Bionomics of aphid, *Aphis gossypii* (Glover) on cumin, *Cuminum cyminum* Linn. under laboratory conditions

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**Abstract**

The study on bionomics was carried out in PG laboratory of Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh during 2019-20. The aphid nymphs were moulted four times before attaining the adult stage. Average body length, width, antennal length & corncile length of first, second, third and fourth instar nymphs were 0.49 ± 0.05, 0.25 ± 0.02, 0.25 ± 0.02 & 0.03 ± 0.01 mm; 0.68 ± 0.03, 0.36 ± 0.03, 0.34 ± 0.03 & 0.05 ± 0.01 mm; 0.88 ± 0.04, 0.46 ± 0.03, 0.49 ± 0.03 & 0.07 ± 0.02 mm and 1.15 ± 0.04, 0.60 ± 0.04, 0.58 ± 0.04 & 0.12 ± 0.03 mm, respectively. Average body length, width, antennal length and corncile length of adult aphid were 1.38 ± 0.05, 0.69 ± 0.03, 0.68 ± 0.05 and 0.18± 0.03 mm, respectively. The average developmental period of first, second, third and fourth nymphal instar nymphs were 1.44 ± 0.50, 2.20 ± 0.65, 2.50 ± 0.51 and 1.50 ± 0.51 days, respectively. The total nymphal duration was 7.63 ± 1.29 days. The mean longevity of adult aphid was showed to be 10.09 ± 1.30 days with an entire life span of 17.72 ± 1.45 days. The pre-reproductive, reproductive and post-reproductive periods were recorded to be 1.31 ± 0.47, 7.04 ± 1.13 and 1.72 ± 0.70 days, respectively. The fecundity was showed to be 26.5± 6.77 nymphs per female and the intrinsic rate of single female per day was an average of 4.3 ± 2.62 nymphs /day.

**Keywords:** cumin, bionomics, aphid, *A. gossypii*

**Introduction**

Cumin (*Cuminum cyminum* Linnaeus) locally known as ‘Jeera’ or ‘Jeru’ belongs to family Umbelliferae. It is a good medicine for digestive and intestinal upsets and used in veterinary medicine (Aiyer and Narayan, 1950) [1]. India is the leading producer (70% of world production), consumer and exporter of cumin in the world. The area under cumin cultivation in India is about 8.08 lakh ha with annual production of 5.03 lakh MT (Anon., 2018a) [2]. Cumin accounts for 7-8% of India’s total spice exports. During 2017-18, total volume of 1.43 lakh tones of cumin valued at Rs 2,418 crore was exported (Anon., 2018b) [3]. Cumin is commercially cultivated in the semi-arid tracts of Gujarat and Rajasthan. In Gujarat, Surendranagar, Banaskatha, Jamnagar and Patan are major cumin producing districts of Gujarat. Aphid is very serious pest of cumin. Both nymph as well as adult cause’s damage to the crop by sucking the cell sap from tender stem, leaves, inflorescence and developing grains and secreting honey dew. Due to their fast multiplication within few days, aphids cover the entire surface of apical shoots and as a result of continuous feeding by such a large population yellowing, curling and subsequent drying of leaves takes place resulting in poor and shriveled seed formation. The knowledge about the biology of the pest is necessary for planning the management schedule of the pest. Therefore, this work included the bionomics of the aphid infesting the cumin crop under laboratory conditions, as a pre-requisite in the concept of integrated pest management.

**Materials and Methods**

**Bionomics of cumin aphid, *Aphis gossypii* Glover**

The study on bionomics was carried out in PG laboratory of Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh during 2019-20.
Method of description and measurement of nymph and adult

Culture maintenance
Initial culture (nymphs and adults) of aphid was raised on cumin plants grown at Entomological Farm, College of Agriculture, JAU, Junagadh. Thereafter, nymphs and adults were collected and shifted to laboratory raised cumin plants, which were grown in pots covered with glass chimney. The upper end of glass chimney was covered with muslin cloth with the help of rubber band.

Technique of rearing
For study on different aspects of bionomics, the aphids were collected from the potted plants and reared individually in Petri dishes. The fresh cumin twigs were provided on daily basis as a food for the aphids. The twigs were wrapped with wetted cotton wool to keep the twigs fresh and turgid for longer time. The aphids were slightly disturbed initially by touching with the hair brush to head so as to withdraw their mouthparts from the twigs and then they were transferred gently on new twigs with the help of wet hair brush.

