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## Diversity of aphids in South Gujarat

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**Abstract**

The diversity work on aphids was carried out in all seven districts (Bharuch, Narmada, Surat, Tapi, Navsari, The Dangs and Valsad) of South Gujarat region during January 2018 to December 2018. Extensive survey of various fields of all seven districts of South Gujarat was carried out during the study period. The work resulted in record of total fourteen species of aphids of which *Aphis gossypii* Glover was found most abundant whereas *Therioaphis trifolii* Monell found least occurring from all over South Gujarat region. In all the seven districts, *A. gossypii* was found the most abundant while, *Aphis nerii* Boyer de Fonscolombe was found least abundant except Narmada and Navsari districts where *Therioaphis trifolii* Monell was least occurring.

**Keywords:** Diversity, aphids, South Gujarat

**Introduction**

Aphids are small sized (1 to 10 mm), soft bodied insects belonging to order Hemiptera, sub-order Sternorrhyncha, super-family Aphidoidea and ten families viz., Pemphigidae, Anoeciidae, Hormaphididae, Mindaridae, Aphididae, Thelaxidae, Drepanosiphidae, Phloeomyzidae, Greenideidae, and Lachnidae [1]. They are also known as greenfly, blackfly or plant lice. They can easily be identified by their pear or globular shaped soft body, cauda pointed at the end of the abdomen (not present in all species) and one pair of siphunculi present on either 5<sup>th</sup> or 6<sup>th</sup> tergite of uromeres. Two forms of aphids, winged (alate) and wingless (apterous) are observed. Winged forms usually fly at speed of about 1.6 to 3.2 km per hour [1]. Most of aphids are polyphagous, but some also are found monophagous. According to various species of plants they feed on, different body colours like white, black, brown, grey, yellow, green, pink, red they exhibit. They are adapted to wide range of climate as they do not only found in tropical, sub-tropical but temperate regions of the world, too. It is believed that aphids are evolved from adelgids and phylloxerids. The oldest known fossil aphid is *Triassoaphis cubitus* Evans from Triassic period about 220 million years ago [1]. Aphids have piercing and sucking type of mouth parts and that whole composition is called rostrum with which they suck juices from phloem of succulent and tender plant parts causing curling, stunting or yellowing of leaves, poor pod and seed formation. Besides these damages, some also act as vectors of some plant viruses. Aphids generally transmit potyviridae family of plant viruses in non circulative or non-persistent manner that means the viruses are only stylet borne not reaching to the gut of aphids [2]. All over the world around 4702 aphid species have been recorded [3]. However, in case of oriental region, 1015 species have been recorded [4]. Out of these, Aphididae family covers around 653 species in India [5]. Diversity work regarding aphids in South Gujarat was not done yet. The present paper provides district wise population and diversity data of aphids of South Gujarat region.

**Materials and Methods**

Diversity of aphids was calculated in all seven districts (Bharuch, Narmada, Surat, Tapi, Navsari, The Dangs and Valsad) of South Gujarat during January 2018 to December 2018. The survey of aphids was carried out by critically taking spot observations of various agricultural fields as well as random plants present in South Gujarat region. The collected aphid specimens were identified by NBAIR, Bengaluru. Besides, the keys given in a book entitled "Handbook on Hemipteran Pests in India" by L. K. Ghosh [6] as well as other relevant internet sources like <http://idtools.org/id/AphID/polycosmo10.html> [http://influentialpoints.com/Gallery/Aphid\\_genera.htm](http://influentialpoints.com/Gallery/Aphid_genera.htm)

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were also referred for identification of aphid species. Aphid diversity was evaluated on the basis of relative abundance of

aphid species on various host plants. Colonies of aphids were recorded in zero to four grades (Table 1).

**Table 1:** Zero to four grades to classify colonies of aphids

Indices	Description
0	Plant free from aphid
1	Aphid present but colonies are not built up. No injury due to pest apparent on the plant
2	Small colonies of aphid are present
3	Large colonies of aphids present on tender parts and countable but plant parts show the damage symptoms due to aphid
4	Entire plant is covered by aphids. Counts of aphids in colonies are impossible and plants show the damage symptoms due to aphid

At some places, aphids did not form colonies, at that time, for ease of analysis, counting of aphids was done by classifying population in zero to four grades (Table 2).

