.\) gossypii eggs in castor bean leaves did not vary between the four studied temperatures (Table 1); however, the survival of the nymphal phase ranged from 26% to 60%. The maximum survival was observed at 25 °C and the minimum at 20 °C. Among the nymphal instars, the survival rates for the first, second, third, fourth, and fifth instars for the four temperatures studied were 50-82%, 75.6-100%, 76.5-89.2%, 76.9-93.8%, and 80-100%, respectively (Table 2).

The developmental time of eggs and nymphs phases, and the egg-adult cycle of \(C.\) gossypii with castor bean leaves gradually decreased with the increase in the temperature (Table 1), but did not differ between the sexes. The incubation periods of eggs and development period of the nymphal phase and egg-adult cycle were 7.6-17 days, 10.2-27.5 days, and 16.9-44.5 days, respectively, at 20-28 °C.

The development time of the nymphal phase of \(C.\) gossypii in castor bean leaves varied within each instar stage and between the instars and sexes (Table 2), according to the

**Table 1.** Survival and development time of the egg and nymph phases and egg-adult cycle of *Corythucha gossypii* (Hemiptera: Tingidae) with castor leaves at temperatures 20 °C, 23 °C, 25 °C and 28 °C, relative humidity of 60 ± 10% and photophase of 12 hours.

| Stage/ cycle | Temp. \(^\circ\)C | Ind. | Sur. (%) | Female (N) | Male (N) | Female + Male (N) |
|--------------|-----------------|------|----------|------------|----------|-------------------|
| Egg          | 20              | 50   | 100      | 17.38 ± 0.43 | 4         | 16.67 ± 0.17\(^{NS}\) | 3       | 17.03 ± 0.28 | 7        |
|              | 23              | 50   | 100      | 10.95 ± 0.05 | 11        | 11.00 ± 0.00\(^{NS}\) | 8       | 10.97 ± 0.03 | 19       |
|              | 25              | 50   | 100      | 9.13 ± 0.06  | 15        | 9.43 ± 0.13\(^{NS}\) | 15      | 9.28 ± 0.07 | 30       |
|              | 28              | 50   | 100      | 7.33 ± 0.17  | 5         | 7.80 ± 0.20\(^{NS}\) | 9       | 7.57 ± 0.16 | 14       |
| Nymph        | 20              | 13   | 26       | 27.13 ± 0.80 | 4         | 27.83 ± 0.60\(^{NS}\) | 3       | 27.48 ± 0.51 | 7        |
|              | 23              | 19   | 38       | 16.77 ± 0.40 | 11        | 17.13 ± 0.51\(^{NS}\) | 8       | 17.05 ± 0.31 | 19       |
|              | 25              | 30   | 60       | 11.13 ± 0.16 | 15        | 11.47 ± 0.14\(^{NS}\) | 15      | 11.30 ± 0.11 | 30       |
|              | 28              | 16   | 32       | 9.83 ± 0.60  | 5         | 10.60 ± 0.51\(^{NS}\) | 9       | 10.22 ± 0.20 | 14       |
| Egg-adult    | 20              | 13   | 100      | 44.50 ± 0.96 | 4         | 44.50 ± 0.50\(^{NS}\) | 3       | 44.50 ± 0.55 | 7        |
|              | 23              | 19   | 100      | 27.73 ± 0.39 | 11        | 28.13 ± 0.51\(^{NS}\) | 8       | 27.93 ± 0.30 | 19       |
|              | 25              | 30   | 100      | 20.27 ± 0.16 | 15        | 20.90 ± 0.22\(^{NS}\) | 15      | 20.58 ± 0.15 | 30       |
|              | 28              | 16   | 100      | 16.80 ± 0.30 | 5         | 16.94 ± 0.27\(^{NS}\) | 9       | 16.87 ± 0.20 | 14       |

\(^{NS}\) = Not significant for the duration of development between female and male by F test \((P = 0.05)\); Temp = temperature; Ind = number of individuals per instar at each temperature; Sur = Survival; SE = standard error; N = number of individuals that achieved the adult stage.
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Within each instar, the duration gradually decreased with increasing temperature. On the other hand, longer periods between instars were observed for the fifth-instar nymphs and shorter periods for the second- and third-instar nymphs, except for similar amount of days for the first- and fifth-instar nymphs at 20 °C. Among the second- and third-instar nymphs at 20 °C, the nymphs that originated males showed a longer development time than those that originated females.

