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## 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 & cornicle length of first, second, third and fourth instar nymphs were  $0.49 \pm 0.05$ ,  $0.25 \pm 0.02$ ,  $0.25 \pm 0.02$  &  $0.03 \pm 0.01$  mm;  $0.68 \pm 0.03$ ,  $0.36 \pm 0.03$ ,  $0.34 \pm 0.03$  &  $0.05 \pm 0.01$  mm;  $0.88 \pm 0.04$ ,  $0.46 \pm 0.03$ ,  $0.49 \pm 0.03$  &  $0.07 \pm 0.02$  mm and  $1.15 \pm 0.04$ ,  $0.60 \pm 0.04$ ,  $0.58 \pm 0.04$  &  $0.12 \pm 0.03$  mm, respectively. Average body length, width, antennal length and cornicle length of adult aphid were  $1.38 \pm 0.05$ ,  $0.69 \pm 0.03$ ,  $0.68 \pm 0.05$  and  $0.18 \pm 0.03$  mm, respectively. The average developmental period of first, second, third and fourth nymphal instar nymphs were  $1.44 \pm 0.50$ ,  $2.20 \pm 0.65$ ,  $2.50 \pm 0.51$  and  $1.50 \pm 0.51$  days, respectively. The total nymphal duration was  $7.63 \pm 1.29$  days. The mean longevity of adult aphid was showed to be  $10.09 \pm 1.30$  days with an entire life span of  $17.72 \pm 1.45$  days. The pre-reproductive, reproductive and post-reproductive periods were recorded to be  $1.31 \pm 0.47$ ,  $7.04 \pm 1.13$  and  $1.72 \pm 0.70$  days, respectively. The fecundity was showed to be  $26.5 \pm 6.77$  nymphs per female and the intrinsic rate of single female per day was an average of  $4.3 \pm 2.62$  nymphs /day.

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

### Introduction

Cumin (*Cuminum cyminum* Linnaeus), locally known as 'Jeera' or 'Jeru' belongs to the family Umbelliferae. It is a good medicine for digestive and intestinal upsets and is used in veterinary medicine (Aiyer and Narayan, 1950) <sup>[1]</sup>. India is the leading producer (70% of world production), consumer and exporter of cumin worldwide. In India, the area under cumin cultivation is about 8.08 lakh ha, with an annual production of 5.03 lakh MT (Anon., 2018a) <sup>[2]</sup>. Cumin accounts for 7-8% of India's total spice exports. During 2017-18, a total volume of 1.43 lakh tones of cumin valued at Rs 2,418 crore was exported (Anon., 2018b) <sup>[3]</sup>. 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 a 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 honeydew. Due to their fast multiplication within a 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 take place resulting in poor and shriveled seed formation. The knowledge about the pest's biology 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 the PG laboratory of the Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh during 2019-20.

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## 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 the glass chimney was covered with muslin cloth with the help of a rubber band.

### Technique of rearing

To study 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 food for the aphids. The twigs were wrapped with wetted cotton wool to keep the twigs fresh and turgid for a longer time. The aphids were initially slightly disturbed by touching with the hairbrush to the head to withdraw their mouthparts from the twigs and then they were transferred gently to new twigs with the help of a wet hairbrush.

### 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 casted off in the Petri dishes and recorded the days of instars. The measurements of length and width of each nymphal instar were recorded with the help of a Leica microscope with its measuring software.

### Longevity and measurements

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

### Mode of reproduction

To study the pre-reproductive, reproductive and post-reproductive periods as well as the intrinsic rate and fecundity of aphids on cumin, the nymphs after fourth moulting were reared individually in separate Petri dishes. The pre-reproductive period was considered from the emergence of adults to the starting of nymph laying. The post-reproductive period was the period between the birth of the last young one to the death of an adult. The number of young ones produced by a single aphid was counted daily and considered as its reproductive capacity. Thus, all the reproductive aspects, the longevity of adults, and the entire life span were 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 conditions at the 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 conditions. The number and time 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 a Leica microscope with its measuring software. The results of 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 1<sup>st</sup> instar aphid was varied from 0.41 to 0.61 mm with an average of  $0.49 \pm 0.05$  mm and the width of 1<sup>st</sup> instar aphid was varied from 0.21 to 0.31 mm with an average of  $0.25 \pm 0.02$  mm. The average antennal length was  $0.25 \pm 0.02$  mm, while the cornicle measured on an average of  $0.03 \pm 0.01$  mm.