**Table 2:** Zero to four grades to classify scattered aphids

Indices	Description
0	0 aphids are observed on plant (scattered)
1	1-5 aphids are observed on plant (scattered)
2	6-10 aphids are observed on plant (scattered)
3	11-15 aphids are observed on plant (scattered)
4	More than 15 aphids observed on plant (scattered)

Average aphid grade was calculated by the following formula.

$$\text{Average aphid grade per specie} = \frac{N_0 + N_1 + N_2 + N_3 + N_4}{\text{Total number of plants observed}}$$

Where,

0, 1, 2, 3, 4 are the aphid indices

N = number of plants showing respective aphid index

The diversity index for aphid was computed using Shannon-Wiener Species Diversity Index formula [7].

$$\text{Species diversity index (H)} = - \sum_{i=1}^k p_i (\ln p_i)$$

Where,

$p_i$  = Proportion of  $i^{\text{th}}$  specie in the total sample

$p_i = f_i/n$

$f_i$  = Number of specimens of the  $i^{\text{th}}$  specie

$n$  = Total number of specimen in sample

$k$  = Total number of species

$\ln$  = Natural logarithm ( $\log_e$ )

The evenness of a community was calculated by Pielou's evenness index [8].

$$\text{Evenness (J)} = \frac{H}{H_{\max}}$$

Where,

$H$  = number derived from the Shannon diversity index

$H_{\max}$  = maximum possible value of  $H$

$$H_{\max} = - \sum_{i=1}^n \ln N$$

Where,

$N$  = the total number of species

## Results and Discussions

Total 14 aphid species were recorded from all seven districts of South Gujarat region during January 2018 to December 2018.

The species wise aphid diversity is presented in Table 3. *Aphis gossypii* Glover was highly abundant specie in South Gujarat with 26.04% relative abundance (6696 aphid index). It is because of its polyphagous feeding nature and more availability of variety of its host plants in all seven districts of South Gujarat. The next abundant specie was *Rhopalosiphum maidis* Fitch with 13.31% relative abundance (3423 aphid index) followed by *Hysteroneura setariae* Thomas with 11.05% (2842 aphid index), *Melanaphis sacchari* Zehntner with 10.81% (2779 aphid index), *Aphis craccivora* Koch with 9.16% (2354 aphid index), *Myzus persicae* Sulzer with 8.24% (2119 aphid index), *Brevicoryne brassicae* Linnaeus was 6.93% (1783 aphid index), *Lipaphis erysimi* Kaltendach with 5.00% (1294 aphid index), *Uroleucon compositae* Theobald with 3.15% (810 aphid index), *Acyrtosiphon pisum* Harris with 2.35% (604 aphid index), *Hyadaphis coriandri* Das with 2.09% (537 aphid index), *Aphis nerii* Boyer de Fonscolombe with 0.89% (230 aphid index), *Macrosiphoniella sanborni* Gillette with 0.75% (193 aphid index) and *Therioaphis trifolii* Monell with 0.20% (51 aphid index). Restricted host range and less availability of specific host plants were principal reasons for lower abundance of *A. nerii*, *M. sanborni* and *T. trifolii* in South Gujarat region.

**Table 3:** Population and relative abundance of aphids in South Gujarat

Sr. No.	Aphid species	Population (Aphid index)	Relative Abundance (%)
1.	<i>Aphis gossypii</i>	6696	26.04
2.	<i>Rhopalosiphum maidis</i>	3423	13.31
3.	<i>Hysteroneura setariae</i>	2842	11.05
4.	<i>Melanaphis sacchari</i>	2779	10.81
5.	<i>Aphis craccivora</i>	2354	9.16
6.	<i>Myzus persicae</i>	2119	8.24
7.	<i>Brevicoryne brassicae</i>	1783	6.93
8.	<i>Lipaphis erysimi</i>	1294	5.03
9.	<i>Uroleucon compositae</i>	810	3.15
10.	<i>Acyrtosiphon pisum</i>	604	2.35
11.	<i>Hyadaphis coriandri</i>	537	2.09
12.	<i>Aphis nerii</i>	230	0.89
13.	<i>Macrosiphoniella sanborni</i>	193	0.75
14.	<i>Therioaphis trifolii</i>	51	0.20
	South Gujarat	25715	100