The longevity of *C. gossypii* adults in castor bean leaves were 24.3–46.8 days and 21.3–42.3 days for females and males nymphs, respectively (Table 3). The greatest longevity period was observed for females nymphs at 23 °C, followed by those kept at 25 °C. The smallest longevity of *C. gossypii* adults was observed for those kept at 28 °C.

The fecundity of *C. gossypii* in castor bean leaves varied with temperature (Table 3), with a better performance demonstrated at higher temperatures. At 20 °C, the females did not lay any eggs. Similarly, the sex ratio in castor bean leaves varied with the temperature, with values of 0.57, 0.58, 0.50, and 0.38 at temperatures of 20, 23, 25, and 28 °C, respectively.

The development rate to the egg and nymph stages and the egg-adult cycle of *C. gossypii* with castor bean leaves

### Table 2. Survival and development time (day, mean ± standard error) of nymphs in the different instar of *Corytucha gossypii* in castor leaves, at 20 °C, 23 °C, 25 °C and 28 °C, relative humidity of 60 ± 10% and photophase of 12 hours.

| Nymphal stage | Temp. (°C) | Ind. | Sur. (%) | Development time (days) ± standard error |
|---------------|------------|------|----------|------------------------------------------|
|               |            |      |          | Fêmea (N) | Macho (N) |
| 1st instar    | 20         | 25   | 50.00    | 6.75 ± 0.66 | 4 | 6.83 ± 0.73<sup>N.S</sup> | 3 |
|               | 23         | 41   | 82.00    | 2.86 ± 0.20 | 11 | 3.13 ± 0.26<sup>N.S</sup> | 8 |
|               | 25         | 37   | 74.00    | 2.67 ± 0.06 | 15 | 2.57 ± 0.05<sup>N.S</sup> | 15 |
|               | 28         | 40   | 80.00    | 2.00 ± 0.00 | 5  | 2.17 ± 0.17<sup>N.S</sup> | 9  |
| 2nd instar    | 20         | 19   | 76.00    | 3.50 ± 0.29 | 4  | 5.00 ± 0.20* | 3  |
|               | 23         | 31   | 75.61    | 2.56 ± 0.26 | 11 | 2.41 ± 0.16<sup>N.S</sup> | 8  |
|               | 25         | 37   | 100.00   | 1.63 ± 0.06 | 15 | 1.63 ± 0.06<sup>N.S</sup> | 15 |
|               | 28         | 34   | 85.00    | 1.50 ± 0.00 | 5  | 1.44 ± 0.10<sup>N.S</sup> | 9  |
| 3rd instar    | 20         | 16   | 84.21    | 4.25 ± 0.14 | 4  | 5.67 ± 0.33* | 3  |
|               | 23         | 24   | 77.42    | 3.50 ± 0.31 | 11 | 3.14 ± 0.14<sup>N.S</sup> | 8  |
|               | 25         | 33   | 89.19    | 1.80 ± 0.07 | 15 | 1.63 ± 0.06<sup>N.S</sup> | 15 |
|               | 28         | 26   | 76.47    | 1.50 ± 0.12 | 5  | 1.50 ± 0.00<sup>N.S</sup> | 9  |
| 4th instar    | 20         | 15   | 93.75    | 5.63 ± 0.38 | 4  | 5.00 ± 0.50<sup>N.S</sup> | 3  |
|               | 23         | 21   | 87.50    | 3.86 ± 0.21 | 11 | 3.88 ± 0.31<sup>N.S</sup> | 8  |
|               | 25         | 30   | 90.91    | 2.03 ± 0.08 | 15 | 2.20 ± 0.07<sup>N.S</sup> | 15 |
|               | 28         | 20   | 76.92    | 2.20 ± 0.20 | 5  | 2.11 ± 0.25<sup>N.S</sup> | 9  |
| 5th instar    | 20         | 13   | 86.67    | 5.50 ± 0.20 | 4  | 6.83 ± 0.67<sup>N.S</sup> | 3  |
|               | 23         | 19   | 90.48    | 4.50 ± 0.28 | 11 | 4.06 ± 0.11<sup>N.S</sup> | 8  |
|               | 25         | 30   | 100.00   | 3.17 ± 0.14 | 15 | 3.27 ± 0.10<sup>N.S</sup> | 15 |
|               | 28         | 16   | 80.00    | 3.10 ± 0.10 | 5  | 3.22 ± 0.24<sup>N.S</sup> | 9  |

