Int.J.Curr.Microbiol.App.Sci (2018) *7*(1): 1419-1441

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 01 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.701.174

Levels of Plant Resistance in Chillies *Capsicum* spp against Whitefly, *Bemisia tabaci*

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Keywords

Chillies, Host plant resistance, Whitefly, *Bemisia tabaci*.

Article Info

Accepted:
12 December 2017
Available Online:
10 January 2018

A B S T R A C T

Chillies (*Capsicum annuum*) are an important commercial and export-oriented crop in India. Whitefly, *Bemisia tabaci* is a serious pest on chillies by destabilizing the plants through desapping plant juice and also transmitting chilli leaf curl disease (ChiLCD). Varietal resistance is the most economic, least complicated and environmental friendly approach for the control of insect pest damage. Fifteen accessions of *Capsicum* were screened against whitefly, under green house condition for categorization of the mechanism(s) of resistance. Accessions CA9, CA28, CA29, ACC 05, ACC 16, ACC18 and ACC 29 were found to be less preferred for adult settlement, whereas accessions CA17, CA30, CA187, CA189, CA247 and ACC08 were the most preferred one. In resistant accessions of chillies accumulative reduction in pest population was noticed by reduced rate of reproduction and increased developmental period. The number of eggs laid and the percentage of nymphal and adult emergence were low on resistant accessions *viz.*, CA9, CA28, CA29, ACC 05, ACC 16, ACC18 and ACC 29. In population build-up study, significantly lower numbers of progeny were observed on accessions CA9, CA28 and ACC05. Conversely, the number of progeny produced by F_2 was significantly greater on ACC 08. Additional experiment indicated that tolerance category of resistance was present in the accessions *viz*., K2, CA 247, CA 189 and CA 187 for *B. tabaci* feeding. The accessions CA 9, CA28 and ACC 05 have displayed strong antixenotic and antibiotic effect against whitefly, *Bemisia tabaci.*

Introduction

Chillies (*Capsicum annuum* L. Solanaceae) is one of the most important and widely cultivated crops grown worldwide. Besides the traditional use as a vegetable, spice, condiment, sauce and pickle, chillies is also being used by pharmaceuticals, cosmetics and beverage industries (Tiwary *et al.*, 2005). India is a major producer, exporter and consumer of chillies in the world and production of chillies in India is about 1492

million tonnes from an area of 775 million ha with an average productivity of 1.9 million tonnes per ha. (http://nhb.gov.in/area-pro/database-2015). However, the average productivity of chillies is very low in India when compared to that of other countries.

The cultivation and yield of chillies are frequently hampered in tropical and subtropical regions of India by the occurrence of pests and diseases. The crop is infested by more than 21 insect and non-insect pests (Dey *et al.,* 2001). Among the insect pests harbouring chillies, the whitefly, *Bemisia tabaci* Genn. (Aleyrodidae: Hemiptera) has become a serious threat to crop production in recent years not only by causing direct feeding damage but also by vectoring and transmission of *Begomoviruses* and *Criniviruses* that cause serious problems (Morales, 2007; Marubayashi *et al.,* 2013). Particularly, the epidemics of chilli leaf curl disease (ChiLCuD), caused by Chilli leaf curl virus (ChiLCV) and transmitted by *B. tabaci* is a serious challenge to yield of chillies in South India (Raj *et al.,* 2005; Kumar *et al.,* 2006; Senanayake *et al.,* 2007; Chattopadhyay *et al.,* 2008).

The whitefly, *B. tabaci* lays whitish eggs, usually in circular groups, on the underside of leaves, and is anchored by a pedicel, which is inserted into a fine slit made by the female in the tissues. The eggs turn brown on aging and hatch after 5-9 days at 30°C depending very much on host species, temperature and humidity (Bedford *et al.,* 1994). A female whitefly can lay 300-400 eggs in her four weeks lifespan (Byrne *et al.,* 1990). On hatching, the first instar, or "crawler", is flat, oval and scale-like and the only nymphal stage that is mobile. The crawlers find a suitable feeding location on the lower surface of the leaf, settle for feeding with its legs are lost in the ensuing moult and thus the nymphs becomes sessile. The first three nymphal stages last 2-4 days each and the fourth nymphal stage, called the 'puparium', lasts about 6 days, dependent on temperatures (Bedford *et al.,* 1994). The adult emerges through a "T"-shaped rupture in the skin of the puparium and copulation begins 12-20 h after emergence and takes place several times throughout the life of the adult. The female could live up to 60 d whereas male live shorter (9 and 17 d). The *B. tabaci* produces eleven to fifteen generations within one year (Bedford *et al.,* 1994).

The whitefly, *B. tabaci* causes direct damage to chillies by feeding on the phloem of the leaves and cause plant nutrient loss, physiological disorders, honey dew excretions upon leaf lamina over which black sooty mould develops which interferes in photosynthetic process. Thus, the direct visible damage is the leaf deformation and this together with ChiLCD symptoms support the perpetuation of thrips and mites by providing suitable niches. A satisfactory control of viral diseases may be achieved with the application of certain pesticides, however pesticides are costlier and a threat to environment, health of growers and consumers and also highly unsafe to non-target arthropods. Frequent use of pesticides also leads to resistant whiteflies (Erdogan *et al.,* 2008) and *B. tabaci* population had developed high levels of resistance to synthetic insecticides (Roditakis *et al.,* 2009). Alternative approaches are the use of resistant varieties or biological control using pathogens, parasitoids and/or predators of the whitefly or a combination of them (Van Lenteren and Martin 1999). To cope with potential damage caused by *B. tabaci* in horticultural agro ecosystems, the exploration of host plant resistance (HPR) has been considered a promising alternative in sustainable agriculture (Sharma and Ortiz, 2002).

Painter (1951) explained HPR using three functional categories: antibiosis, non-preference (antixenosis), and tolerance.

Antibiosis describes the negative influence of the plant on the biology of an insect attempting to use that plant as a host (Smith 2005) and may be explained after reduced body size and mass, prolonged periods of development in the immature stages, reduced fecundity, or failure to pupate or eclose when trying to explore the host plant for nutrition. Antixenosis resistance occurs when the plant acts as a poor host and is not favored by the arthropod as food, shelter, or an oviposition site. Non-preference results in reduced colonization of a plant by arthropods, thus reducing losses caused by the pest (Pedigo, 1999; Smith, 2005).

Tolerance, in an insect plant interaction context, is the plants response to insect attack, and it indicates the plants ability to withstand or compensate for insect damage and to yield significantly higher dry mass than a susceptible plant under similar conditions of infestation (Pedigo, 1999; Smith, 2005). Therefore, tolerance helps raise the level at which plant economic injury occurs, delays or negates the need for chemical control, and is a desirable trait for inclusion in commercial cultivars for durable arthropod resistance. Consequently, HPR is an economically sound and ecologically safe method for managing insect pests (Smith, 2005). Thus, the best way to reduce the whitefly population and chilli leaf curl disease (ChiLCD) is to understand the resistant mechanisms in chillies (Moshe and Michael, 2002). The maximum existence of diversity for different quality parameters among chillies provides opportunities for genotypic exploration for whitefly resistance. Until now, there is limited information available on detailed aspects of whitefly resistance in chillies. This research was carried out to investigate the levels of resistance to whitefly, *B. tabaci* in chillies accessions using different types of assays on the possible categories of mechanism(s) of resistance.