Among all seven districts, the highest relative abundance of 25.40% (6533 aphid index) was recorded in Navsari (Table 4) followed by Bharuch with 15.56% (4002 aphid index), The

Dangs with 12.92% (3322 aphid index), Surat with 12.62% (3245 aphid index), Tapi with 12.40% (3188 aphid index), Narmada with 11.40% (2931 aphid index) and lowest in Valsad with 9.70% with (2494 aphid index). The primary study area was located in Navsari district; maybe that is the reason why it had been recorded with the highest (6533) aphid index. In contrast to that, due to less variability in cropping pattern in Valsad district it might be recorded with the lowest (2494) aphid index among all districts.

**Table 4:** District wise population and relative abundance of aphids in South Gujarat

Sr. No.	Districts	Population of all aphid species (Aphid index)	Relative Abundance (%)
1.	Bharuch	4002	15.56
2.	Narmada	2931	11.40
3.	Surat	3245	12.62
4.	Tapi	3188	12.40
5.	Navsari	6533	25.40
6.	The Dangs	3322	12.92
7.	Valsad	2494	9.70
	Total	25715	100

In Bharuch, total 10 aphid species (Table 5) were recorded of which highly abundant specie was *A. gossypii* with 34.78% (1392 aphid index) followed by *R. maidis* with 11.82% (473 aphid index), *M. persicae* with 10.64% (426 aphid index), *H. setariae* with 10.34% (414 aphid index), *M. sacchari* with 8.85% (354 aphid index), *A. craccivora* with 8.70% (348 aphid index), *B. brassicae* with 7.30% (292 aphid index), *L. erysimi* with 4.65% (186 aphid index), *H. coriandri* with 1.75% (70 aphid index) and *A. nerii* with 1.17% (47 aphid index).

**Table 5:** Population and relative abundance of aphids in Bharuch

Sr. No.	Aphid species	Population (Aphid index)	Relative Abundance (%)
1.	<i>Aphis gossypii</i>	1392	34.78
2.	<i>Rhopalosiphum maidis</i>	473	11.82
3.	<i>Myzus persicae</i>	426	10.64
4.	<i>Hysteroneura setariae</i>	414	10.34
5.	<i>Melanaphis sacchari</i>	354	8.85
6.	<i>Aphis craccivora</i>	348	8.70
7.	<i>Brevicoryne brassicae</i>	292	7.30
8.	<i>Lipaphis erysimi</i>	186	4.65
9.	<i>Hyadaphis coriandri</i>	70	1.75
10.	<i>Aphis nerii</i>	47	1.17
	Total	4002	100

In Narmada, total 13 aphid species (Table 6) were recorded of which highly abundant specie was found *A. gossypii* with 28.15% (825 aphid index) followed by *R. maidis* with 14.40% (422 aphid index), *A. craccivora* with 12.32% (361 aphid index), *H. setariae* with 11.43% (335 aphid index), *M. sacchari* with 11.22% (329 aphid index), *M. persicae* with 7.40% (217 aphid index), *A. pisum* with 4.57% (134 aphid index), *U. compositae* with 2.56% (75 aphid index), *B. brassicae* and *H. coriandri* with 2.39% (70 aphid index), *A.*

*nerii* with 1.50% (44 aphid index), *L. erysimi* with 0.95% (28 aphid index) and *T. trifolii* with 0.72% (21 aphid index).