<sup>N.S</sup> = Not significant and *significant for the duration of development between female and male by F test (P = 0.05); Temp = temperature; Ind = number of individuals per instar at each temperature; Sur = Survival; N = number of individuals that achieved the adult stage.

### Table 3. Longevity (day, mean ± standard error) and fecundity (total eggs, mean ± standard error) of *Corytucha gossypii* in castor bean leaves at 20 °C, 23 °C, 25 °C and 28 °C, relative humidity of 60 ± 10% and photophase of 12 hours.

| Temp. (°C) | Sex  | N  | Longevity (day, mean ± standard error) | Fecundity (total eggs, mean ± standard error) |
|-----------|------|----|----------------------------------------|-----------------------------------------------|
| 20        | Female | 3  | 14.17 ± 1.48                           | -                                             |
|           | Male   | 3  | 13.50 ± 1.00                           | -                                             |
| 23        | Female | 6  | 46.82 ± 2.18                           | 146.33 ± 31.17                               |
|           | Male   | 6  | 42.31 ± 2.54                           | -                                             |
| 25        | Female | 6  | 34.53 ± 1.80                           | 148.00 ± 32.80                               |
|           | Male   | 6  | 34.47 ± 4.16                           | -                                             |
| 28        | Female | 5  | 24.30 ± 3.61                           | 167.00 ± 28.00                               |
|           | Male   | 5  | 21.28 ± 2.56                           | -                                             |
Table 4. Linear regression equations between the rates of development r(T) and temperature (20 °C, 23 °C, 25 °C and 28 °C) to determine the base temperature (Tb) and thermal constant (K) for egg and nymph stages and egg-adult cycle of Corythucha gossypii in castor leaves.

| Phase    | Instar | Tb (°C) | K      | a(T) ± standard error | b(T) ± standard error | Pr > F² | R²  |
|----------|--------|---------|--------|-----------------------|-----------------------|---------|-----|
| Egg      |        | 15.14   | 86.81  | -0.17446 ± 0.02121    | 0.01152 ± 0.00088     | 0.0057  | 0.98|
| First    |        | 15.26   | 26.70  | -0.57176 ± 0.17614    | 0.03746 ± 0.00729     | 0.0358  | 0.89|
| Second   |        | 16.74   | 15.90  | -1.03640 ± 0.15045    | 0.06291 ± 0.00622     | 0.0096  | 0.97|
| Third    |        | 16.95   | 16.15  | -1.04962 ± 0.37136    | 0.06193 ± 0.01536     | 0.0564  | 0.84|
| Fourth   |        | 15.92   | 23.72  | -0.67116 ± 0.28193    | 0.04215 ± 0.01166     | 0.0687  | 0.80|
| Fifth    |        | 11.92   | 47.55  | -0.25070 ± 0.12738    | 0.02103 ± 0.00527     | 0.0574  | 0.83|
| Nymphal  |        | 15.40   | 123.46 | -0.12477 ± 0.03222    | 0.00810 ± 0.00133     | 0.0260  | 0.92|
| Egg-adult|        | 15.36   | 208.33 | -0.07375 ± 0.00866    | 0.00480 ± 0.00036     | 0.0055  | 0.98|

(1) The base temperature or low development threshold (Tb) is calculated as Tb = 0/a; (2) The thermal constant, k (day-degrees) is calculated as k = 1/b. a is the intercept, and b is the regression line slope. The values of Tb and k were calculated for each instar and nymph stage (from hatching to the adult stage).