### Second instar nymph

Freshly mounted second instar nymph differed in size and appearance from the first instar nymph. 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  $0.68 \pm 0.03$  mm in length, while the width was varied from 0.30 to 0.42 mm with an average of  $0.36 \pm 0.03$  mm. The average antennal length was found to be  $0.34 \pm 0.03$  mm, while the cornicle was measured on an average of  $0.05 \pm 0.01$  mm.

### Third instar nymph

The color of the third instar nymph remained more or less similar to the second instar nymph but differed in its comparative size. The compound eyes were round, a 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  $0.88 \pm 0.04$  mm while the width of the 3<sup>rd</sup> instar aphid was varied from 0.41 to 0.54 mm with an average of  $0.46 \pm 0.03$  mm. The average antennal length was found  $0.49 \pm 0.03$  mm, while the cornicle was measured on an average of  $0.07 \pm 0.02$  mm.

### Fourth instar nymph

The 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  $1.15 \pm 0.04$  mm and the width of the 4<sup>th</sup> instar aphid was varied from 0.55 to 0.70 mm with an average of  $0.60 \pm 0.04$  mm.

**Table 1:** Measurement of nymphal instars and adult of cumin aphid, *A. gossypii*

Stage	No. of observation	Body length (mm)			Body width (mm)			Antennal length (mm)	Cornicle length (mm)
		Max	Min	Av. ± S.D.	Max	Min	Av. ± S.D.		
1 <sup>st</sup> instar	25	0.61	0.41	0.49±0.05	0.31	0.21	0.25±0.02	0.25±0.02	0.03±0.01
2 <sup>nd</sup> instar	25	0.76	0.64	0.68±0.03	0.42	0.30	0.36±0.03	0.34±0.03	0.05±0.01
3 <sup>rd</sup> instar	23	0.99	0.83	0.88±0.04	0.54	0.41	0.46±0.03	0.49±0.03	0.07±0.02
4 <sup>th</sup> instar	21	1.23	1.08	1.15±0.04	0.70	0.55	0.60±0.04	0.58±0.04	0.12±0.03
Adult	21	1.51	1.27	1.38±0.05	0.78	0.64	0.69±0.03	0.68±0.05	0.18±0.03

**Table 2:** Duration of different nymphal and adult of aphid, *A. gossypii*

Stage	No. of observation	Duration (Days)			Temperature (°C)			Relative Humidity (%)		
		Max	Min	Av. ± S.D.	Max	Min	Av. ± S.D.	Max	Min	Av. ± S.D.
1 <sup>st</sup> instar	25	2	1	1.44 ± 0.50	30.00	29.30	29.65 ± 0.49	27.00	26.00	26.50 ± 0.71
2 <sup>nd</sup> instar	25	3	1	2.20± 0.65	29.30	26.90	27.77 ± 1.33	29.00	27.00	27.67 ± 1.15
3 <sup>rd</sup> instar	23	3	2	2.5± 0.51	28.10	27.10	27.53 ± 0.51	32.00	27.00	30.00 ± 2.65
4 <sup>th</sup> instar	21	2	1	1.5± 0.51	29.10	28.10	28.63 ± 0.50	36.00	32.00	34.33 ± 2.08
Adult	21	12	7	10.09± 1.30	30.20	27.00	28.82 ± 1.00	41.00	28.00	33.78 ± 4.35