**Table 6:** Population and relative abundance of aphids in Narmada

Sr. No.	Aphid species	Population (Aphid index)	Relative Abundance (%)
1.	<i>Aphis gossypii</i>	825	28.15
2.	<i>Rhopalosiphum maidis</i>	422	14.40
3.	<i>Aphis craccivora</i>	361	12.32
4.	<i>Hysteroneura setariae</i>	335	11.43
5.	<i>Melanaphis sacchari</i>	329	11.22
6.	<i>Myzus persicae</i>	217	7.40
7.	<i>Acyrtosiphon pisum</i>	134	4.57
8.	<i>Uroleucon compositae</i>	75	2.56
9.	<i>Brevicoryne brassicae</i>	70	2.39
10.	<i>Hyadaphis coriandri</i>	70	2.39
11.	<i>Aphis nerii</i>	44	1.50
12.	<i>Lipaphis erysimi</i>	28	0.95
13.	<i>Therioaphis trifolii</i>	21	0.72
	Total	2931	100

In Surat, total 11 aphid species (Table 7) were recorded of which *A. gossypii* was found highly abundant specie with 22.56% (732 aphid index) followed by *R. maidis* with 13.74% (446 aphid index), *M. sacchari* with 12.85% (417 aphid index), *A. craccivora* with 11.53% (374 aphid index), *H. setariae* with 11.40% (370 aphid index), *M. persicae* with 11.16% (362 aphid index), *B. brassicae* with 9.00% (292 aphid index), *L. erysimi* with 5.02% (163 aphid index), *U. compositae* with 1.76% (57 aphid index), *H. coriandri* with 0.89% (29 aphid index) and *A. nerii* with 0.09% (3 aphid index).

**Table 7:** Population and relative abundance of aphids in Surat

Sr. No.	Aphid species	Population (Aphid index)	Relative Abundance (%)
1.	<i>Aphis gossypii</i>	732	22.56
2.	<i>Rhopalosiphum maidis</i>	446	13.74
3.	<i>Melanaphis sacchari</i>	417	12.85
4.	<i>Aphis craccivora</i>	374	11.53
5.	<i>Hysteroneura setariae</i>	370	11.40
6.	<i>Myzus persicae</i>	362	11.16
7.	<i>Brevicoryne brassicae</i>	292	9.00
8.	<i>Lipaphis erysimi</i>	163	5.02
9.	<i>Uroleucon compositae</i>	57	1.76
10.	<i>Hyadaphis coriandri</i>	29	0.89
11.	<i>Aphis nerii</i>	3	0.09
	Total	3245	100

In Tapi, total 10 aphid species (Table 8) were recorded of which highly abundant specie was *A. gossypii* with 27.92% (890 aphid index) followed by *M. persicae* with 11.67% (372 aphid index), *A. craccivora* with 11.23% (358 aphid index), *B. brassicae* with 11.10% (354 aphid index), *R. maidis* with 10.73% (342 aphid index), *M. sacchari* with 10.41% (332 aphid index), *H. setariae* with 9.19% (293 aphid index), *L. erysimi* with 5.58% (178 aphid index), *H. coriandri* with 1.32% (42 aphid index) and *A. nerii* with 0.85% (27 aphid index).

**Table 8:** Population and relative abundance of aphids in Tapi

Sr. No.	Aphid species	Population (Aphid index)	Relative Abundance (%)
1.	<i>Aphis gossypii</i>	890	27.92
2.	<i>Myzus persicae</i>	372	11.67
3.	<i>Aphis craccivora</i>	358	11.23
4.	<i>Brevicoryne brassicae</i>	354	11.10
5.	<i>Rhopalosiphum maidis</i>	342	10.73
6.	<i>Melanaphis sacchari</i>	332	10.41
7.	<i>Hysteroneura setariae</i>	293	9.19
8.	<i>Lipaphis erysimi</i>	178	5.58
9.	<i>Hyadaphis coriandri</i>	42	1.32
10.	<i>Aphis nerii</i>	27	0.85
	Total	3188	100

In Navsari, total 14 aphid species (Table 9) were recorded of which highly abundant species was found *A. gossypii* with 19.16% (1252 aphid index) followed by *R. maidis* with 11.11% (726 aphid index), *B. brassicae* with 10.09% (659 aphid index), *H. setariae* with 8.83% (577 aphid index), *L. erysimi* with 8.27% (540 aphid index), *M. sacchari* with 8.04% (525 aphid index), *A. pisum* with 7.19% (470 aphid index), *U. compositae* with 7.16% (468 aphid index), *A. craccivora* with 7.15% (467 aphid index), *M. persicae* with 5.83% (381 aphid index), *H. coriandri* with 4.41% (288 aphid index), *M. sanborni* with 1.61% (105 aphid index), *A. nerii* with 0.69% (45 aphid index) and *T. trifolii* with 0.46% (30 aphid index).

