



## Influence of trichomes types on occurrence of whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) population on minicore accessions of tomato (*Solanum lycopersicum* L.)

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### Abstract

Trichomes are the physical and chemical barrier present on the aerial surface of different plant parts which place an important role against insect herbivores. Aerial surface tissues of tomato are inhabited by diversified morphologically distinct types of trichomes which place an important role in whitefly (*Bemisia tabaci*) resistance. Field evaluation of 260 tomato minicore accessions during rabi and summer seasons revealed that, the trichome type played an important role in whitefly resistance on tomato. The accessions with trichome types I, II, III, IV, V and VII have recorded significantly less number of whiteflies (26.50 nymphs/ pl) whereas, significantly higher number of whiteflies were recorded from the accessions with trichome type I, III, V (41.75 nymphs/ pl). Tomato accessions having trichome type VI, IV and Type I have recorded significantly lesser number of whitefly nymphs at 45 and 60 DAT. All these trichome types are glandular trichomes with single or four lobes. Tomato accessions with high density of different glandular trichomes are correlated with the higher level of whitefly (*B. tabaci*) repellence.

**Keywords:** Tomato, minicore accessions, *bemisia tabaci*, Trichome types, Glandular trichomes, Non-glandular trichomes

### Introduction

Tomato (*Solanum lycopersicum*), being an most important vegetable crop worldwide is attacked by a broad range of insect pests. Among them whitefly, *Bemisia tabaci* is an important pest which causes 20-100 per cent potential yield loss. *B. tabaci* affects tomato production by directly feeding and indirectly by transmitting virus [7, 8]. Host plant resistance is one of the most promising method of management among the possible control methods [6, 31]. In most of the wild relatives of tomato (*Solanum pennellii*, *S. habrochaites*, *S. lycopersicum* var. *cerasiforme*, *S. pimpinellifolium*, *S. galapagense*) whitefly resistance is due to the presence of high density of different types trichomes [3, 12-14, 16, 21, 25, 26, 29].

Trichomes are the specialized aerial appendages, which arises from the epidermal cells of plant tissues. These trichomes are either unicellular or multicellular which vary in their shape, density and size. These trichomes play an important role in protecting plant tissues from different biotic and abiotic stress factors *viz.*, insect pest and pathogen attack, excess light and also from extreme temperature [21, 25]. Morphologically these trichomes are classified as glandular and non-glandular. The glandular structures are helpful to synthesize, store and secrete specialized metabolites [10, 32, 33].

In tomato several types of trichomes are present on different plant parts *viz.*, hypocotyls, leaves, stems, floral organs and also on immature fruit. According to Luckwill's taxonomic studies on tomato species, four morphologically distinct

glandular trichomes and three non-glandular trichomes are present among them, type I, type IV, type VI and type VII are glandular and type II, Type III and type V are non-glandular. Type I trichomes with multicellular base, a long multicellular stalk (2 mm) and a small glandular tip. Type IV trichomes, with a short stalk (0.3 mm) having a unicellular base, a multicellular stalk shorter than type I and a small glandular tip. Type VI trichomes contains four-celled glandular head on a short (0.1 mm) multicellular stalk. Type VII trichomes consists of short (<0.05 mm) unicellular stalk with an irregularly shaped 4 to 8 celled gland. Type II and type III trichomes are similar in length (0.2–1.0 mm) but differ by the presence of a multicellular and unicellular base, respectively. Type V trichomes are shorter (0.1–0.3 mm) and have a unicellular base [21].

Diversity in density type and chemical composition within the tomato species helps in protection against various factors [29]. Non-glandular trichomes mechanically obstruct the movement of herbivores across the plant surface [17, 32] whereas, glandular trichome physically entrap the insect upon rupture of the trichome gland and the metabolites that exert toxic effects on insect herbivores such as acyl sugars, methylketones, and sesquiterpenes. These compounds may also cause change in insect behaviour which reduces the host colonization (antixenosis) or reduces insect fitness leads to reduced oviposition, survival and development (antibiosis) [1, 5]. Hence to understand the influence of different types of trichomes on whitefly population present study was undertaken.