Materials and Methods

Insect culture

Adults of cotton whitefly, *B. tabaci* were collected from chillies (*C. annuum*) and cotton (*Gossypium* spp.) near Srivilliputhur, Virudhunagar district, Tamil Nadu, India and were cultured in the greenhouse of Insectary, Agricultural College and Research Institute, Madurai on mixed host plants of cotton (cultivar ARBH 1401), Black night shade (*Solanum nigrum*) and chillies (*C. annuum*) (cultivar: K2).

The plants were grown on cocopith and soil medium with proper fertigation and irrigation. The plants were maintained in cages 150cmx150cmx150cm and covered with 100 micron mesh cloth. Thirty to forty day old pest free fresh plants were introduced inside the culture cages every fortnight. For collection of naïve whitefly adults for use in experiments individual plants were caged for 3-4 days separately and the adults emerged and trapped inside the 100 micron mesh cloth cage were collected using glass tubes [25 by 150 mm (width and height)].

Species identification of whitefly

DNA isolation and PCR amplification

Total genomic DNA was extracted obtained from fifty whiteflies using E.Z.N.A.® Insect DNA Kit (Omega, USA). For polymerase chain reaction (PCR) amplification of mitochondrial DNA (mt DNA), the primers C1-J-2195- (5'TTGATTTTTGGTCATCC AGAAGT3') and L2-N-3014- (5'TCCA ATGCACTAATCTGCCATATTA3') were used for the amplification of mitochondrial cytochrome c oxidase subunit I – COI (Frohlich *et al.*, 1999). The PCR was conducted in a Fast PCR (Medline, U.K). PCR reactions were carried out in a volume of 15

µL containing 100 ng of DNA template 1 µl, Master mix (Ampliqon, Denmark - Taq 2X master mix RED, 1.5 mM $MgCl_2$) 7.5 µL, 1 µl of 20 picomoles of each primer, and sterile water 4 µL. The thermo cycler was set for 34 cycles of denaturation at 94°C for 30 sec, annealing at 52°C for 30 sec, extension at 72 °C for 1 min. Runs included an initial denaturation at 94 °C for 2 min and a final extension step at 72 °C for 10 min. PCR products were electrophoresed on 1.2 % agarose gels stained with ethidium bromide (10 mg/ml) and were viewed in a gel documentation system (Bio-rad, USA).

The amplified DNA was purified using Genei pure gel extraction kit (Bangalore, India). The PCR amplified fragments were eluted and the product was sent for sequencing to AgriGenome Labs Private Limited, Kochi, Kerala, India. Homology search was carried out using Blast (http://www.ncbi.nlm.nlh.gov) and the difference in COI sequences of *B. tabaci* were determined using the sequence alignment editor Bio Edit version (7.1) and compared against the consensus sequences (GenBank:KM821541.1; *Bemisia tabaci* isolate Asia _II_7 cytochrome oxidase subunit I gene, partial cds; mitochondrial) of National Center for Biotechnology Information (NCBI).

Plant material

The seeds of chillies test accessions *viz.*, CA9, CA17, CA28, CA29, CA30, CA185, CA187, CA188, CA189, CA247, ACC 05, ACC08, ACC 16, ACC18, ACC29 were obtained from the Department of Vegetable Crops, Horticultural College and Research Institute, Periyakulam Tamil Nadu, India.

Unless otherwise indicated all the experiments were performed in the greenhouse where plants were grown in cocopith and soil potting mix in 13cm dia x15 cm height mud pots. Plants were maintained at 30-35ºC temperature and 70-80% of relative humidity. Antixenosis (non-preference), antibiosis, and tolerance resistance in chillies were determined by using modifications of the methods as described then and there.

Antixenosis (non-preference)

The procedure suggested by Firdaus *et al.*, (2011) with modification was followed. Seeds of each accession were treated with 1% KNO_3 in a petridish for overnight and single seeds of each accession were planted at centre of a single pot (13cm dia x 15 cm height). At 4 to 6 leaf stage of seedling growth, three pots (replicates) for each accession were selected for uniform growth and pest free condition and were arranged in a completely randomized block design. Then each seedling was individually covered with in a glass chimney (6.5 cm dia x 15 cm height) in an inverted position with mouth to the bottom and base at the top that was lined with 100 micron mesh cloth to prevent the escape of adult whiteflies. To each pot 10 pairs of freshly emerged adults were released. The number of adults (male and female) settled on individual plants were recorded at 4, 8, 12, 24 and 48 h after release (HAR). The experiment was repeated twice to confirm the results.

Antibiosis

Fecundity test

The modified method as described by Jindal *et al.*, (2008) was followed. The test accessions were raised as described in antixenosis experiment**.** Ten pairs of newly emerged adult insects were released. Then, each seedling was individually covered with in a glass chimney (6.5 cm dia x 15 cm height) in an inverted position with mouth to the bottom and base at the top that was lined with 100 micron mesh cloth to prevent the escape of adult whiteflies.

At 3, 5, 8 and 12 d after release (DAR), the adults were removed and eggs were counted.

Egg hatchability

The test accessions were sown in protrays (98Cavities, width 300mm, length 485mm; depth 38mm, 0.75mm thickness) after treatment with 1% KNO_3 overnight soaking. When the seedlings reached six leaf stage, healthy seedlings were transplanted individually in mud pots (13cm diax 15 cm height). Ten days after transplanting (DAT), each plant was infested with five pairs of adult whiteflies to each seedling and covered with glass chimney as described in fecundity test. At 3 DAR the number of eclosed eggs and nymphs on each seedling was counted using destructive sampling method and the per cent hatchability of nymphs were observed (Jindal *et al.,* 2008).

Nymphal development

The test accessions were raised in small mud pots (13cm dia x 15 cm height). Seeds of each accession were treated with 1% KNO_3 in a petridish for overnight and single seed of each accession was planted at centre of a single pot (13cm dia x 15 cm height). When plants reached 30-day-old, the pots were arranged in a completely randomized block design in 5 replicates. Each plant was infested with five pairs of adult whitefly over the test seedlings. Then each seedlings was individually covered with in a glass chimney (6.5 cm dia x 15 cm height) as described in fecundity test. At 10 DAR, the number of nymphs on each seedling was counted and recorded. (Jindal *et al.*, 2008)

Population build-up

The method described by Jindal and Dhaliwal (2009) was adopted with modifications. Test accessions were raised in portrays as previously described in hatchability test. Twenty days after germination, the healthy seedlings were transferred to (50 cm x 50 cm) grow bag covered with 45cmx45cmx45cm micron mesh cage. At 6 leaf stage (30 day old), each seedling was infested with five pairs of adult whiteflies to each accession. Totally 20 replicates were maintained. At 15 DAI, out of the 20 replicates, 10 were, used to estimate the F1 adult population and the remaining 10 replicates were left undisturbed for further monitoring of F2 population build-up. At the end of 30 DAI, destructive sampling was used to assess the progeny build up in each plant. When P1 produced its first nymph (F2), the time (in d) was recorded. The F_2 progeny build-up was recorded and expressed in numbers.