**Table 9:** Population and relative abundance of aphids in Navsari

Sr. No.	Aphid species	Population (Aphid index)	Relative Abundance (%)
1.	<i>Aphis gossypii</i>	1252	19.16
2.	<i>Rhopalosiphum maidis</i>	726	11.11
3.	<i>Brevicoryne brassicae</i>	659	10.09
4.	<i>Hysteroneura setariae</i>	577	8.83
5.	<i>Lipaphis erysimi</i>	540	8.27
6.	<i>Melanaphis sacchari</i>	525	8.04
7.	<i>Acyrtosiphon pisum</i>	470	7.19
8.	<i>Uroleucon compositae</i>	468	7.16
9.	<i>Aphis craccivora</i>	467	7.15
10.	<i>Myzus persicae</i>	381	5.83
11.	<i>Hyadaphis coriandri</i>	288	4.41
12.	<i>Macrosiphoniella sanborni</i>	105	1.61
13.	<i>Aphis nerii</i>	45	0.69
14.	<i>Therioaphis trifolii</i>	30	0.46
	Total	6533	100

In The Dangs, total 10 aphid species (Table 10) were recorded of which *A. gossypii* was highly abundant species with 25.07% (833 aphid index) followed by *R. maidis* with 16.68% (554

aphid index), *H. setariae* with 16.56% (550 aphid index), *M. sacchari* with 14.84% (493 aphid index), *A. craccivora* and *M. persicae* with 6.92% (230 aphid index), *L. erysimi* with 5.21% (173 aphid index), *B. brassicae* with 3.49% (116 aphid index), *U. compositae* with 2.44% (81 aphid index) and *A. nerii* with 1.87% (62 aphid index).

**Table 10:** Population and relative abundance of aphids in The Dangs

Sr. No.	Aphid species	Population (Aphid index)	Relative Abundance (%)
1.	<i>Aphis gossypii</i>	833	25.07
2.	<i>Rhopalosiphum maidis</i>	554	16.68
3.	<i>Hysteroneura setariae</i>	550	16.56
4.	<i>Melanaphis sacchari</i>	493	14.84
5.	<i>Aphis craccivora</i>	230	6.92
6.	<i>Myzus persicae</i>	230	6.92
7.	<i>Lipaphis erysimi</i>	173	5.21
8.	<i>Brevicoryne brassicae</i>	116	3.49
9.	<i>Uroleucon compositae</i>	81	2.44
10.	<i>Aphis nerii</i>	62	1.87
	Total	3322	100

In Valsad, total 11 aphid species (Table 11) were recorded of which highly abundant species was *A. gossypii* with 30.96% (772 aphid index) followed by *R. maidis* with 18.45% (460 aphid index), *M. sacchari* with 13.19% (329 aphid index), *H. setariae* with 12.15% (303 aphid index), *A. craccivora* with 8.66% (216 aphid index), *M. persicae* with 5.25% (131 aphid index), *U. compositae* with 5.17% (129 aphid index), *M. sanborni* with 3.53% (88 aphid index), *H. coriandri* with 1.52% (38 aphid index), *L. erysimi* with 1.04% (26 aphid index) and *A. nerii* with 0.08% (2 aphid index). Among all districts, aphid species *T. trifolii* was only recorded in Navsari and Narmada districts due to only availability of its host plant in these districts.

