

Relative toxicity of different insecticides to Asian citrus *Psylla* (*Diaphorina citri* Kuwayama)

ABSTRACT

Asian citrus psyllids *Diaphorina citri* (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 management of citrus phylla is one of the prominent and effective method to overcome their menace. However, recently very few insecticides 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 against *D.citri*. Bioassay experiments were conducted during 2022-23. The toxicity was assessed through uptake bioassay technique for systemic insecticides by using fresh citrus twigs. The results showed that, among the five tested insecticides imidacloprid 17.8 % SL was the most effective insecticide with lowest LC₅₀ values for both nymph and adult psyllid i. e. 0.028 and 0.032, respectively. However, except spirotetramat 15.3 % OD, the LC₅₀ values of thiamethoxam 25 % WG, abamectin 1.9 % EC, fenpropathrin 30 % EC were placed 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.

Keywords: Huanglongbing disease, Bioassay, Abamectin, Imidacloprid, Insecticides, Thiamethoxam.

Introduction:

The Asian citrus psyllid, (*Diaphorina citri* Kuwayama) (Homoptera: Psyllidae), is widely distributed in southern Asia. It is an important pest of citrus in several countries and acts as a vector of the causal agent, “*Candidatus liberibacter asiaticus*” for the most devastating disease called greening disease or Huanglongbing (HLB) which causes heavy losses to citrus orchards and has resulted in destruction of several citrus industries in Asia and Africa (Manjunath *et al.*, 2008). 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). The fifth instar nymphs of citrus psyllid acting as the main vector of greening bacterium are accounted for about 83 to 95 per cent yield losses (Dawane *et al.* 2013). 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 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 were chlorotic with green banding along the major veins, matured leaves with yellowish-green patches between veins, fruits were small size, generally lopsided, underdeveloped, unevenly colored, hard and poor in juice. Population of citrus psylla has two peaks in a year during spring and summer and these peaks coincided with the availability of new flush (Beloti *et al.*, 2013). Insecticides are best strategic measure to manage psyllid populations. Imidacloprid and aldicarb were suggested as effective in the period of November and April (Qureshi and Stansly, 2007; 2008; Rogers *et al.*, 2008). Similarly, broad spectrum insecticides were used in winter, spring and summer season as foliar sprays (Rogers *et al.*, 2008; Rogers, 2008; Stansly *et al.*, 2009), but they gave short term protection against immatured psyllids (Qureshi and Stansly, 2007 and 2009). Also cultural, mechanical and biological management practices for this citrus psyllids are not easily applicable, labourious and not greatly effective during their severe attack in citrus trees. Hence the use of chemical insecticides for management of citrus psylla is one of the prominent, effective and rapid methods to overcome their menace. However, recently a very few insecticides have been found under label claim for this pest. Therefore, is an important need to test some novel chemical insecticides against *D.citri*, as an

alternate option for label claim insecticides in view to reduce the development of resistances and residual effect. With these views facts, the present investigation was carried out to determine the toxicity of some new chemistry insecticide against *D.citri*.

Methodology:

The bioassay experiments were conducted against *D.citri* during 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 as described by Prabhaker *et al.* 2006 and Molina *et al.* 2022, for five insecticides viz. Thiamethoxam 25 % WG, Abamectin 1.9 % EC, Imidacloprid 17.8 % SL, Spirotetramat 15.3 % OD and Fenpropathrin 30 % EC. Bioassays were conducted against nymphs and adults stages of *D.citri* in laboratory with four replicates per insecticide.

The nymphs of psylla were collected in the zipped plastic bags and adults were carefully captured in glass vials or polythene bags tied with rubber band to avoid the escape. The collected psyllids were brought to the laboratory and reared. They were provided with fresh and moisten leaves till the start of bioassays. Citrus shoots (about 15 cm in length and with at least two-three terminal leaves) infested with psyllid nymphs were placed in glass tubes (50 ml) containing an insecticide solution for 24 h. Distilled water was used for control treatment. Each shoot 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 (1 litre) capacity with a filter paper disc at the bottom and a 2 ml water vial as a humidity source. Ten adults were released in each container covered with muslin cloth and on the numbers of dead and live psyllids adults, observations were recorded at 6, 12, 24 and 48 hours after the treatment (Molina *et al.*, 2022). The corrected per cent mortalities were determined as per Abbott's formula (Abbott, 1925) and the LC₅₀ 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. LC₅₀ and LC₉₀ values were calculated to compare the toxicity of various insecticides (Pandi *et al.*, 2013). The bioassay results showed that, amongst the five insecticides tested imidacloprid 17.8 % SL was the most effective insecticide with lowest LC₅₀ values. In nymphal bioassay at the LC₅₀ levels, the imidacloprid was 3.61 times more toxic than spirotetramat 15.3 % OD. 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 that of spirotetramat. The next better insecticides were abamectin, thiamethoxam and fenpropathrin which recorded relative toxicity values of 2.94, 2.70 and 2.44 fold more toxic than spirotetramat (Unity), which was found least toxic to *D. citri* (Table 2).

A similar trend of toxicity at LC₉₀ level was observed against nymphs and adults for the all the tested insecticides. However, except spirotetramat, the LC₅₀ values of thiamethoxam, abamectin, fenpropathrin were lying within the fiducial limit of most toxic insecticide i.e. imidacloprid and hence considered as on par and equally toxic to *D. citri*.

The above results, on relative toxicity of different insecticides were in agreement with the findings of previous workers Chauhan and Srivastava (2018) 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 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) 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 @ 0.3 ml/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 on par with the results of Molina *et al.* (2022) who reported that thiamethoxam and imidacloprid were the equally effective on African citrus psylla (*Trioza erytrae*) 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 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, 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 various insecticide tested could be arranged in sequence of better toxicity as imidacloprid > abamectin > thiamethoxam > fenpropathrin > spirotetramat against adult psyllids and imidacloprid > thiamethoxam > abamectin > fenpropathrin > spirotetramat against psyllids nymph.

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Fig. 1 Adult psylla bioassay



Fig. 2 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 at LC50 | 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 | Fenprothrin 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 ₅₀ (%) | Fiducial Limit | | LC ₉₀ (%) | Fiducial Limit | | Relative Toxicity at LC ₅₀ | 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 | Spirotetram at 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 |