Table 5. Annual accumulation of degree-days and probable number of generations of Corythucha gossypii in five regions with castor bean crops in the State of Bahia, based on the thermal constant (1).

| Municipality | Annual degree-days | Number of generations per year |
|--------------|--------------------|--------------------------------|
| Brumado      | 3447.3             | 16.5                           |
| Irecê        | 3007.3             | 14.4                           |
| Itaberaba     | 3642.7             | 17.5                           |
| Jacobina     | 3073.1             | 14.8                           |
| Senhor do     | 2996.1             | 14.4                           |
| Bonfim       |                    |                                |

(1) The daily maximum and minimum temperatures in the municipalities listed in the table were obtained from the INMET (2016) and used for degree-day calculation for the year 2015.

showed a linear and positive correlation with temperatures between 20 °C and 28 °C (Table 4). Within this temperature range, the second- and third-instar nymphs showed higher development rate, which could be confirmed by larger angular coefficients of the regression equations estimated for these instars.

Thermal constants for the egg and nymph stages and the egg-adult cycle of C. gossypii with castor leaves showed a linear and positive correlation with the temperature of 20-28 °C (Table 4).

The likely number of generations of C. gossypii throughout the year in the municipalities of Brumado, Irecê, Itaberaba, Jacobina, and Senhor do Bonfim (the largest castor bean producers in Brazil; Bahia state) ranged from 14.4 to 17.5 (Table 5). The municipalities of Itaberaba and Brumado, two of the hottest cities in the region, possess the greatest potential of annual generations of C. gossypii, while municipalities with cooler temperatures such as Irecê, Jacobina, and Senhor do Bonfim are predicted to yield fewer numbers of generations per year.

4. Discussion

The high viability rate of eggs with castor bean leaves is similar to the >90% value observed for the viability of C. ciliata eggs (Ju et al., 2011a) in the studied temperature range with hybrid plane leaves of Platanus × acerifolia (Aiton). This observation can be attributed to C. ciliata’s oviposition behavior. The females often lay their eggs on both the sides of the leaf and next to the midvein or lateral veins, inserted partially in the leaf parenchyma; this site of oviposition protects the eggs from abiotic stress factors such as water loss and extreme temperatures and biotic ones such as attack by natural enemies (Southwood, 1973).

The shorter incubation period of G. gossypii eggs at temperature between 20 °C and 28 °C as compared to those of 12-19 days by C. cydoniae on leaves of Crataegus phaenopyrum (L.f.) Medik. (Neal Junior and Douglass, 1990), 11.3-26.5 days by C. cydoniae on leaves of Cotoneaster dammeri (Braman and Pendley, 1993), and 8.8-20 days by C. ciliata on hybrid plane leaves (Ju et al., 2011b) can be attributed to differences among the oviposition sites in the plant tissue of the host leaves. The oviposition of C. gossypii is endophytic, while those of C. cydoniae and C. ciliata are pseudo-endophytic and exophytic, respectively. In the endophytic posture, the eggs are inserted into the spongy mesophyll with only the operculum left outside the vegetable tissue, while, in the pseudo-endophytic posture, the eggs are partially inserted in the plant tissue. In the exophytic posture, the eggs are deposited on the surface of the plant tissue (Guidoti et al., 2015).

The differences in the development time of the second- and third-instar nymphs of C. gossypii at 20 °C that originated males and females may be attributed to the reduced number of individuals used to calculate this development period of this lace bug at this temperature. However, the development time of the phases of egg, nymph, and egg-adult did not differ between the sexes at all temperatures, indicating that nymphs at a more advanced instar stage of development can compensate for the possible differences between the sexes in the development time.
of initial instars. The duration time of nymph stage and egg-adult cycle of *C. gossypii* at 20-28 °C were similar to that of 12.1-29.3 days and 22.8-55.6 days observed for the nymph stage and egg-adult cycle of *C. cydoniae* on the leaves of *Cotoneaster dammeri* (19-30 °C) (Braman and Pendley, 1993), respectively, and of 11.3-27.6 days and 20.0-47.6 days for the same development period of *C. ciliata* on the hybrid plane leaves (19-30 °C) (Ju et al., 2011a). Moreover, the durations were greater, ranging from 14.7 to 23.4 days and 26.6 to 42.5 days for the nymph stage and the egg-adult cycle of *C. cydoniae* on the leaves of *Crataegus phaenopyrum* (Neal Junior and Douglass, 1990).