Tolerance

Tolerance was measured by calculating the proportional plant dry weight change (DWT) and tolerance index (TI) as described by Dixon *et al.,* (1990) and Reese *et al.,* (1994) with modifications. Seedlings of each accession was raised and treated as described in antibiosis test. The pots were arranged in a completely randomized block design in 3 replicates. At six leaf stage, each seedling of test accessions was infested with ten pairs of adults. At 30 days after infestations (DAI), the number of nymphs and adults on each seedling was counted and recorded.

Then the test accessions were uprooted carefully with little disturbance to taproot and fibrous root system. The roots were washed in tap water. Then, the shoots and roots were air-dried for 2 h. and further dried in a hot air oven (Lab Tech) at 60°C for 48 h and then, the dry weight was recorded. The uninfested control test accessions were maintained separately and sampling was done as described above. Using these observations, the DWT and TI was worked out.

$$DWT = \frac{(WC - WT)}{WC} \times 100$$

Where WC is the dry weight of the non-infested control plant, WT is the dry weight of the infested plant, and TI is DWT/number of nymphs and adults of whitefly produced on the infested plant (Dixon *et al.*, 1990; Reese *et al.*, 1994). The TI was determined to compensate for the confounding effect of differing numbers of *B. tabaci* on infested plants.

Statistical analyses

Data from resistance category experiments were analyzed by using a one-way analysis of variance (ANOVA) (SAS Institute, 1985). Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05).

Results and Discussion

Species identification of whitefly, *Bemisia tabaci*

Amplification of mtCO I gene fragment using the primers (C1-J-2195 and L2-N-3014) produced *B. tabaci* specific 800bp band (Fig. 3). Whitefly sequence was aligned using NCBI BLAST and 77% to 98% of homology was observed with the *B. tabaci* sequences deposited in NCBI (data not presented).

Non-preference (Antixenosis)

Settling behaviour

The settling behavior of adults differed significantly among different accessions. The maximum number of adults had settled on susceptible accessions whereas less number of adult had settled on resistant accessions at different times of observations (Table 1; Fig. 1) *viz*., 4 hours after release (HAR) (F=2741.89; df=14, ; Pr > F = < 0.0001), 8 HAR (F=4183.22; df=14, ; Pr > F = < 0.0001), 12 HAR (F=2715.80; df=14, ; Pr > F = < 0.0001), 24 HAR (F=2842.91; df=14, ; Pr > F = < 0.0001) and 48 HAR (F=7747.33; df=14, ; Pr > F = < 0.0001) among CA17, CA30, CA187, CA189, CA247, and ACC08 after infestation (Fig. 1). It was noticed that whitefly adults settled on resistant accessions with longest time intervals. Whereas as on susceptible accessions most of the released whiteflies were seen settled on the plants (Table 1).

Antibiosis

Fecundity test

The fecundity of whitefly differed significantly among different accessions (CA 29, CA28, ACC 16, ACC29 and CA 9) in each interval recorded at 3 days after release (DAR) (F=1474.55; df=14; Pr > F = < 0.0001), at 5 DAR (F=2339.98; df=14 ; Pr > F = < 0.0001), at 8 DAR (F=1646.23; df=14; Pr > F = < 0.0001), at 12 DAR (F=1058.41; df=14; Pr > F = < 0.0001) (Table 1).

Significantly lower number of eggs were laid on CA 29 (1.83 no/ leaf), CA28 (2.17 adults/ leaf), ACC 16 (2.17 adults/ leaf), ACC29 (2.17 adults/leaf), CA 9 (2.58 adults/ leaf) followed by ACC18 (3.42 adults/leaf) in comparison to the more number of eggs laid on ACC 08 (8.50 adults/ leaf), CA 17 (8.25 adults/ leaf) and CA187 (8.00 adults/ leaf) (Table 2).

Egg hatchability

The nymphal emergence was noticed to be significantly lower on resistant accession CA 9 (1.00 nymphs/leaf) followed by ACC 05 (1.33 nymphs/leaf) compared with susceptible

accession ACC 08 (8 nymphs/ leaf) (*F*=3092.55; df = 14, Pr > F = <.0001) (Table 3).

The maximum egg hatchability was observed in susceptible accessions ACC 08 (96.06%) followed by CA 30 (95.56%) and CA 185 (95.34%). However, significantly lower egg hatchability was observed in resistant accession CA 9 (30.02%). (*F*=59.48; df = 14, Pr > F = <.0001)

Nymphal development

The nymphal development recorded had revealed significant variations among the accessions at 10 DAR (*F*=2.27; df = 14, Pr > F = 0.0148) (Table 4). The number of nymphs developed was high on ACC08 (8.67 nymphs/leaf) and very low on CA29 (1.33 nymphs/leaf) followed by CA9 (1.67 nymphs/leaf) (Fig. 2).

Population build-up

The population build-up of whitefly on test accessions differed significantly with each other (Table 5 and Table 6).

The adult emergence of whitefly on test accessions differed significantly with each other during both F1 and F2 population. The percentage of adult emergence was high in susceptible accessions ACC 08 (69.00%) followed by CA 30 (64.30%) during F1 progeny build-up (*F*=2518.92; df=14, Pr > F = <.0001) (Table 5). The percentage of adult emergence was also high on susceptible accessions ACC 08 followed by CA 185 during F2 progeny build-up (Table 5). Adult emergence was low on resistant accessions (*F*=4044.96; df=14, Pr > F = <.0001) and significantly lower numbers of progeny were observed on accessions CA9 (0.00 adults/leaf), CA28 (0.00 adult /leaf), ACC05 (0.00 adults /leaf) followed by CA29 (0.33 adults/leaf), ACC29 (0.33 adults/leaf), ACC18 (0.67adults/leaf) and ACC16 (1.00 adults/leaf) (Table 5). Conversely, the number of progeny produced by F_2 was significantly greater on ACC 08 (5.00 adults/plant) had high population build-up followed by CA 185 (3.67 adults/leaf) (*F*=4044.96; df=14, Pr > F = <.0001) (Table 5). In addition, the mean pre reproductive period (d) for F_2 production was significantly longer on accessions CA9 (15.8 d), ACCO5(15.8 d), ACC 29 (15.4) compared to susceptible accession CA 247 (12. 8 d) (Table 6).

Tolerance

We found significant differences among the eight accessions studied in their ability to compensate for damage resulting from *B. tabaci* feeding, as measured by shoot, root and plant percentage proportional dry weight (DWT) loss (*F*=600.27; df=7 Pr > F = <.0001). However, when DWT measurements were corrected for differences in numbers of *B. tabaci* and TI values differed significantly (*F*=600.27; df=7 Pr > F = <.0001) (*F*=247.80; df=7 Pr > F = <.0001) respectively among the accessions (Table 7). Mean of root and shoot tissues significantly differed among the accessions. TI values of accessions CA 189 (0.86%), CA 187 (0.92%), K2 (0.98%) and CA 247 (1.23%) were significantly lower than those of accessions CA 29 (1.58%), CA 9 (1.92%), CA 188 (2.07%) and CA 185 (2.52%) suggesting that K2, CA 189 and CA 187 tolerate *B. tabaci* to a certain extent (Table 7).