**2. Materials and Methods**

A set of 260 tomato germplasm accessions-‘mini-core’ collection were used (Table 1) as experimental material for the experiment. The study was conducted with the field evaluation of these minicore collections during rabi and summer seasons of 2016-17. Augmented Block Design was employed for evaluation of 260 minicore accessions repeating the checks in regular intervals. Crop was raised in a field by following all agronomic practices as per the

package with the spacing of 45 cm × 60 cm. The observations were recorded from randomly selected five plants from each accessions for whitefly nymphal population at 30, 45 and 60 days after transplanting during both the seasons. The observation on presence of different types of trichomes on both abaxial and adaxial leaf surface was determined by following the method described by Luckwill and Channarayappa <sup>19, 221</sup>. Trichomes were classified into the following types.

**Table 1**

Sl. No.	Trichome Type	Trichome characters
1	Type 1	Straight, long and small gland on tip of the trichome (glandular).
2	Type 2	Straight, medium long and sharp tip.
3	Type 3	Straight, long and sharp tip.
4	Type 4	Straight, short and small gland on tip (glandular)
5	Type 5	Straight or hooked, short and sharp tip
6	Type 6	Straight, medium long and big gland on tip (glandular)
7	Type 7	Straight, short and lobed gland on tip (glandular)
8	Type 8	Bent, short and hooked tip

**2.1 Statistical analysis**

All statistical procedures were performed using the statistical software package Windowstat (version 8.2).

**3. Results**

Different types of trichomes were recorded from 260 tomato accessions the data are analyzed and presented in the Table 1. It was clear from the tomato accessions having different types of trichomes were grouped into 12 groups (X<sub>1</sub> to X<sub>12</sub>) and its effect was compared with the *B. tabaci* population recorded during rabi and summer season 2016-17 Results are presented in the Table 2.

Rabi field evaluation recorded significantly lower number of whitefly population in accession group, X<sub>4</sub> (Type III, V, VII) (1.52/ plant) followed by X<sub>1</sub> (Type III, V) (1.53/ plant), X<sub>12</sub> (Type I, II, III, IV, V, VII) (1.53/ plant) and X<sub>8</sub> (Type I, III, IV, V, VII) (1.62/ plant) were statistically on par with each other. Accession group, X<sub>3</sub> (Type III, IV, V) has recorded significantly higher number of whiteflies (1.77/ plant) as compared to all other groups (Table 2). During summer season evaluation, *B. tabaci* population significantly lowest in accession group, X<sub>12</sub> (Type I, II, III, IV, V, VII) with 26.50 whiteflies per plant and followed by X<sub>10</sub> (Type I, II, III, V, VII) (29.73/ plant) which was on par

with X<sub>5</sub>, X<sub>7</sub>, X<sub>11</sub> and X<sub>9</sub>. Significantly higher number of whiteflies were recorded from accession group, X<sub>2</sub> (Type I, III, V) with 41.75 whiteflies per plant which was on par with X<sub>1</sub> (Type III, V) with 40.95 whiteflies (Table 2). The 260 tomato accessions were categorized based on presence of different trichome type viz., Type I, II, III, IV, VI and VII. Type I trichome was recorded in 101 tomato accessions, Type II recorded in all 43 accessions, Type III in 258 accessions, Type IV in 50 accessions, Type V in 260 accessions and Type VII were recorded in 229 accessions (Table 3). The mean whitefly population was recorded non significant result among the trichome types during the rabi season. The whitefly population during summer season has shown significant difference among the trichome type. Forty five days after transplanting (DAT), significantly lesser population was recorded in the populations with Type VII trichomes (29.36 nymphs/ plant) which was on par with the accessions having Type IV trichomes (29.43 nymphs/ plant), followed by Type I (31.63 nymphs/ plant), Type V, Type II and Type III. Same trend was followed during 60 DAT also, accessions with Type VII trichomes has recorded significantly lesser population (25.19 nymphs/ plant), which was on par with the