The survival rates for the first-, second-, third-, fourth-, and fifth-instar for the four temperatures studied were less than those in survival from 63% to 90%, 95% to 100%, 96% to 99%, 96% to 97.5%, and 85% to 95% observed for the respective instars of *C. ciliata* on hybrid plane leaves (19-30 °C). On the other hand, the improved survival of *C. gossypii* at 25 °C and its reduction at 20 °C indicates that these nymph species preferably survive in warmer temperatures.

Variations in the development time of *C. gossypii* within each instar and between instars and sexes according to the temperature confirm that temperature is an important climatic factor that influences the development of these insects. The developmental period gradually decreases with increasing temperature conditions. On the other hand, the longest period observed for the fifth-instar nymphs and shortest for the second- and third-instar nymphs, except for similar durations for the first- and fifth-instar nymphs at 20 °C, are in concordance with the previous results observed for other species of Tingidae (Vogt and McPherson, 1986; Neal Junior and Douglass, 1988, 1990; Braman et al., 1992; Braman and Pendley, 1993; Cividanes et al., 2004; Silva, 2004; Aysal and Kivan, 2008; Ju et al., 2011a; Zhang et al., 2011; Carr and Braman, 2012; Moreira et al., 2013; Sánchez-Ramos et al., 2015), thereby confirming this to be the pattern of development for the nymphal stages of lace bugs, as proposed by Sanchez-Ramos et al. (2015).

In this study, adult longevity and fecundity were prolonged and increased with decreasing temperature. At 25 °C, the life spans of the male and female *C. gossypii* were found to be similar to the life spans of 33.2 days and 34.7 days for the male and female *C. ciliata*, respectively, on hybrid plane leaves at 26 °C (Ju et al., 2011a).

The positive linear correlation between the development rate and the temperature and between the thermal constant and the temperature for the egg, nymph, and egg-adult stages of *C. gossypii* at 20-28 °C indicated the thermophilic nature of Tingidae species. The number of degree-days required for the development of egg and nymph stages and the egg-adult cycle were similar to those observed for the Tingidae species *Monostea unicostata* on the leaves of *Phyllostachys nigra* (Sánchez-Ramos et al., 2015) to those observed for *Gargaphia torresi* on cotton leaves (Silva, 2004) and for *C. cydoniae* on the leaves of *Cotoneaster dammeri* (Braman and Pendley, 1993). On the other hand, the number of degree-days required for the three developmental stages were superior to the lower limits of 10.5, 10.9, and 11.2 °C obtained for the respective stages of *C. ciliata* (Ju et al., 2011a).

The largest number of annual generations estimated for *C. gossypii* in the warm municipalities of Itaberaba and Brumado as compared to those in the colder municipalities of Irecê, Jacobina, and Senhor do Bonfim indicate that the municipalities of Itaberaba and Brumado are most susceptible to population outbreaks and, consequently, to damage caused by castor bean lace bug.

5. Conclusion

From this study, it can be concluded that temperature influences the development time of the egg and nymph stages and the egg-adult cycle as well as the longevity and fecundity of *C. gossypii* on the leaves of castor beans. The temperatures of 25 °C and 28 °C were found to be the most favorable for the development of this lace bug. The study indicated that the municipalities of the Bahia state of Brumado, Irecê, Itaberaba, Jacobina, and Senhor do Bonfim have a greater potential for the population growth of *C. gossypii*. However, the greater number of generations per year of *C. gossypii* observed in Brumado and Itaberaba indicated that *C. gossypii* has more potential to be a pest in these municipalities.

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