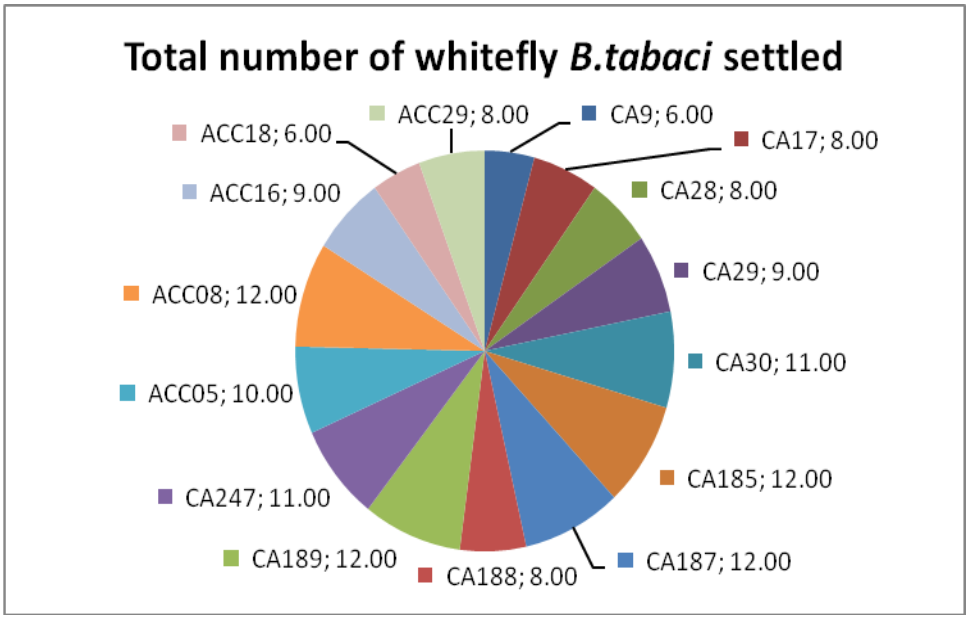
Host plant resistance (HPR) has offered the simple solution for insect pests and insect vector transmissible disease management on several agricultural and horticultural crops from time to time. Breeders are always in search of resistant parent material to develop improved resistant accessions of crops for introduction to cultivation against whitefly

critical issues. The whitefly, *B. tabaci*, a polyphagous insect pest that desap the plants is known to cause serious damage to chillies (*Capsicum* spp) by sucking the phloem juice and destabilizing the growth, but also attained destructive status by transmitting begomoviruses. In the present investigation categorization of resistance in chillies (*Capsicum* spp) against whitefly *B. tabaci* there was formidable and significant difference among the chillies accessions for the three different categories of resistance *viz*., antixenosis (non-preference), antibiosis and tolerance.

The non-preference test had revealed that chillies accessions CA9, CA28, CA29, ACC05, ACC16 and ACC18 were the least preferred one for whitefly adult settling (Fig. 1). The settling behavior of the whitefly is much important for the insect to establish progenies by utilizing the host plants for feeding, oviposition and shelter. The non-preference test performed under no choice condition has revealed that the whiteflies prefered only the most suitable chillies accessions and stay away, from the least preferred accessions. The preference by whitefly may be influenced by several factors.

The cues emanating from the host plant mediate the preferences by the insects. The leaf architecture and colour (Sippell *et al.*, 1987), leaf pubescence (McAuslane 1996), cuticle thickness (Channarayappa *et al.*, 1992) and metabolites were known to play a role as repellent or attractant (Chermenskaya *et al.*, 2009) for the whiteflies. Whiteflies choose the most suitable host not only because they can feed on it, but also because the offspring should be able to survive when they oviposit (Nomikou *et al.*, 2003). Oviposition preference and host plant selection by the female whitefly has a profound effect on the fitness of its offspring (van Lenteren and Noldus, 1990).

Fig.1 Non-preference for whitefly *Bemisia tabaci* adult settling among different chillies *Capsicum* spp accessions

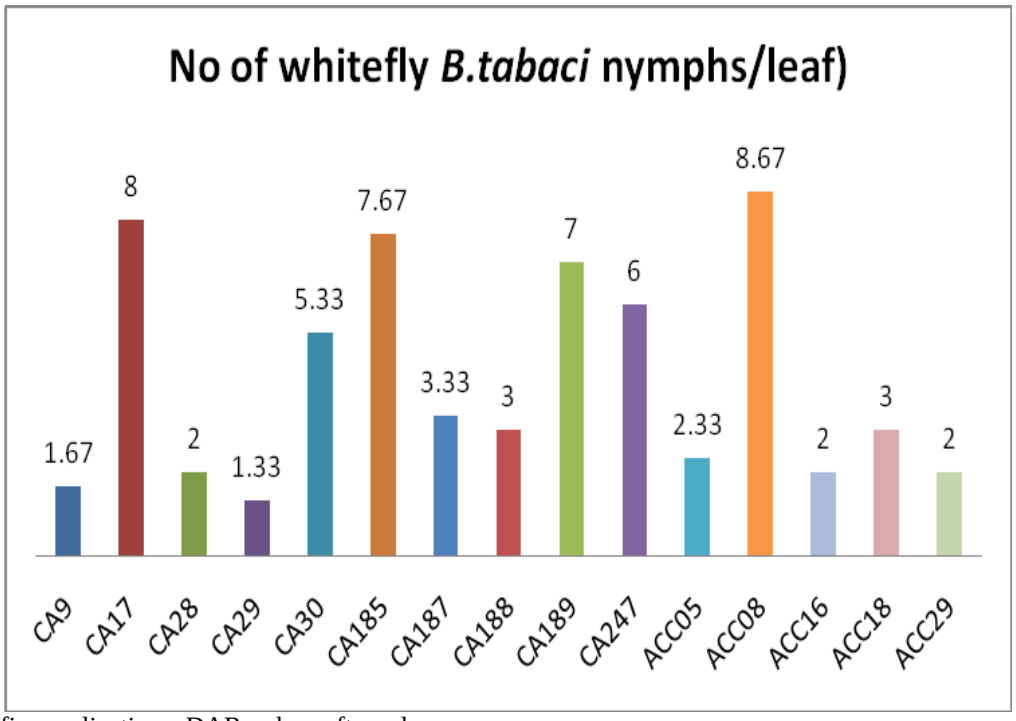


* Mean of three replications, HAR - hours after release

Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05).