**Table 1:** Different types of trichomes identified in 260 tomato accessions

Tomato accessions	I	II	III	IV	V	VII	Tomato accessions	I	II	III	IV	V	VII
Ageta-32	+		+		+	+	EC-381263	+		+	+	+	
Angoorlata			+		+	+	EC-381554			+	+	+	+
Arka Abha			+		+		EC-501574			+		+	+
Arka Alok			+		+	+	EC-501575	+	+	+		+	+
Arka Meghalli	+	+	+	+	+	+	EC-501576			+		+	+
Arka Vikas			+		+		EC-501577			+		+	+
Avinash-2-2-1			+		+	+	EC-501580			+		+	+
Azad T-2	+		+		+	+	EC-501582			+		+	+
Azad T-5			+	+	+		EC-501583			+	+	+	+
B-4-1			+		+	+	EC-519730	+		+		+	+
B-7-2		+	+	+	+	+	EC-520046		+	+		+	+
Bhillai			+		+		EC-520059	+		+	+	+	+
BL-1208			+		+		EC-520061			+		+	+
BTH-9 M			+		+	+	EC-520071			+		+	+
C-1-4	+	+	+		+	+	EC-520074			+		+	+
C-3-2	+	+	+		+	+	EC-520075			+		+	+
C-4-1		+	+		+	+	EC-520078			+		+	+

C-8-1			+		+	+	EC-521039			+		+	+
C-9-2			+		+	+	EC-521056			+		+	+
C-10-2			+		+	+	EC-521078	+	+	+		+	+
C-11-1	+	+	+	+	+	+	EC-526139			+		+	+
C-11-2					+	+	EC-528372	+	+	+		+	+
C-11-3			+		+		EC-528374	+		+	+	+	+
C-20-1			+		+	+	EC-529080	+		+		+	+
C-20-2	+	+		+	+	+	EC-529083			+		+	+
C-26-1	+		+		+	+	EC-538138			+		+	+
CHRT-4	+		+	+	+	+	EC-538155			+		+	+
CH-155			+		+	+	EC-538380	+	+	+		+	+
CO-3	+		+		+	+	EC-538404	+		+		+	+
CLN-2026			+		+	+	EC-538405		+	+		+	+
CLN-2116			+	+	+	+	EC-538408	+		+	+	+	+
CLN-1621			+		+		EC-538419			+		+	+
CLN-2366			+		+	+	EC-538423			+		+	+
D-1-1			+		+	+	EC-538439	+		+		+	+
D-2-2-1	+		+		+	+	EC-538440			+		+	+
D-3-2	+		+		+	+	EC-538441			+		+	+
D-5-1			+	+	+	+	EC-538455			+	+	+	+
DARL-66			+		+	+	EC-552141	+		+		+	+
Dhrubya	+		+		+	+	EC-560340			+		+	+
DT-10	+	+	+		+	+	EC-570028	+		+		+	+
DVRT-1			+		+	+	EC-605694			+		+	+
DVRT-2			+		+		EC-605695			+		+	+
E-4-3	+		+	+	+		EC-605696			+		+	+
EC-2791	+		+		+		EC-620362	+		+	+	+	+
EC-13904	+		+		+	+	EC-620366			+	+	+	+
EC-317-6-1			+	+	+		EC-620370			+		+	+
EC-273966			+	+	+		EC-620373			+		+	+