Nymphs
To study the number of nymphal instars, their duration and the total nymphal period, twenty five newly laid nymphs were transferred individually to each Petri dish containing fresh cumin twigs. The food was changed daily in the morning. The number and duration of nymphal instars were confirmed by the presence of exuviae cast off in the Petri dishes and recorded the days of instars. The measurements of length and width of each nymphal instar were recorded with help of Leica microscope with its measuring software.

Longevity and measurements
The adult longevity was calculated on cumin. For the study, twenty newly developed adults were reared individually in each Petri dish. Entire life span was studied from newly born nymphs to the death of adults on cumin. Thus, longevity of adult and life span was worked out. The measurements of length and width of each adult and entire life span were recorded with the help of Leica microscope with its measuring software.

Mode of reproduction
In order to study the pre-reproductive, reproductive and post-reproductive periods as well as intrinsic rate and fecundity of aphids on cumin, the nymphs after fourth moultng were reared individually in separate Petri dishes. The pre-reproductive period was considered from the emergence of adult to the starting of nymph laying. The post reproductive period was the period between birth of last young one to the death of adult. The number of young ones produced by single aphid were counted daily and considered as its reproductive capacity. Thus, all the reproductive aspects, longevity of adult and entire life span was carried out.

Results and Discussion

Bionomics of cumin aphid, A. gossypii Glover
The present investigation on the biological parameters of aphids, A. gossypii was carried out under laboratory condition at Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh. The results are presented hereunder.

Description and measurement of nymphs
The study on nymphal duration was conducted during 2019 under laboratory condition. The number and duration of nymphal instars were confirmed by the presence of exuviae cast-off in the Petri dishes. The measurement of length and width of each nymphal instar were recorded with the help of Leica microscope with its measuring software. The results on the measurement of nymphs are presented hereunder.

First instar nymph
The first instar nymph was wingless, delicate, transparent, and oval in shape, dorsally convex, greenish-brown in color with three pairs of legs. The antennae were found as five segmented, which was fairly long, setaceous /conspicuous and shorter than the body length. The compound eyes were small, just behind the base of antennae and blackish. The thoracic legs were well developed and found uniformly covered with thin hairs. A pair of small blackish coloured cornicles was visible laterally near the tip of the abdomen.

The data presented in Table 1 recorded that the body length of 1st instar aphid was varied from 0.41 to 0.61 mm with an average of 0.49± 0.05 mm and the width of 1st instar aphid was varied from 0.21 to 0.31 mm with an average of 0.25± 0.02 mm. The average antennal length was 0.25± 0.02 mm, while cornicle measured on an average of 0.03 ± 0.01 mm.

Second instar nymph
Freshly mounted second instar nymph differed from the first instar nymph in size and appearance. The nymph was oval and greenish-brown to dark green in colour. Compound eyes were alike to the first instar both in colour and shape. The cornicles were quite distinct and cylindrical.

The data indicate in Table 1 revealed that the body length was varied from 0.64 to 0.76 mm with an average of 0.68± 0.03 mm in length while the width was varied from 0.30 to 0.42 mm with an average of 0.36 ± 0.03 mm. The average antennal length was found 0.34 ± 0.03 mm, while cornicle measured on an average of 0.05 ± 0.01 mm.

Third instar nymph
The colour of third instar nymph remained more or less similar to second instar nymph but differed in its comparative size. The compound eyes were round, little larger than the second instar and brownish.

The data were obtainable in Table 1 exposed that the body length was varied from 0.83 to 0.99 mm with an average of 0.88± 0.04 mm while the width of 3rd instar aphid was varied from 0.41 to 0.54 mm with an average of 0.46± 0.03 mm. The average antennal length was found 0.49± 0.03 mm, while cornicle measured on an average of 0.07± 0.02 mm.

Fourth instar nymph
Fourth instar nymph was found dark green to blackish in colour and elongated in shape. The nymph was very active and moved rapidly when disturbed. The compound eyes were enlarged and reddish black. The cornicles were visible with naked eyes.

The results obtainable in Table 1 indicated that the body length was varied from 1.08 to 1.23 mm with an average of 1.15± 0.04 mm and the width of 4th instar aphid was varied from 0.55 to 0.70 mm with an average of 0.60 ± 0.04 mm.
The average antennal length was found 0.58± 0.04 mm, while cornicle was found 0.12± 0.03 mm long.