Values in parantheses are square root transformed

Fig.2 Number of nymphs of whitefly *Bemisia tabaci* developed on seedlings of chillies *Capsicum* spp accessions



* Mean of five replications, DAR – days after release

Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05), Values in parantheses are square root transformed

Fig.3 Polymerase chain reaction amplification of mitochondrial DNA of marker cytochrome oxidase I (COI) in whitefly, *Bemisia tabaci* using primers (C1-J-2195 and L2-N-3014)

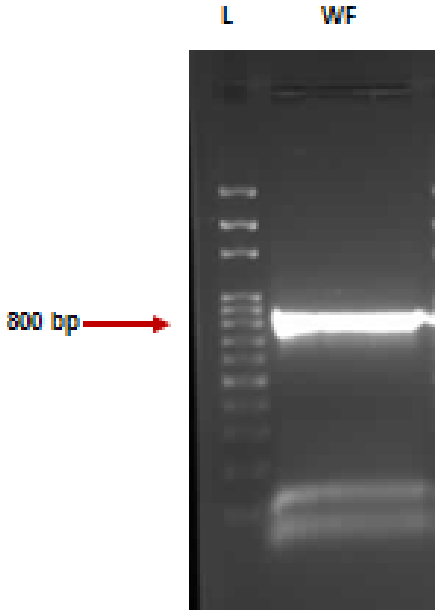


Table.1 Non-preference for whitefly *Bemisia tabaci* adult settling among different chillies *Capsicum* spp accessions

Accessions	Settling*					Total number settled
	4HAR	8HAR	12HAR	24HAR	48HAR	
CA9	1.00 (1.22)^{b}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{d}	5.00 (2.35)^{a}	6.00 (2.55)^{a}
CA17	3.00 (1.87)^{d}	3.00 (1.87)^{d}	1.00 (1.22)^{b}	1.00 (1.22)^{c}	0.00 (0.71)^{e}	8.00 (2.92)^{b}
CA28	3.00 (1.87)^{d}	0.00 (0.71)^{a}	1.00 (1.22)^{b}	1.00 (1.22)^{c}	3.00 (1.87)^{b}	8.00 (2.92)^{b}
CA29	0.00 (0.71)^{a}	1.00 (1.22)^{b}	3.00 (1.87)^{d}	3.00 (1.87)^{a}	2.00 (1.58)^{c}	9.00 (3.08)^{c}
CA30	5.00 (2.35)^{f}	4.00 (2.12)^{e}	1.00 (1.22)^{b}	1.00 (1.22)^{c}	0.00 (0.71)^{e}	11.00 (3.39)^{e}
CA185	4.00 (2.12)^{e}	3.00 (1.87)^{d}	2.00 (1.58)^{c}	2.00 (1.58)^{b}	1.00 (1.22)^{d}	12.00 (3.54)^{f}
CA187	6.00 (2.55)^{g}	2.00 (1.58)^{c}	2.00 (1.58)^{c}	2.00 (1.58)^{b}	0.00 (0.71)^{e}	12.00 (3.54)^{f}
CA 188	3.00 (1.87)^{d}	0.00 (0.71)^{a}	1.00 (1.22)^{b}	1.00 (1.22)^{c}	3.00 (1.87)^{b}	8.00 (2.92)^{b}
CA189	5.00 (2.35)^{f}	3.00 (1.87)^{d}	2.00 (1.58)^{c}	2.00 (1.58)^{b}	0.00 (0.71)^{e}	12.00 (3.54)^{f}
CA247	7.00 (2.74)^{h}	2.00 (1.58)^{c}	1.00 (1.22)^{b}	1.00 (1.22)^{c}	0.00 (0.71)^{e}	11.00 (3.39)^{e}
ACC05	3.00 (1.87)^{d}	2.00 (1.58)^{c}	1.00 (1.22)^{b}	1.00 (1.22)^{c}	3.00 (1.87)^{b}	10.00 (3.24)^{d}
ACC08	6.00 (2.55)^{g}	2.00 (1.58)^{c}	2.00 (1.58)^{c}	2.00 (1.58)^{b}	0.00 (0.71)^{e}	12.00 (3.54)^{f}
ACC16	0.00 (0.71)^{a}	1.00 (1.22)^{b}	3.00 (1.87)^{d}	3.00 (1.87)^{a}	2.00 (1.58)^{c}	9.00 (3.08)^{c}
ACC18	3.00 (1.87)^{d}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{d}	3.00 (1.87)^{b}	6.00 (2.55)^{a}
ACC29	2.00 (1.58)^{c}	3.00 (1.87)^{d}	0.00 (0.71)^{a}	0.00 (0.71)^{d}	3.00 (1.87)^{b}	8.00 (2.92)^{b}
SEd	0.0169	0.0112	0.0107	0.0103	0.0100	0.0310
CD(.05)	0.0345	0.0228	0.0218	0.0209	0.0205	0.0632

* Mean of three replications, HAR - hours after release

Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05).

Values in parantheses are square root transformed

Table.2 Number of eggs laid by whitefly *Bemisia tabaci* on different chillies *Capsicum* spp accessions under laboratory condition

Accessions	Number of eggs/leaf				Average
	3DAR	5DAR	8DAR	12DAR	
CA9	2.00 (1.58)^{c}	2.33 (1.68)^{d}	2.67 (1.78)^{d}	3.33 (1.96)^{c}	2.58
CA17	6.33 (2.61)^{h}	6.67 (2.68)^{i}	9.67 (3.19)^{j}	10.33 (3.29)^{h}	8.25
CA28	1.67 (1.47)^{b}	2.00 (1.58)^{b}	2.33 (1.68)^{b}	2.67 (1.78)^{b}	2.17
CA29	1.33 (1.35)^{a}	1.67 (1.47)^{a}	2.00 (1.58)^{a}	2.33 (1.68)^{a}	1.83
CA30	6.00 (2.55)^{g}	6.67 (2.68)^{i}	7.00 (2.74)^{f}	7.33 (2.80)^{f}	6.75
CA185	7.00 (2.74)^{j}	7.00 (2.74)^{j}	7.00 (2.74)^{f}	8.00 (2.92)^{g}	7.25
CA187	7.00 (2.74)^{j}	7.33 (2.80)^{l}	7.67 (2.86)^{h}	10.00 (3.24)^{h}	8.00
CA 188	4.00 (2.12)^{j}	4.00 (2.12)^{f}	4.00 (2.12)^{e}	4.67 (2.27)^{e}	4.17
CA189	5.67 (2.48)^{e}	7.00 (2.74)^{g}	7.33 (2.80)^{g}	8.33 (2.97)^{g}	7.08
CA247	6.33 (2.61)^{f}	7.00 (2.74)^{h}	7.00 (2.74)^{f}	7.33 (2.80)^{f}	6.92
ACC05	1.67 (1.47)^{h}	2.00 (1.58)^{b}	2.33 (1.68)^{b}	2.33 (1.68)^{a}	2.08
ACC08	6.67 (2.68)^{b}	7.67 (2.86)^{k}	9.33 (3.14)^{i}	10.33 (3.29)^{h}	8.50
ACC16	1.67 (1.47)^{i}	2.00 (1.58)^{b}	2.33 (1.68)^{b}	2.67 (1.78)^{b}	2.17
ACC18	3.00 (1.87)^{b}	3.33 (1.96)^{e}	3.67 (2.04)^{d}	3.67 (2.04)^{d}	3.42
ACC29	1.67 (1.47)^{b}	2.00 (1.58)^{c}	2.33 (1.68)^{c}	2.67 (1.78)^{b}	2.17
SEd	0.0221				
CD(0.05)	0.0427				

* Mean of three replications, DAR – days after adult release

Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05).