Tomato accessions	I	II	III	IV	V	VII	Tomato accessions	I	II	III	IV	V	VII
EC-620374			+		+	+	FEB.-04	+	+	+		+	+
EC-620375			+		+	+	FLA-7171	+		+		+	+
EC-620383	+		+		+	+	FLA-7421			+		+	+
EC-620386			+		+	+	Flora-dade			+		+	+
EC-620398			+		+	+	G-4-5	+		+		+	+
EC-620401	+		+		+	+	G-5-4			+		+	+
EC-620403	+	+	+		+	+	G-6-3			+		+	+
EC-620406			+		+	+	GT-1			+		+	+
EC-620409	+		+	+	+	+	GT-2	+		+		+	+
EC-620410			+		+	+	GT-3			+		+	+
EC-620411			+		+	+	H-88-78-1	+	+	+	+	+	+
EC-620413			+		+	+	H-88-78-2	+	+	+		+	+
EC-620419			+		+	+	H-88-78-3			+		+	+
EC-620421			+	+	+	+	H-88-78-4			+		+	+
EC-620438			+		+	+	H-88-78-5			+		+	+
EC-620444	+		+		+	+	Hawai	+		+	+	+	+
EC-620446	+		+		+	+	Hisar Anmol	+	+	+	+	+	+
EC-620455			+		+	+	H. Arun (Sel-7)	+	+	+		+	+
EC-620456	+	+	+		+	+	Hisar Lalit			+		+	+
EC-620464			+		+	+	I-4-4			+		+	+
EC-620469			+		+	+	IC-373378	+		+		+	+
EC-620470	+		+		+		IC-427766			+		+	+
EC-620474			+		+	+	IC-447708	+		+		+	+
EC-620476			+		+	+	IC-469626	+		+		+	+
EC-620480			+		+	+	IIHR-01			+		+	+
EC-620486	+		+	+	+		IIHR-2202	+	+	+		+	
EC-620500			+	+	+	+	INDAM-2102			+		+	
EC-620502	+	+	+	+	+	+	INDAM-2103	+		+		+	
EC-620514			+		+	+	INDAM-2103-1	+		+		+	
EC-620519	+	+	+		+	+	INDAM-2103-1-1			+		+	
EC-620530	+		+		+	+	INDAM-2103-4	+	+	+		+	
EC-620533			+		+	+	INDAM-2103-6			+		+	
EC-620540	+		+	+	+	+	INDAM-2103-6-1	+		+		+	
EC-620556	+		+	+	+	+	INDAM-2103-6-4		+	+		+	
EC-620568	+		+		+	+	Jawahar-99	+	+	+		+	
EC-620575			+		+	+	Kashi Hemant	+		+		+	



	(1.53-1.73)	(29.67-32.33)
X <sub>12</sub>	1.53(0.60-2.73)	26.50(20.13-43.40)
SEm ±	0.03	0.62
C. D @ 5 %	0.09	1.83

\*Tomato accessions with different trichome types

- |                                   |  |   |
|-----------------------------------|--|---|
| X <sub>1</sub> = Type III, V      | X <sub>5</sub> = Type I, III, IV, V      | X <sub>9</sub> = Type I, III, IV, V, VII      |
| X <sub>2</sub> = Type I, III, V   | X <sub>6</sub> = Type I, III, V, VII     | X <sub>10</sub> = Type I, II, III, V, VII     |
| X <sub>3</sub> = Type III, IV, V  | X <sub>7</sub> = Type III, IV, V, VII    | X <sub>11</sub> = Type II, III, IV, V, VII    |
| X <sub>4</sub> = Type III, V, VII | X <sub>8</sub> = Type I, III, IV, V, VII | X <sub>12</sub> = Type I, II, III, IV, V, VII |

Accessions having Type IV trichomes (25.80 nymphs/ plant), followed by Type I (27.57 nymphs/ plant). Mean whitefly population from 30, 45 and 60 DAT also followed with the same trend *i.e.*, Trichome Type VII containing accessions were recorded significantly lesser whitefly population (29.37 nymphs/ plant) and on par result were observed in populations with Trichome IV (29.37 nymphs/ plant) which were followed by Type I (Table 3).