The average antennal length was found  $0.58 \pm 0.04$  mm, while the cornicle was found  $0.12 \pm 0.03$  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 cornicle length was measured with an average of  $0.51 \pm 0.06$ ,  $0.25 \pm 0.03$ ,  $0.23 \pm 0.01$  &  $0.04 \pm 0.01$  mm;  $0.70 \pm 0.09$ ,  $0.38 \pm 0.03$ ,  $0.35 \pm 0.02$  &  $0.08 \pm 0.01$  mm;  $0.95 \pm 0.06$ ,  $0.53 \pm 0.07$ ,  $0.50 \pm 0.05$  &  $0.10 \pm 0.01$  mm and  $1.16 \pm 0.09$ ,  $0.67 \pm 0.02$ ,  $0.58 \pm 0.03$  &  $0.19 \pm 0.01$  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 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars aphids were on average of  $0.49 \pm 0.084$  mm,  $0.70 \pm 0.035$  mm,  $0.87 \pm 0.034$  mm and  $1.17 \pm 0.055$  mm, respectively while, the width of all four instars were  $0.25 \pm 0.026$  mm,  $0.36 \pm 0.029$  mm,  $0.51 \pm 0.046$  mm and  $0.61 \pm 0.031$  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  $0.26 \pm 0.018$  mm,  $0.36 \pm 0.028$  mm,  $0.50 \pm 0.040$  mm and  $0.53 \pm 0.02$  mm &  $0.02 \pm 0.008$  mm,  $0.05 \pm 0.022$  mm,  $0.10 \pm 0.024$  mm and  $0.17 \pm 0.027$  mm, respectively.

#### Description and measurement of adults

The measurement of length and width of each adult was recorded with the help of a 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 possessed a well-developed and conspicuous black coloured pair of cornicles, a pair antenna and three pairs 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 apterous adults is composed of six segments and is 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  $1.38 \pm 0.05$  mm while the width was varied from 0.64 to 0.78 mm with an average of  $0.69 \pm 0.03$  mm. The average antennal length was found  $0.68 \pm 0.05$  mm, while the cornicle was measured on an average of  $0.18 \pm 0.03$  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  $1.29 \pm 0.08$  &  $0.70 \pm 0.08$  and  $1.29 \pm 0.089$  mm &  $0.68 \pm 0.031$  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.  $1.12 \pm 0.03$  &  $0.27 \pm 0.01$  and  $0.66 \pm 0.030$  mm &  $0.21 \pm 0.028$  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  $1.44 \pm 0.50$  days at an average laboratory temperature of  $29.65 \pm 0.49$  °C in the range of 29.30 to 30.00 °C and the relative humidity of  $26.50 \pm 0.71$  percent in the range of 26.00 to 27.00 percent.

##### Second nymphal instars

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

##### Third nymphal instars

The third instar nymphal period was varied from 2 to 3 days with an average of  $2.5 \pm 0.51$  days with an average laboratory temperature of  $27.53 \pm 0.51$  °C in the range of 27.10 to 28.10 °C and the relative humidity of  $30.00 \pm 2.65$  percent in the range of 27.00 to 32.00 percent.

##### Fourth nymphal instars

The fourth instar nymphal period was varied from 1 to 2 days with an average of  $1.5 \pm 0.51$  days with an average laboratory temperature of  $28.63 \pm 0.50$  °C in the range of 28.10 to 29.10 °C and the relative humidity of  $34.33 \pm 2.08$  percent in the range of 32.00 to 36.00 percent.

#### 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  $7.63 \pm 1.29$  days at an average laboratory temperature of  $28.33 \pm 1.13$  °C in the range of 26.90 to 30.00 °C and the relative humidity of  $30.38 \pm 3.78$  percent in the range of 26.00 to 36.00 percent.

The present findings effectively follow Ghetiya (1992) [4], who found the average period of first, second, third and fourth nymphal instar in the range of  $1.475 \pm 0.506$ ,  $1.730 \pm 0.693$ ,

1.676 $\pm$  0.587 and 1.586 $\pm$ 0.501 days, respectively. The total days for developing all four instars were 6.586 $\pm$  1.086 days, for *A. gossypii* on coriander. On the cumin crop, the average period of the first, second, third and fourth nymphal instar of

*A. gossypii* was found to be 1.675+ 0.474, 1.833+ 0.655, 1.774+ 0.717 1.555 $\pm$  0.506 days, respectively while 6.926 $\pm$  1.0720 days required for total nymphal development (Kathrotia, 1995)<sup>[8]</sup>.