Values in parantheses are square root transformed

Table.3 Per cent hatchability of nymphs of whitefly *Bemisia tabaci* on different chillies *Capsicum* spp accessions

Per cent hatchability of nymphs/pair/leaf			
Accessions	**No. of eggs laid/leaf**	**No of nymphs emerged/leaf**	**Per cent hatchability**
CA9	3.33 (1.96)[c]	1.00 (1.22)[a]	30.00 (33.22)[a]
CA17	6.33 (2.61)[f]	5.33 (2.42)[g]	84.21 (66.61)[ce]
CA28	2.67 (1.78)[b]	2.00 (1.58)[d]	75.00 (60.12)[cd]
CA29	2.33 (1.68)[a]	1.67 (1.47)[c]	71.43 (57.69)
CA30	7.33 (2.80)[i]	7.00 (2.74)[j]	95.45 (78.77)[f]
CA185	7.00 (2.74)[h]	6.67 (2.68)[i]	95.24 (77.73)[f]
CA187	8.00 (2.92)[j]	6.33 (2.61)[h]	79.17 (62.88)[de]
CA 188	4.00 (2.12)[e]	3.33 (1.96)[f]	83.33 (65.91)[e]
CA189	6.67 (2.68)[g]	6.33 (2.61)[h]	95.00 (77.45)[f]
CA247	7.00 (2.74)[h]	6.67 (2.68)[i]	95.24 (77.77)[f]
ACC05	2.33 (1.68)[a]	1.33 (1.35)[b]	57.14 (49.11)[b]
ACC08	8.33 (2.97)[k]	8.00 (2.92)[k]	96.00 (78.86)[f]
ACC16	2.33 (1.68)[a]	1.33 (1.35)[b]	57.00 (49.04)[b]
ACC18	3.67 (2.04)[d]	2.67 (1.78)[e]	72.73 (58.59)[cd]
ACC29	2.67 (1.78)[b]	2.00 (1.58)[d]	75.00 (60.04)[cd]
SEd	0.0149	0.0267	2.4503
CD(0.05)	0.0303	0.0545	5.0042

* Mean of three replications

Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05).

Values in parantheses are square root transformed

Table.4 Number of nymphs of whitefly *Bemisia tabaci* developed on seedlings of chillies *Capsicum* spp accessions

Accessions	No. of (nymphs/leaf)
CA9	1.67 (1.42)^{ab}
CA17	8.00 (2.73)^{de}
CA28	2.00 (1.52)^{ab}
CA29	1.33 (1.32)^{a}
CA30	5.33 (2.28)^{abcde}
CA185	7.67 (2.68)^{de}
CA187	3.33 (1.87)^{abcde}
CA 188	3.00 (1.79)^{abcd}
CA189	7.00 (2.57)^{cde}
CA247	6.00 (2.40)^{bcde}
ACC05	2.33 (1.62)^{abc}
ACC08	8.67 (2.83)^{e}
ACC16	2.00 (1.52)^{ab}
ACC18	3.00 (1.79)^{abcd}
ACC29	2.00 (1.52)^{ab}
SEd	0.4988
CD(0.05)	0.9991

* Mean of five replications, DAR – days after releae

Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05), Values in parantheses are square root transformed.

Table.5 Population build-up of whitefly *Bemisia tabaci* on chillies *Capsicum* spp accessions under greenhouse condition

	Population build-up/ pair/leaf					
	F1	F2				
Accessions	No of adult emerged	No of adult emerged	No of eggs	No of nymphs emerged	No of pupa	No of adult emerged
CA9	0.33 (0.91)^{a}	0.33 (0.91)^{a}	0.33 (0.91)^{a}	0.33 (0.91)^{b}	0.00 (0.71)^{a}	0.00 (0.71)^{a}
CA17	5.17 (2.38)^{g}	5.17 (2.38)^{g}	4.33 (2.20)^{f}	3.67 (2.04)^{h}	3.33 (1.96)^{g}	3.00 (1.87)^{f}
CA28	1.33 (1.35)^{c}	1.33 (1.35)^{c}	1.00 (1.22)^{b}	0.33 (0.91)^{b}	0.33 (0.91)^{b}	0.00 (0.71)^{a}
CA29	1.03 (1.24)^{b}	1.03 (1.24)^{b}	1.00 (1.22)^{b}	1.00 (1.22)^{d}	0.33 (0.91)^{b}	0.33 (0.91)^{b}
CA30	6.43 (2.63)^{j}	6.43 (2.63)^{j}	5.67 (2.48)^{i}	4.67 (2.27)^{j}	4.00 (2.12)^{i}	3.33 (1.96)^{g}
CA185	5.70 (2.49)^{i}	5.70 (2.49)^{i}	6.00 (2.55)^{j}	5.00 (2.35)^{k}	4.33 (2.20)^{j}	3.67 (2.04)^{h}
CA187	5.50 (2.45)^{h}	5.50 (2.45)^{h}	4.67 (2.27)^{g}	4.00 (2.12)^{i}	3.67 (2.04)^{h}	3.33 (1.96)^{g}
CA 188	2.70 (1.79)^{d}	2.70 (1.79)^{d}	2.00 (1.58)^{c}	1.33 (1.35)^{e}	1.00 (1.22)^{d}	0.67 (1.08)^{c}
CA189	4.67 (2.27)^{f}	4.67 (2.27)^{f}	4.00 (2.12)^{e}	3.33 (1.96)^{g}	3.00 (1.87)^{f}	2.33 (1.68)^{e}
CA247	5.33 (2.41)^{gh}	5.33 (2.41)^{gh}	5.00 (2.34)^{h}	4.00 (2.12)^{i}	3.33 (1.96)^{g}	3.00 (1.87)^{f}
ACC05	0.33 (0.91)^{a}	0.33 (0.91)^{a}	0.33 (0.91)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}	0.00 (0.71)^{a}
ACC08	6.90 (2.72)^{k}	6.90 (2.72)^{k}	6.33 (2.61)^{k}	5.67 (2.48)^{l}	5.33 (2.42)^{k}	5.00 (2.35)^{i}
ACC16	3.00 (1.87)^{e}	3.00 (1.87)^{e}	3.00 (1.87)^{d}	2.33 (1.68)^{f}	1.67 (1.47)^{e}	1.00 (1.22)^{d}
ACC18	1.33 (1.35)^{c}	1.33 (1.35)^{c}	1.00 (1.22)^{b}	0.67 (1.08)^{c}	0.67 (1.08)^{c}	0.67 (1.08)^{c}
ACC29	1.33 (1.35)^{c}	1.33 (1.35)^{c}	1.00 (1.22)^{b}	1.00 (1.22)^{d}	0.67 (1.08)^{c}	0.33 (0.91)^{b}
SEd	0.0193	0.0193	0.0183	0.0134	0.0151	0.0133
CD(0.05)	0.0393	0.0393	0.0375	0.0273	0.0307	0.0271

* Mean of ten replications

Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05).