**4. Discussion**

Field evaluation of tomato minicore accessions was conducted to access influence of trichome types on whitefly resistance and to find out the resistant accessions to *B. tabaci*. Influence of trichome types on *B. tabaci* population during *rabi* season indicated significantly lower whitefly population on tomato accession group X<sub>4</sub> (1.52 nymphs/ plant) which was followed by X<sub>1</sub> (1.53 nymphs/ plant), X<sub>12</sub> (1.53 nymphs/ plant) and X<sub>8</sub> (1.62 nymphs/ plant) and were statistically on par with each other. Accession group, X<sub>3</sub> (trichome type III, IV, V) has recorded significantly higher number of whiteflies (1.77) as compared to all other groups Whereas during summer season, significantly least number of *B. tabaci* were recorded from accession group, X<sub>12</sub> (26.50 nymphs per plant) followed by X<sub>10</sub> (29.73 nymphs/ plant). Significantly higher number of whiteflies were recorded from accession group X<sub>2</sub> with 41.75 nymphs per plant. The

results clearly indicate that, the tomato accessions with more types of trichome, hinders the population growth of *B. tabaci* compared to the accessions with less number of trichome types. This shows the role of type of trichomes in growth and development of whiteflies. Earlier works carried out on plant resistance to *B. tabaci* showed that, this insect can be affected by leaf morphological characters such as leaf shape, hairiness and glandular trichomes [4]. In solanaceous crops like tomato, there was a negative correlation between total number of trichomes and the attractiveness to the adults as well as number of eggs laid [15, 27, 28].

In the present study, it was also observed that, tomato accessions having trichome Type VII, IV and Type I has recorded significantly lesser number of whitefly nymphs at 45 and 60 DAT and mean whitefly population as compared to accessions having other trichome types. All three trichome types are glandular trichomes with single or four lobes. The glandular trichome may hinder the *B. tabaci* population. The presence of glandular trichomes is considered as one of the main causes of morphological resistance in plants and can affect oviposition and feeding of small sucking insects [16, 24]. The importance of these structures as resistance source against whitefly has been reported by earlier studies [3, 11, 20].

**Table 3:** Influence of glandular and non glandular trichomes on whitefly population

Sl. No.	Trichome type	No. of accessions	Whitefly population during <i>Rabi</i> season	Whitefly population during summer season		
				45 DAT	60 DAT	Mean
Glandular trichomes						
1	Type I	101	1.63	31.63	27.57	31.64
2	Type IV	50	1.65	29.43	25.80	29.86
3	Type VII	229	1.64	29.36	25.19	29.37
Non- glandular trichomes						
4	Type II	43	1.58	34.33	29.28	33.93
5	Type III	258	1.58	34.36	29.31	33.96
6	Type V	260	1.58	33.83	29.04	33.49
SEm			NS	0.31	0.36	0.25
CD @ 5 %				0.98	1.15	0.80

**DAT: Days after treatment, ns: non significant**

The potential effects of the trichomes on the whitefly can vary, depending on the trichome angle on the leaf surface, length and type. These factors potentially affect oviposition, fixing and juvenile feeding [2, 9].

Results are also in close argument with previous authors [15] who reported that, morphological leaf characters like leaf trichome density and trichome length played important roles in attraction and oviposition choice of *B. tabaci*. The results proved that, the highly preferred eggplant varieties possessed the highest densities and the longest trichomes, indicating these two trichome characteristics may be a mechanism influencing the adult whitefly populations as well as oviposition. Trichome number, length and spatial

arrangement also appear to influence the population density of whiteflies on different crops [16, 18]. Eggplant varieties having higher trichome densities recorded lower numbers of whitefly adults and eggs than other varieties [15].

**5. Conclusion**

Thus, the field evaluation of 260 tomato minicore accessions revealed the importance of trichome type in whitefly resistance on tomato. Tomato accessions with high density of different glandular trichomes are correlated with the higher level of whitefly (*B. tabaci*) repellence. Selection of accessions having more trichome types is effective to obtain lines with increased resistance to *B. tabaci*.

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