The present findings of the size and shape of different instars of aphid, A. gossypii are found in support of the results of Ranila (2015) [10] and Kathrotia (1995) [8]. According to Ranila (2015) [10], the body length, width, antennal length and cornical length was measured with an average of 0.51± 0.06, 0.25± 0.03, 0.23± 0.01 & 0.04± 0.01mm; 0.70± 0.09, 0.38 ± 0.03, 0.35 ± 0.02 & 0.08± 0.01mm; 0.95± 0.06, 0.5± 0.07, 0.50± 0.05 & 0.10± 0.01 mm and 1.16± 0.09, 0.67± 0.02, 0.58± 0.03 & 0.19± 0.01 mm for first, second, third and fourth instar nymph, respectively when aphids, A. gossypii were reared on coriander crop. Kathrotia (1995) [8] indicated that the body length of 1st, 2nd, 3rd and 4th instars aphids were on average of 0.49± 0.084 mm, 0.70± 0.035 mm, 0.87± 0.034 mm and 1.17± 0.055 mm, respectively while, the width of all four instars were 0.25± 0.026 mm, 0.36± 0.029 mm, 0.51± 0.046 mm and 0.61± 0.031 mm, respectively when A. gossypii were reared on cumin crop as they were found the antennal & cornicle length in chronological order of all four instars were 0.26± 0.018 mm, 0.36± 0.028 mm, 0.50± 0.040 mm and 0.53± 0.02 mm & 0.02± 0.008 mm, 0.05± 0.022 mm, 0.10 ± 0.024 mm and 0.17± 0.027 mm, respectively.

### Description and measurement of adults

The measurement of length and width of each adult was recorded with the help of Leica microscope with its measuring software. It was shown that the adult was dark green to blackish in colour with a somewhat pear-shaped elongated pyriform body. It obsessed a well developed and conspicuous black coloured pair of cornicles, a pair antenna and three pair of legs. The compound eyes were dark black and bulged. The third pair of legs was longer than the first and second one. The abdomen was dark green mottled with darker patches. The antenna of apterate adults composed of six segments and shorter than body length.

The results presented in Table 1 revealed that the body length was varied from 1.27 to 1.51 mm with an average of 1.38± 0.05 mm while the width was varied from 0.64 to 0.78 mm with an average of 0.69± 0.03 mm. The average antennal length was found 0.68± 0.05 mm, while cornicle was measured on an average of 0.18± 0.03 mm. The results of present findings are more or less similar to that of earlier worker i.e. Ranila (2015) [10] and Kathrotia (1995) [8] as they both reported 1.29± 0.08 & 0.70±0.08 and 1.29± 0.089 mm & 0.68± 0.031 mm body length and width of adult A. gossypii, when it was reared on coriander & cumin, respectively. In connection to antennal and cornicle length, similar results were found by both the workers i.e. 1.12± 0.03 & 0.27± 0.01 and 0.66± 0.030 mm & 0.21± 0.028 mm, respectively.

### Duration of nymphal instars

#### First nymphal instars

The results presented in Table 2 indicated that the first instar nymphal period was varied from 1 to 2 days with an average of 1.44 ± 0.50 days at an average laboratory temperature of 29.65 ± 0.49 °C in the range of 29.30 to 30.00 °C and the relative humidity of 26.50 ± 0.71 per cent in the range of 26.00 to 27.00 per cent.

#### Second nymphal instars

The second nymphal instar period was varied from 1 to 3 days with an average of 2.20± 0.65 days at the prevailing average laboratory temperature of 27.77 ± 1.33 °C in the range of 26.90 to 29.30 °C and the relative humidity of 27.67 ± 1.15 per cent in the range of 27.00 to 29.00 per cent.

#### Third nymphal instars

The third instar nymphal period was varied from 1 to 3 days with an average of 2.65± 0.78 days at the prevailing average laboratory temperature of 27.27 ± 1.33 °C in the range of 26.90 to 29.30 °C and the relative humidity of 26.50 ± 0.71 per cent in the range of 26.00 to 27.00 per cent.

#### Fourth nymphal instars

The fourth instar nymphal period was varied from 1 to 2 days with an average of 3.78± 0.90 days at the prevailing average laboratory temperature of 28.00 ± 0.51 °C in the range of 27.77 to 29.10 °C and the relative humidity of 34.33 ± 2.08 per cent in the range of 34.20 to 36.00 per cent.

#### Total nymphal period

The data presented in Table 3 indicated that the total nymphal period was varied from 5 to 10 days with an average of 7.63 ± 1.29 days at an average laboratory temperature of 28.33 ± 1.13 °C in the range of 26.90 to 30.00 °C and the relative humidity of 30.38 ± 3.78 per cent in the range of 26.00 to 36.00 per cent.

