

# Relative toxicity of different insecticides to Asian citrus

## *Psylla (Diaphorinacitri Kuwayama)*

### ABSTRACT

Asian citrus psyllids, *Diaphorinacitri* (Kuwayama) act as vector of the devastating citrus disease, Huanglongbing (HLB), also known as citrus greening which is widely spread in citrus growing regions. The use of insecticides for control management of citrus phylla is one of the prominent and effective method to overcome their menace. However, recently very few insecticides s have been found under label claim for this pest. The present investigation was conducted in order to know the toxicity of some new chemistry insecticides s against *D. citri*. ~~The~~ Bioassay experiments was/were conducted during ~~the year~~ 2022-23 at Toxicology Laboratory, Department of Entomology by Dr. PDKV., Akola (M.S.). The toxicity was assessed through uptake bioassay technique for systemic insecticides s by using fresh citrus twigs. The results showed ~~demonstrated~~ that, among ~~st~~ the five tested insecticides s imidacloprid 17.8% SL was the most ~~the~~ effective insecticide with lowest LC<sub>50</sub> value. However, except spirotetramat 15.3 % OD, the LC<sub>50</sub> values of thiamethoxam 25% WG, abamectin 1.9% EC, fenpropathrin 30% EC were lying within the fiducial limit of most toxic insecticide i.e. imidacloprid 17.8% SL. They are considered ~~as~~ at par and equally toxic to *D. citri*. The relative toxicity trend against the adult psylla was imidacloprid > abamectin > thiamethoxam > fenpropathrin > spirotetramat and for the nymph, the trend was imidacloprid > thiamethoxam > abamectin > fenpropathrin > spirotetramat against psylla. Abamectin ~~showed~~ least toxic effect against nymph than adult psylla.

**Keywords:** Abamectin, Bioassay, Huanglongbing, Insecticides, Imidacloprid, Psylla, ~~Relative toxicity, Thiamethoxam relative toxicity.~~

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## Introduction:

The Asian citrus psyllid, (*Diaphorinacitri*Kuwayama) (Homoptera: Psyllidae), is widely distributed in southern Asia. It is an important pest of citrus in several countries as it acts as a vector of the causal agent, "*Candidatus liberibacter asiaticus*", for the most devastating disease called greening disease or Huanglongbing (HLB) caused by "*Candidatus liberibacter asiaticus*", which causes heavy losses to citrus orchards and emanates the destruction of several citrus industries in Asia and Africa (Manjunath *et al.*, 2008). Fifth instar nymphs of citrus psyllid act as a vector of greening bacterium which accelerates the decline of 83 to 95 per cent yield losses (Dawane *et al.* 2013). Both nymphs and adults of citrus psylla suck the plant cell sap with the help of their sharp piercing mouth parts, resulted curling, leaves and flowers defoliation and die back of branches from tip to downward and premature dropping of fruits (Shah and Saleem, 2000). HLB acts to disrupt the phloem of the citrus tree by limiting its ability to uptake nutrients. Initially this leads to yellowing of leaves, infested trees showing with stunted growth, sparsely foliated branches, unseasonal bloom, promotion of premature leaf and fruit drop, twig dieback, production of small and misshapen fruits that contain bitter juice with no economic value (Salifu *et al.* 2012). Earlier Capoor *et al.*, (1974) also reported that the young leaves in affected plants were chlorotic with green banding along the major veins. Matured leaves have with yellowish-green patches between veins, fruits with were small size, generally lopsided, underdeveloped, unevenly colored, hard and poor in juice (Capoor *et al.*, 1974). The population of citrus psylla has two peaks in a year during spring and summer and (Belotiet *et al.*, 2013), these peaks obtained coincided with the availability of new flush (Belotiet *et al.*, 2013). Insecticides are the best strategic measure to control manage psyllid populations. Imidacloprid and aldicarb were suggested as effectively in the period of November and April (Qureshi and Stansly, 2007; 2008; Rogers *et al.*, 2008). Similarly, broad spectrum insecticides we are used in winter, spring and summer seasons as foliar sprays (Rogers *et al.*, 2008; Rogers, 2008; Stansly *et al.*, 2009), but they give short term protection against immatured psyllids (Qureshi and Stansly, 2007 and 2009). Also Even if, cultural, mechanical and biological control management practices for this citrus psyllids are not easily applicable, laborious demanding and not greatly effective

in ~~during~~ heavy ~~their~~ severe attack in citrus trees due to different reasons. Hence, the use of chemical insecticides for control management of citrus psylla is one of the prominent, effective and rapid method to overcome their menace. However, recently a very few insecticides have been found under label claim for this pest. Therefore, it is an important need to test some novel chemical insecticides against *D. citri*, as an alternate option for to-label claim insecticides in view to reduce the development of resistances and residual effect. So, keeping these views in mind, the present investigation was aimed to determine the toxicity of some new chemistry insecticide against *D. citri*.