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

Particulars	No. of observation	Duration (Days)			Temperature ( $^{\circ}$ 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 $\pm$ 1.29	30.00	26.90	28.33 $\pm$ 1.13	36.00	26.00	30.38 $\pm$ 3.78
Total life span	21	21	16	17.72 $\pm$ 1.45	30.20	26.90	28.59 $\pm$ 1.06	41.00	26.00	32.18 $\pm$ 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 $\pm$ 0.47	9	5	7.04 $\pm$ 1.13	3	1	1.72 $\pm$ 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 $\pm$ 6.77	9	1	4.3 $\pm$ 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  $\pm$  1.49 days at an average laboratory temperature of 28.82  $\pm$  1.00  $^{\circ}$ C in the range of 27.00 to 30.20  $^{\circ}$ C and the relative humidity of 33.78  $\pm$  4.35 percent in the range of 28.00 to 41.00 percent. The present findings confirm with the results declared by Ghetiya (1992)<sup>[4]</sup> and Kathrotia (1995)<sup>[8]</sup>, who indicated that the average period of *A. gossypii* adult longevity was 11.759 $\pm$  1.662 and 10.741 $\pm$  1.810 days on coriander & cumin, respectively.

### Entire life span

The duration of the entire life span from the first instar nymph to the death of an adult of *A. gossypii* is presented in Table 3. The data presented that the whole life span varied from 15 to 21 days with an average of 17.33  $\pm$  1.91 days at an average laboratory temperature of 28.59  $\pm$  1.06  $^{\circ}$ C in the range of 26.90 to 30.20  $^{\circ}$ C and the relative humidity of 32.18  $\pm$  4.33 percent in the range of 26 to 41 percent which is recorded by the findings of Ghetiya (1992)<sup>[4]</sup> and Kathrotia (1995)<sup>[8]</sup> as they have reported that *A. gossypii* have completed their life cycle after 18.344  $\pm$  2.468 and 17.629 $\pm$  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)<sup>[4]</sup> and Kathrotia (1995)<sup>[8]</sup> reported that *A. gossypii* was found to reproduce parthenogenetically on coriander and cumin crops

### 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 $\pm$  0.47, 7.04 $\pm$  1.13 and 1.72 $\pm$  0.70 days, respectively at an average laboratory temperature of 28.82  $\pm$  1.00  $^{\circ}$ C in the

range of 27.00 to 30.20  $^{\circ}$ C and the relative humidity of 33.78  $\pm$  4.35 percent in the range of 28.00 to 41.00 percent Ghetiya (1992)<sup>[4]</sup> and Kathrotia (1995)<sup>[8]</sup> reported that the pre-reproductive, reproductive and post-reproductive period for *A. gossypii* on an average of 1.28  $\pm$  0.20, 8.44  $\pm$  2.49 and 1.64  $\pm$  0.79 days & 1.76  $\pm$  0.77, 8.43  $\pm$  1.86 and 2.10  $\pm$  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 $\pm$  2.62 nymphs at the average laboratory temperature of 28.90  $\pm$  1.14  $^{\circ}$ C in the range of 27.00 to 30.20  $^{\circ}$ C and the relative humidity of 34.14  $\pm$  4.53 percent in the range of 28.00 to 41.00 percent. The results are more or less similar with the findings of Ghetiya (1992)<sup>[4]</sup> and Kathrotia (1995)<sup>[8]</sup> who reported the intrinsic rate of *A. gossypii* on coriander and cumin crop as 3.688 $\pm$  2.127 & 2.91 $\pm$  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 the 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 $\pm$  6.77 nymphs at the average laboratory temperature of 28.90  $\pm$  1.14  $^{\circ}$ C in the range of 27.00 to 30.20  $^{\circ}$ C and the relative humidity of 34.14  $\pm$  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)<sup>[4]</sup> and Kathrotia (1995)<sup>[8]</sup> reported that the single female produced on an average of 29.31 $\pm$  8.965 & 20.777 $\pm$  7.062 nymphs on coriander and cumin crop for *A. gossypii*, respectively.