The present findings are effectively following Ghetiya (1992)
who found the average period of first, second, third and fourth nymphal instar in the range of 1.475 ± 0.506, 1.730 ± 0.693, 1.676 ± 0.587 and 1.586 ± 0.501 days, respectively. The total days for the development of all four instars were 6.586 ± 1.086 days, for *A. gossypii* on coriander. On the cumin crop, the average period of first, second, third and fourth nymphal instar of *A. gossypii* was found 1.675 ± 0.474, 1.833 ± 0.655, 1.774 ± 0.717 and 1.555 ± 0.506 days, respectively while 6.926 ± 1.0720 days required for total nymphal development (Kathrotia, 1995) [8].

### Table 3: Total nymphal period and life span of aphid, *A. gossypii*

| Particulars            | No. of observation | Duration (Days) | Temperature (°C) | Relative Humidity (%) |
|------------------------|--------------------|-----------------|------------------|-----------------------|
|                        |                    | Max  | Min  | Av. ± S.D. | Max  | Min  | Av. ± S.D. | Max  | Min  | Av. ± S.D. |
| Total Nymph period     | 21                 | 10   | 5    | 7.63 ± 1.29 | 30.00 | 26.90 | 28.33 ± 1.13 | 36.00 | 26.00 | 30.38 ± 3.78 |
| Total life span        | 21                 | 21   | 5    | 17.72 ± 1.45 | 30.20 | 26.90 | 28.59 ± 1.06 | 41.00 | 26.00 | 32.18 ± 4.33 |

### Table 4: Pre-Reproductive, reproductive, post-reproductive period of aphid, *A. gossypii*

| No. of observation | Pre-Reproductive (Days) | Reproductive (Days) | Post-Reproductive (Days) |
|-------------------|-------------------------|---------------------|--------------------------|
|                   | Max | Min | Av. ± S.D. | Max | Min | Av. ± S.D. | Max | Min | Av. ± S.D. |
| 21                | 2   | 1   | 1.31 ± 0.47 | 9   | 5   | 7.04 ± 1.13 | 3   | 1   | 1.72 ± 0.70 |

### Table 5: Fecundity and intrinsic rate of aphid, *A. gossypii*

| No. of observation | Fecundity (No. /adult) | Intrinsic rate (No. of nymph /female /days) |
|-------------------|------------------------|-----------------------------------------|
|                   | Max | Min | Av. ± S.D. | Max | Min | Av. ± S.D. |
| 21                | 39  | 16  | 26.5 ± 6.77 | 9   | 1   | 4.3 ± 2.62 |

### Longevity

The results presented in Table 4.3 revealed that the adult aphids were lived up to 8 to 12 days with an average of 10.14 ± 1.49 days at an average laboratory temperature of 28.82 ± 1.00 °C in the range of 27.00 to 30.20 °C and the relative humidity of 33.78 ± 4.35 per cent in the range of 28.00 to 41.00 per cent. The present findings confirm with the results declared by Ghetiya (1992) [4] and Kathrotia (1995) [8] who indicated that the average period of *A. gossypii* adult longevity was 11.759 ± 1.662 and 10.741 ± 1.810 days on coriander & cumin, respectively.

### Entire life span

The duration of the entire life span from the first instar nymph to death of adult of *A. gossypii* is presented in Table 3. The data presented that the entire life span varied from 15 to 21 days with an average of 17.33 ± 1.91 days at an average laboratory temperature of 28.59 ± 1.06 °C in the range of 26.90 to 30.20 °C and the relative humidity of 32.18 ± 4.33 per cent in the range of 26 to 41 per cent which is recorded by the findings of Ghetiya (1992) [4] and Kathrotia (1995) [8] as they have reported that *A. gossypii* have completed their life cycle after 18.344 ± 2.468 and 17.629 ± 2.289 days on coriander & cumin crop, respectively.

### Mode of reproduction (reproductive period, intrinsic rate and fecundity)

It was found that *A. gossypii* was reproduced parthenogenetically by laying young ones throughout the study period. The males were not found during the entire period of this investigation on the cumin crop. Ghetiya (1992) [4] and Kathrotia (1995) [8] reported that *A. gossypii* was found to reproduce parthenogenetically on coriander and cumin crop.