## Methodology:

The bioassay experiments were conducted against *D. citri* during the year 2022-23 in the Toxicology Laboratory, Department of Entomology, by Dr. PDKV., Akola (M.S.). The toxicity was assessed through uptake bioassay technique for systemic insecticides (Molina *et al.*, 2022) using five insecticides viz. Thiamethoxam 25 % WG, Abamectin 1.9 % EC, Imidacloprid 17.8 % SL, Spirotetramat 15.3% OD, and Fenpropathrin 30% EC etc. Bioassays were conducted against nymphs and adults of *D. citri* in laboratory with four replicates per insecticide. The nymphal population of psylla was collected in the zipped plastic bags and brought to the laboratory. The adults were carefully captured in glass vials or polythene bags and tied with rubber band to avoid the escape. The collected psyllids were brought to the laboratory and reared on fresh and moisten leaves in the laboratory till the start of assays. Citrus plant shoots infested with psyllid nymphs of 15 cm (at least two-three terminal leaves) were placed in a glass tubes (50 ml) with each one insecticide solution for 24 h. Distilled water was used as a control treatment. Each shoot stem was protected with a paper cone with glycerin in the corners to prevent the nymphs from escaping. After that, the shoots were transferred to a glass tubes with water, where nymphal mortality was checked after 24, 48, 72 and 96 hours.

For the bioassay experiment for adults, citrus shoots were placed in each insecticide solution for 24 h. After that, shoots were transferred to a clean 50 ml tubes with water. Each tube was placed inside a plastic container of (1 Litre) capacity with a filter paper disc on the bottom and a 2 ml water vial as a humidity source. Ten adults were released in each container and covered with muslin cloth and the numbers of dead and live psyllids adults were

counted the observations were recorded at 6, 12, 24 and 48 hours after the treatment. The corrected per cent mortalities were determined as per Abbott's formula (Abbott, 1925) and the LC<sub>50</sub> values were determined by running probit analysis (Finney, 1952).

## Results and Discussion:

The nymph and adult mortality of *D. citri* were studied by exposed to different concentrations of insecticides. LC<sub>50</sub> and LC<sub>90</sub> values were calculated to compare the toxicity of various insecticides (Pandi *et al.*, 2013). The bioassay results demonstrated that, amongst the five tested insecticides, imidacloprid 17.8 % SL was the most effective insecticide with lowest LC<sub>50</sub> values. In case of nymphal bioassay, at the LC<sub>50</sub> levels, the imidacloprid was 3.61 times more toxic than spirotetramat 15.3 % OD (Unity). Abamectin 1.9 % EC, thiamethoxam 25 % WG and fenpropathrin 30% EC recorded 2.97, 3.48 and 2.73 fold higher toxic than spirotetramat (Table 1). In adult, the relative toxicity of imidacloprid was found 3.13 fold more toxic than the unity i.e. that of spirotetramat. The next better insecticides were abamectin, thiamethoxam and fenpropathrin which recorded recording relative toxicity values, respectively of 2.94, 2.70 and 2.44 respectively fold more toxic than spirotetramat (Unity), which was found least toxic to *D. citri* (Table 2).

A similar trend of toxicity at LC<sub>90</sub> level was observed against nymphs and adults for the all the tested insecticides. However, except spirotetramat, the LC<sub>50</sub> values of thiamethoxam, abamectin, fenpropathrin were lying within the fiducial limit of most toxic insecticide i.e. imidacloprid. They are and hence considered as at on par and equally toxic to *D. citri*.

The above results, regarding the on relative toxicity of different insecticides are were in agreement with the findings of previous workers. Chauhan and Srivastava (2018) who tested the field efficacy of different insecticide against *D. citri* and revealed that, imidacloprid was most effective in reduction of nymph and adult population of psylla, followed by thiamethoxam and novaluron. The results of the present study is was also supported by Powell *et al.* (2007) who reported that, the biannual or more frequent applications of Admire (imidacloprid) significantly reduced psyllid population, percentage of trees infestations and percentage of flushes infestations.

Similar results were reported by Childers and Rogers (2005) reported that, in which foliar

applications with thiamethoxam and imidacloprid was found to reduce psylla population of 86.9-96.4 % and 91.5-98.0 % over control up to 12 DAT (Sharma 2008). Foliar application with abamectin @ 0.3ml/l resulted 90.2-92.5% reduction in psylla population (Rao and Shivankar 2011). Sarada *et al.* (2014) also reported that foliar application of abamectin @ 0.0007 % reduced psylla population more than 80 % after 3 and 7 DAT. The present findings are in line with the findings of Boina *et al.* (2009) who reported that feeding by psylla adults on daily treated plants with a sublethal concentration (0.1µ/L) of imidacloprid significantly reduced the population of citrus psylla. Khan *et al.* (2012) reported that, bioassay with methomyl and imidacloprid inflicted 97-100% mortality to *D. citri*. They also observed gradually decline in mortality in case of methomyl but it was very quick in imidachloprid and lambda cyhalothrin.