Values in parantheses are square root transformed

Table.6 Mean of whitefly *Bemisia tabaci* F2 nymph pre reproductive period (d) and No of progeny produced by P1 (F2) adults on chillies *Capsicum* spp accessions

Accessions	Mean ± SE F2 nymph pre reproductive period (d)	Mean ± SE no. of progeny produced by P1(F2) adults/leaf
CA9	15.8±0.20^{a}	0.71± 0.00^{a}
CA17	14.4±0.40^{cd}	1.87± 0.00^{f}
CA28	14.6±0.37^{abc}	0.71±0.00 ^{a}
CA29	14.4±0.51^{bcd}	0.91 ± 0.00^{b}
CA30	13.8±0.37^{de}	1.96 ±0.00 ^{g}
CA185	13.0±0.32^{e}	2.04 ± 0.00^{h}
CA187	13.8±0.49^{d}	1.96± 0.02^{g}
CA 188	14.0±0.32 ^{cd}	1.08 ± 0.00^{c}
CA189	13.0±0.32^{e}	1.68 ±0.00 ^{e}
CA247	12.8±0.32^{e}	1.87±0.02^{f}
ACC05	15.8±0.20^{a}	0.71 ±0.00 ^{a}
ACC08	13.8±0.37^{de}	2.35 ±0.02 ^{i}
ACC16	14.6±0.24^{bcd}	1.22±0.00^{d}
ACC18	14.6±0.24^{bcd}	1.08±0.00^{c}
ACC29	15.4±0.2^{ab}	0.91 ± 0.00^{b}
SEd	0.0644	0.0133
CD(0.05)	0.1289	0.0271

* Mean of ten replications

Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05). Values in parantheses are square root transformed

Table.7 Mean ± SE of percentage proportional dry weight loss (DWT) and tolerance index (TI) of eight chillies accessions challenged with *Bemisia tabaci* adults and recorded 30 days after infestations

Genotypes	Mean ± SE % DWT	Number of nymphs and adults/leaf	Mean±SE %TI
CA247	40.00±0.25^{d}	32.55±0.44^{c}	1.23±0.01^{c}
CA187	55.77±0.17^{a}	60.43±0.47^{f}	0.92±0.01^{ab}
K2	53.49±0.72^{b}	54.46±1.00^{e}	0.98±0.02^{b}
CA189	44.44±0.97^{c}	51.92±0.86^{d}	0.86±0.01^{a}
CA29	20.00±0.46^{h}	12.70±0.20^{a}	1.58±0.06^{d}
CA188	33.33±0.54^{t}	16.12±0.41^{b}	2.07±0.08^{t}
CA185	37.74±0.12^{e}	15.00±0.32^{b}	2.52±0.05^{g}
CA9	25.00±0.29^{g}	13.00±0.14^{a}	1.92±0.04^{e}
SEd	0.4392	0.4831	0.1283
CD(0.05)	0.9310	1.0242	0.2720

* Mean of three replications

Means, when significant, were separated by using the Tukeys studentized range (significant difference) test procedure (P=0.05).

The results of the present investigation are from the no choice method of test and there is every chance that these varieties might not further be performed if given with a choice test. Earlier studies by Firdaus *et al.,* (2011) suggested that those chillies accessions preferred under no choice condition were not preferred under a choice scenario. Further, Firdaus *et al.,* (2011) had suggested that those difference for preference could be the outcome of the plants ability to produce repellents (or) expression of physical barriers that culminate with the avoidance by the whitefly. However, *B. tabaci* could live on the non-preferred accessions with difficulties in its performance. It was reported that soybean whitefly, *Bemisia argentifolii* had a strong preference for hairy-leaf varieties of cotton and less preference for glabrous-leaf varieties (McAuslane, 1996). According to Berlinger (1986), whiteflies had two different flight patterns: short distance and long-distance flights.

Short-distance flights remained within the plant canopy and the insect traveled from plant to plant within a field. The short flights are less than 15 ft in distance and mainly involved the flight from the lower leaves, whereas, the long flights were from border to border of the chamber in search of suitable host plant where they prefer to lay eggs. In the present study, the adults showed no long-distance flights and they just remained consistent within the experimental arena (glass chimney). Also, Oriani *et al.,* (2011) from their study suggested that, high levels of antixenosis for oviposition was related to type IV glandular trichomes of tomato accessions against *B. tabaci.* In *Capsicum* spp. Firdaus *et al.,* (2011) had found that there was not only a highly positive correlation of non-glandular trichome density with whitefly density and oviposition rate, but also suggested that the glandular trichomes had an important role in whitefly preference. However, trichomes were not the only architecture of the plant that influenced the whitefly preferences (Firdaus *et al.,* 2011).

Antibiosis seems to be the most noticeable category of resistance. Whitefly mortality on resistant plants could be caused by starvation resulting from chemical compounds such as secondary metabolites. Such a resistance mechanism to different kinds of phloem feeding/piercing insects has been reported in tomato, cotton and cassava (Bellotti and Arias 2001; Jindal *et al.,* 2008). Other plant secondary metabolites such as methyl-ketones and derivates of sesquiterpene carboxylic acid could have negative effects on population development of insects (Williams *et al.,* 1980; Eigenbrode *et al.,* 1994). These compounds could be present in the leaf mesophyll or they can be released as volatiles that could play a role as a repellent or antibiotic substance to herbivores (Antonious and Kochhar 2003; Chermenskaya *et al.,* 2009). Thomas *et al.,* (1995) observed that, when the tryptophan decarboxylase (TDC) gene (isolated from *Cantharanthus roseus* (periwinkle) when expressed in transgenic tobacco, the 55-kD TDC enzyme and tryptamine accumulated had caused 97% reduction in *B. tabaci* reproduction. Production of tryptamine, its derivatives, or other products resulting from TDC activity may discourage whitefly reproduction (Thomas *et al.,* 1995).

In our present study, lower numbers of eggs were noticed on chillies accessions CA 29, CA28, ACC 16, ACC29 and CA9. The visual and olfactory cues (Prokopy and Owens, 1983; Visser, 1988) offer the directions for phytophagous insects to select their host plants. The ovipositional difference among the chillies accessions might be due to the morphological traits or the production of defense compounds in the leaves of such accessions. These traits are characterization of leaf surface, colour or odour that made the

foliage less attraction to *B. tabaci* (Walker and Perring, 1994). Gomez *et al.,* (2013) reported reduced number of *B. tabaci* eggs on chillies accessions.