**Table 11:** Population and relative abundance of aphids in Valsad

Sr. No.	Aphid species	Population (Aphid index)	Relative Abundance (%)
1.	<i>Aphis gossypii</i>	772	30.96
2.	<i>Rhopalosiphum maidis</i>	460	18.45
3.	<i>Melanaphis sacchari</i>	329	13.19
4.	<i>Hysteroneura setariae</i>	303	12.15
5.	<i>Aphis craccivora</i>	216	8.66
6.	<i>Myzus persicae</i>	131	5.25
7.	<i>Uroleucon compositae</i>	129	5.17
8.	<i>Macrosiphoniella sanborni</i>	88	3.53
9.	<i>Hyadaphis coriandri</i>	38	1.52
10.	<i>Lipaphis erysimi</i>	26	1.04
11.	<i>Aphis nerii</i>	2	0.08
	Total	2494	100



The relative abundance data were utilised to calculate diversity index and evenness (Table 12). Overall species diversity index was 2.23 in South Gujarat. Among all seven districts, highest species diversity index was found in Navsari district (2.41), followed by Narmada (2.14), Surat (2.10), Tapi (2.05), The Dangs (2.03), Bharuch (1.98) and Valsad (1.95). Overall evenness was 0.85 in South Gujarat. Among all seven districts, highest evenness was found in Navsari district (0.91), followed by Tapi (0.89), Surat (0.88), The Dangs

(0.88), Bharuch (0.86), Narmada (0.83) and Valsad (0.81).

Among all the districts, Navsari was observed with the highest (14) species richness followed by Narmada (13), Surat and Valsad (11), Bharuch, Tapi and The Dangs (10). The only district Navsari which was observed with all fourteen numbers of aphid species which were present in whole South Gujarat region might be due to similar study location as well as more intense and frequent surveys in the particular district (Table 12).

**Table 12:** Species richness, diversity index and evenness of aphids in various districts of South Gujarat

Sr. No.	Districts	Species richness (S)	Species diversity (H)	Evenness (E)
1.	Bharuch	10	1.98	0.86
2.	Narmada	13	2.14	0.83
3.	Surat	11	2.10	0.88
4.	Tapi	10	2.05	0.89
5.	Navsari	14	2.41	0.91
6.	The Dangs	10	2.03	0.88
7.	Valsad	11	1.95	0.81
	South Gujarat (Total)	14	2.23	0.85

Similarly, Chaudhari <sup>[9]</sup> studied diversity of alate (winged) aphids by installing total of fifteen yellow pan water traps at various locations in Anand Agricultural University, Anand during September-2015 to June-2016. He recorded total fifteen species of aphids. During rest of the months, overall *L. erysimi* was found the most abundant with relative abundance of 51.94% followed by *A. gossypii* (15.05%), *A. craccivora* (8.75%), *M. persicae* (7.80%), *A. nerii* (6.94%), *R. maidis* (2.38%), *H. coriandri* (1.79%), *U. compositae* (1.38%), *Aphis spiraeicola* Patch (0.98%), *M. sacchari* (0.91%), *Rhopalosiphum padi* L. (0.85%), *A. pisum* (0.82%), *M. sanborni* (0.18%), *H. setariae* (0.17%) and *Schoutedenia emblica* Patel and Kulkarni (0.07%). During September-2015, no aphids were observed. Overall species diversity index (H) and evenness (E) of all aphid species were evaluated 0.884 and 0.36, respectively. In contrary to that, present investigations showed *A. gossypii* as the dominant specie with relative abundance of 26.04% during the year whereas, *L. erysimi* was on eighth position with relative abundance of only 5.03%. Since here only wingless and plant settled aphids were observed, *A. gossypii* was found as the most common and polyphagous aphid specie in all seven districts of South Gujarat region. *A. gossypii* had crop plants as well as weed plants as its host plants which is believed to be the principal reason for the highest abundance.

The present investigations were based on the observations on settled down aphids on host plants whether in colonies or scattered form in whole South Gujarat region whereas, Chaudhari <sup>[9]</sup> carried out surveys on only alate (winged) aphids trapped in yellow pan water traps in Anand Agricultural University, Anand, middle Gujarat; maybe this was the principal reason for non-identical results achieved in both of the studies. The differences in results might be due to change in climatic zone as well as cropping pattern of the areas.

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