### Reproductive period (pre-reproductive, reproductive and post-reproductive)

The data presented in Table 4 revealed that the pre-reproductive, reproductive and post-reproductive period was varied from 1 to 2, 5 to 9 and 1 to 3 days with an average of 1.31 ± 0.47, 7.04 ± 1.13 and 1.72 ± 0.70 days, respectively  at an average laboratory temperature of 28.82 ± 1.00 °C in the range of 27.00 to 30.20 °C and the relative humidity of 33.78 ± 4.35 per cent in the range of 28.00 to 41.00 per cent.

Ghetiya (1992) [4] and Kathrotia (1995) [8] reported that the pre-reproductive, reproductive and post-reproductive period for *A. gossypii* on an average of 1.28 ± 0.20, 8.44 ± 2.49 and 1.64 ± 0.79 days & 1.76 ± 0.77, 8.43 ± 1.86 and 2.10 ± 1.02 days in fennel crop, respectively.

### Intrinsic rate

The data on the rate of reproduction is presented in Table 5 indicate that the young ones produced by a single female per day were varied from 1 to 9 with an average of 4.3 ± 2.62 nymphs at the average laboratory temperature of 28.90 ± 1.14 °C in the range of 27.00 to 30.20 °C and the relative humidity of 34.14 ± 4.53 per cent in the range of 28.00 to 41.00 per cent. The results are more or less similar with the findings of Ghetiya (1992) [4] and Kathrotia (1995) [8] who reported the intrinsic rate of *A. gossypii* on coriander and cumin crop as 3.688 ± 2.127 & 2.91 ± 1.398 nymphs per female /day, respectively.

### Fecundity

The mother aphid was found to withhold the newly born nymphs in protruded condition until the legs of new nymph spread out and capable of movements. The interval between the birth of young ones and the total young ones born were varied greatly with individuals. The reproductive capacity of each female was calculated by nymphs laid per day during its entire life span. The data on the rate of reproduction and reproductive capacity are presented in Table 5.

The data given in table 5 revealed that the number of young ones produced by a single female throughout its entire reproductive period was varied from 16 to 39 with an average of 26.5 ± 6.77 nymphs at the average laboratory temperature of 28.90 ± 1.14 °C in the range of 27.00 to 30.20 °C and the relative humidity of 34.14 ± 4.53 per cent in the range of 28.00 to 41.00 per cent which is in great connection with the findings of Ghetiya (1992) [4] and Kathrotia (1995) [8] reported that the single female produced on an average of 29.31 ± 8.965 & 20.77 ± 7.062 nymphs on coriander and cumin crop for *A. gossypii*, respectively.
Fig 1: Fecundity and intrinsic rate of aphid, *A. gossypii*

Reference

1. Aiyer AK, Narayan Y. “Field crops of India” The Bangalore printing and Publishing Co. Ltd. 1950, 315-317.
2. Anonymous. 2018a. http://indianspices.com/sites/default/file/spices_growing.pdf. Retrieved 12 1 2018, from spices wise area & production. Spices Board India.
3. Anonymous. 2018b. http://indianspices.com/sites/default/file/Monthly_estimate_2018.pdf. Retrieved 12 25, 2018, from Estimated export of spices from India, Spices board of India.
4. Ghetiya LV. Bionomics, population dynamics and chemical control of aphid, *A. gossypii* on coriander. M. Sc. (Agri.) Thesis Submitted to GAU, Junagadh. 1992.
5. Hirpara KD. Bionomics and control of *H. coriandri* (Das) on fennel. M. Sc thesis submitted to GAU, Junagadh campus. 2000.
6. Jid JK. Biology and management of cumin aphid, *Myzus persicae* (Sulzer) on cumin. M. Sc. (Agri.) A Thesis submitted to SDAU, Sardarkrushinagar. 2011.
7. Kanjiya RR. Bionomics, population dynamics and management of aphid, *H. coriandri* infesting fennel. M. Sc. (Agri.) A Thesis submitted to JAU, Junagadh. 2017.
8. Kathrotia RL. Bionomics, population dynamics and efficacy of insecticides in combination with spreader against aphid, *A. gossypii* on cumin. M. Sc. (Agri.) Thesis submitted to GAU, Junagadh. 1995.
9. Patil SJ, Patel SR, Bhatt BJ. Biology of aphid, *A. gossypii* infesting isabgul crop. Medicinal Plant Research. 2013;3(7):52-56.
10. Ranila A, Borad PK, Kanani MK. Bionomics of aphid, *A. gossypii* infesting coriander. The Bioscan 2015a;10(1):63-66.