As discussed previously the trichomes may play a major role in the ovipositional preference of whiteflies (Oriani *et al.,* 2011). Further, the release of volatile compounds and defense against phytophagous insects may be another reason for reduced fecundity (Frantz *et al.,* 2004; Kashiwagi *et al.,* 2005). The number of eggs significantly varied among the chillies accessions. The lower eggs production received on ACC 16 and CA29 (2.33/leaf) and the lower level of eggs hatchability found on CA 9 (30%) followed by ACC05 (57.14%). In a similar study Gomez *et al.,* (2013) had reported the lowest percentage of egg hatchability of *B. tabaci* on resistant chillies accessions. Previous studies with other crops such as tomato (Oriani *et al.,* 2011; Muigai *et al.,* 2003; Fancelli *et al.,* 2003) cotton (Torres *et al.,* 2007) and bean (Campos *et al.,* 2003) had shown such differences in egg hatchability and (or) nymphal survival. Nombela *et al.,* (2000) and Rodriguez *et al.,* (2011) had found that oviposition of *B. tabaci* on tomato leaves was higher in those with higher sugar esters in the glandular exudates of type IV trichomes.

The developmental time of insect pests may vary with the quality of the host plants and Coudriet *et al.,* (1985) had reported time difference to complete development by *B. tabaci*. The developmental period is much influenced by the plant texture, metabolites in the sap, plant nutrient status and plant volatiles (Nombela *et al.,* 2000; Mansaray and Sundufu, 2009; Pontes *et al.,* 2010). Thus a shorter developmental time of *B. tabaci* and coupled with high survivorship of immatures may cause population to build-up faster to a threatening level (Mansaray and Sundufu, 2009) in *B. tabaci.*

Population build-up gives a cumulative antibiosis effect of specific chilli accession. In the present study, the population build-up of *B. tabaci* on different chilli accessions was significantly different with each other. The accessions *viz.,* CA9, CA28 and ACC05 had recorded a lower progeny production and a prolonged nymphal pre reproductive period (Table 6). Similarly, Jindal and Dhaliwal (2009) registered that, when F2 generation whiteflies were released on test accessions such as LD694 recorded the significantly lowest ($0.28/cm^2$) number of eggs, which indicated it was least preferred for egg laying, followed by PA183 and LK861 in cotton.

According to Munthali (1992), among several biological characteristics, the duration of development of an insect is most useful to categorize accessions as resistant and susceptible. Among the chillies accessions test of ACC 08 and CA 185 had high population build-up with a lower nymphal pre reproductive period (Table 6) and are thus tend to be susceptible. The mean pre reproductive period (d) for F_2 production was significantly longer on accessions CA9, ACCO5, ACC 29 when compared to susceptible accession CA 247 (12. 8 d). Increased nymphal periods of whiteflies on resistant than on susceptible accessions of tomatoes (Muigai *et al.,* 2002) and cucumber, the longest and the total developmental time on resistant varieties of beans (Berlinger, 1986; Boica and Vendramim, 1986) for *B. tabaci* were reported. Morillo and Marcano (1997) also recorded differences in egg and nymphal periods and total life cycle of whiteflies on resistant and susceptible tomato accessions.

When the tolerance index (TI) was determined to compensate for the confounding effect of differing numbers of whiteflies on infested plant, we found that accessions K2, CA189, and CA 187 showed

significantly less TI values in comparison to the susceptible check CA 247 selected out of the present study. Even though no previous studies have examined tolerance to whiteflies among chillies accessions even a common variety K2 used for comparison in the present study showed a considerable level of tolerance. Our study did not include a well-defined tolerant control for comparison and is only based on a susceptible check (CA 247) found out of the antibiosis tests.

For the research on whitefly tolerance is however necessary to identify a suitable control and find out the potential reasons for such an expressions for tolerance. While antibiosis resistance may effectively reduce the incidence of ChiLCD on chillies, however tolerance does not owing to the continuous support by a tolerant plant to help the vector *B. tabaci* establish and build-up population and therefore is lower importance as has been demonstrated in other crops (Harvey *et al.*, 1990; Conner *et al.*, 1991).

The identification of whitefly species in adult stage is problematic. Morphological differentiation of pupae is one of the better methods for determining identity of species, but it may vary depending on the host plant on which they develop which can lead to misidentifications and erroneous naming of new species. Polymerase chain reaction (PCR) fragment amplified from the mitochondrial cytochrome oxidase I (COI) gene is often used for mitochondrial haplotype identification that can be associated with specific species. Mitochondrial DNA (mtDNA) has been extensively used in phylogenetic studies of animals because it evolves much more rapidly than nuclear DNA, favoring the accumulation of nucleotide differences (i.e., polymorphisms) between closely related species (Brown *et al.*, 1979; Lunt *et al.*, 1996). The accumulation of these polymorphisms is primarily caused by the loss or gain of restriction sites without a detectable change in genome size (Hebert *et al.*, 2003). Generally, sequencing of the polymerase chain reaction (PCR) fragment amplified from the COI gene is used for mitochondrial haplotype identification that can be then associated with specific species (Shatters *et al.*, 2009). This approach was useful for whitefly detection and identification. Thus, amplification of mtCO I gene fragment using the primers (C1-J-2195 and L2-N-3014) produced *B. tabaci* specific 800bp band (Fig. 3) and 99% homology observed with consensus sequences deposited with NCBI (GenBank: KM821541.1; *Bemisia tabaci* isolate Asia _II_7 cytochrome oxidase subunit I gene, partial cds; mitochondrial). The results were line in with Kumar *et al.*, (2016) who explained that *B. tabaci* populations from Tamil Nadu were distributed into three clades (Asia I, Asia II 7, and Asia II 8) based on mitochondrial cytochrome c oxidase I (coxI) sequences.

Similarly, Swati *et al.*, (2014) registered that amplification of mtCO I gene fragment using the primers (C1-J-2195 and L2-N-3014) produced *B. tabaci* specific ~800bp band. COI sequence analysis has proven to be a good molecular marker for intra- and interspecific variation in whitefly species not only in this study but others (Thao and Baumann 2004; Boykin *et al.*, 2007; Shoorcheh *et al.*, 2008; Chu *et al.*, 2012; Henri *et al.*, 2013). In conclusion, we have identified chillies accessions that differ in whitefly resistance and preference.

Whitefly resistance and preference seem to be present in the accessions evaluated, and this offers opportunities for doing genetic studies and breeding whitefly-resistant chillies varieties. For successful molecular marker assisted resistant breeding programme, the knowledge of heritable systems of host and vector is also important and crucial.

Acknowledgements

The financial support given by The Department of Biotechnology, Government of India under the project No. DR/P7/S2/DBT Scheme/ 2015 dt: 25.05.15 is kindly acknowledged. The authors are also grateful to Dr. K. Prabakaran Department of Agricultural Economics, Agricultural College and Research Institute, Madurai, Tamil Nadu, India for his guidance to perform the statistical analysis of the data.

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How to cite this article:

Niranjanadevi Jeevanandham, Murugan Marimuthu, Senthil Natesan, Shanthi Mukkaiyah and Sathiyamurthy Appachi. 2018. Levels of Plant Resistance in Chillies *Capsicum* spp against Whitefly, *Bemisia tabaci*. *Int.J.Curr.Microbiol.App.Sci.* 7(01): 1419-1441.
doi: https://doi.org/10.20546/ijcmas.2018.701.174