According to Wankhade *et al.* (2015) the treatment with abamectin 1.9 EC @ 0.4 ml/l (0.0007%) was found most effective in recording the least nymphal population under field conditions followed by imidacloprid 17.8 SL which proved effective against citrus psylla. The present studies are also in line on par with the results of Molina *et al.* (2022) who reported that thiamethoxam and imidacloprid were the equally effective on African citrus psylla (*Triozaerytrae*) nymphs and were persistent over time. Spirotetramat and abamectin were the least effective on *T. erytrae* nymph control, which collaborates with the results in the present studies. Khan *et al.* (2013) reported a cumulative mortality of adult *D. citri* with Confidor® (imidacloprid), Movento® (spirotetramat) and Radiant® (spinetoram) with were more than 95% at commercially recommended doses. Qasim and Hussian (2015) reported that, imidacloprid was better than Bifenthrin against *D. citri*. The results of present studies are in congruent with Dalvaniya *et al.* (2015) who reported that foliar applications of imidacloprid and thiamethoxam significantly reduced *D. citri* population in lime plants. In accordance with the present findings, of Rao *et al.* (2011) revealed that, module with foliar application of thiamethoxam, abamectin and imidacloprid at 20 days interval before, during and after flushing periods was found to be superior in protecting new flush against *D. citri*.

### Conclusion:

Based on the relative toxicity values obtained in the present studies, the various insecticide tested can be arranged in sequence of better toxicity as imidacloprid > abamectin > thiamethoxam > fenpropathrin > spirotetramat against adult psyllids and imidacloprid > thiamethoxam > abamectin > fenpropathrin > spirotetramat against psyllid nymph.

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*Fig. 1 Bioassay experiment for Adult psylla bioassay*



*Fig. 2 Bioassay experiment for Nymph psylla bioassay*

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**Table 1. Median lethal concentration (LC 50) of different insecticides on citrus psylla (nymph) under laboratory conditions.**

Sr. no.	Insecticide	Slope	Regression equation (y)	Chi-Square	LC50 %	Fiducial Limit		LC90 %	Fiducial Limit		Relative Toxicity atLC50	Relative Toxicity Rank
						Lower	Upper		Lower	Upper		
1	Thiamethoxam 25 % WG	2.72	$Y=4.19+2.72x$	0.566	0.029	0.018	0.045	0.086	0.055	0.134	3.48	2
2	Abamectin 1.9 % EC	17.28	$Y=25.35+17.28x$	0.622	0.034	0.032	0.037	0.040	0.038	0.044	2.97	3
3	Imidacloprid 17.8 % SL	4.33	$Y=6.70+4.33x$	0.754	0.028	0.021	0.038	0.056	0.041	0.076	3.61	1
4	Spirotetramat 15.3 % OD	4.46	$Y=4.44+4.46x$	0.737	0.101	0.077	0.133	0.196	0.149	0.257	1.00	5
5	Fenproprathrin 30 % EC	20.04	$Y=28.73+20.04x$	0.755	0.037	0.035	0.039	0.043	0.040	0.045	2.73	4

**Table 2. Median lethal concentration (LC 50) of different insecticides on citrus psylla (Adult) under laboratory conditions.**

Sr. no.	Insecticide	Slope	Regression equation (y)	Chi-Square	LC <sub>50</sub> (%)	Fiducial Limit		LC <sub>90</sub> (%)	Fiducial Limit		Relative Toxicity at LC <sub>50</sub>	Relative Toxicity Rank
						Lower	Upper		Lower	Upper		
1	Thiamethoxam 25 % WG	2.56	Y=3.67+2.56x	0.020	0.037	0.023	0.060	0.117	0.072	0.191	2.70	3
2	Abamectin 1.9 % EC	16.94	Y=24.97+16.94x	0.952	0.034	0.031	0.036	0.040	0.037	0.043	2.94	2
3	Imidacloprid 17.8 % SL	3.30	Y=4.92+3.30x	0.283	0.032	0.022	0.047	0.079	0.054	0.114	3.13	1
4	Spirotetramat 15.3 % OD	4.54	Y=4.54+4.54x	0.811	0.100	0.076	0.131	0.192	0.146	0.251	1.00	5
5	Fenproprithrin 30 % EC	16.35	Y=22.73+16.35x	0.837	0.041	0.037	0.044	0.049	0.045	0.053	2.44	4