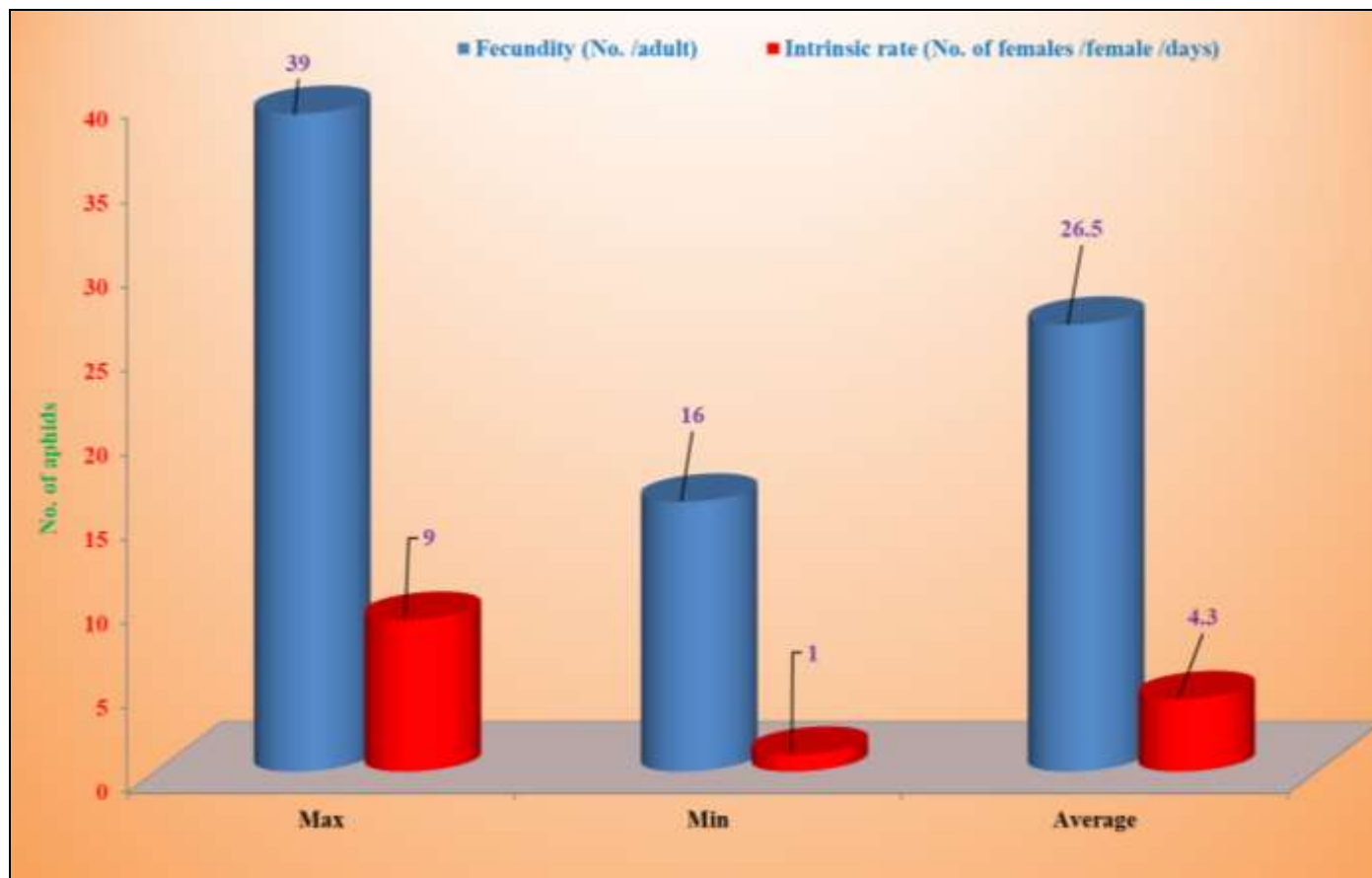


Fig 1: Fecundity and intrinsic rate of aphid, *A. gossypii*

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