

EFFICACY OF INSECTICIDES AGAINST CITRUS PSYLLA (*DIAPHORINA CITRI* KUWAYAMA) IN FIELD AND LABORATORY CONDITIONS

M. QASIM^{1*}, D. HUSSIAN²

*E-mail: cmqasimgill@gmail.com

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ABSTRACT. The experiments were conducted in a citrus orchard to check the efficacy of insecticides against citrus psylla, and mortality was observed after three days, seven days and then after one month. Four insecticides, Polytrin-C, Talstar, Bifenthrin and Imidacloprid applied, had an almost equal effect on the population reduction of citrus psylla on all citrus plants. The trial was laid out in randomized complete block design (RCBD) having five treatments with three replications in a citrus orchard, after three days of spray showed percentage control as 96.91%, 94.33%, 93.83% and 93.06% of following insecticides Polytrin-C, Imidacloprid, Bifenthrin and Actara, respectively, calculated by Minitab 15. Psylla adults were exposed to different concentrations (500, 400, 300, 200 and 100 ppm) of Imidacloprid and Bifenthrin, and two controlled conditions (with leaves and without leaves). Both Imidacloprid and Bifenthrin insecticides proved to be the most effective against *D. citri* with lethal times (LT_{50s}) of 4 and 5 hours, respectively, at a concentration of 500 ppm, calculated from probability test with Minitab-15.

Key words: Citrus psylla; Percentage control; Imidacloprid; Bifenthrin.

INTRODUCTION

Citrus psylla (*Diaphorina citri* Kuwayama) (Homoptera: Psyllidae) is the most devastating and important insect pest of citrus cause heavy losses to citrus orchards through the greening disease of citrus being a viral vector (Hall *et al.*, 2012). It was first time identified from South-East Florida during 1998, known as Asian citrus psyllid (ACP) (Halbert and Manjunath, 2004; Bové, 2006), which with the combination of citrus leafminer (*Phyllocnistis citrella* Stainton), slowed down development of young citrus trees in whole Florida. Then, ACP was recorded from Texas during 2001 (French *et al.*, 2001). ACP has a wide range of host up to sixty plants including different *Citrus*

¹ Department of Agricultural Entomology, University of Agriculture, Faisalabad, Pakistan

² Department of Agricultural Entomology, Ayub Agricultural Research Institute, Faisalabad, Pakistan

spp., orange jasmine, orange boxwood, Chinese boxthorn and Rutaceae family (Halbert and Manjunath, 2004).

Developmental period of *D. citri* fluctuates with the variation of temperature ranging from 17 days to 50 days at 25°C to 15°C (Tsai and Liu, 2000; Wenninger and Hall, 2007), having an optimal temperature range of 24-28°C (Fung and Chen, 2006) with high relative humidity (McFarland and Hoy, 2001), but fails to complete its development beyond 10°C-33°C (Liu and Tsai, 2000; Ashihara, 2004; Nava *et al.*, 2007). The population of citrus psylla has two peaks in a year during spring and summer (Beloti *et al.*, 2013).

Management included different control measures like insecticides, botanicals, insect growth regulators and biological (Khan *et al.*, 2013). Application of these control measures against citrus psylla, were recommended at 10-15 days interval (Shivankar *et al.*, 2000).

Insecticides are best strategic measure to control psyllid populations. Imidacloprid and Aldicarb are suggested effectively in the period of November and April (Qureshi and Stansly, 2007; 2008; Rogers *et al.*, 2008). Similarly, broad spectrum insecticides are used in winter, spring and summer season as foliar sprays (Rogers *et al.*, 2008; Rogers, 2008; Stansly *et al.*, 2009), but they give short term protection against immature psyllids (Qureshi and Stansly, 2007 and 2009).

Our research was focused on the evaluation of long time worth of insecticides in the field against citrus psylla and to find out lethal time against citrus psylla in the laboratory.

MATERIALS AND METHODS

Field trial. The trial was conducted in a RCBD having five treatments with three replications in the orchard at Chak No. 80/J.B Sarlian, Jhang Road Faisalabad. The insecticides were sprayed on May 06, 2011, at morning time. Pre-treatment data was recorded on the basis of population of psylla from five different randomly selected sites per replication. After three days, seven days and then after one month % age control/mortality was observed.

Bioassay

Citrus psylla's collection. Citrus psylla's were collected from the orchard at Chak No. 80/J.B Sarlian, Jhang Road Faisalabad. Collected population was placed in the zipped plastic bags, brought to the Entomological laboratory at Ayub Agricultural Research Institute (AARI) and was provided fresh, moistened leaves in plastic jars, kept at 26°C until ready to use. Psylla's collected from the orchard were used at the time of assay in the laboratory within a week.

Determination of chemical's toxicity. Toxicity tests were done in jars of 8 cm diameter, having a fresh shoot of citrus with 8-10 leaves, after application of insecticidal treatment, as mentioned in *Table 1*, and control treatment. And jars were covered meshed cloth, to keep environment same as a laboratory. Serial concentrations of Imidacloprid 5EC and Bifenthrin 10EC were made and each shoot was dipped in the solution, having insecticides. In one control treatment only

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leaves were used and in second control nothing was used. 20 adults of *D. citri* were released in each jar having treated and control environment. These jars were placed in the laboratory 28±2°C and 80±5% R.H conditions, maintained by Air

conditioner (AC). Psylla were examined after every 2 hours up to 12 hours, and later, at a time interval of 12 hours until all adults died.

Table 1 - Chemical and their doses

Treatments	Chemical name	Trade name	Dose / 100 liters of water
T ₁	Control	-	-
T ₂	Cypermethrin+Profenofos	Polytrin-C	50 ml
T ₃	Bifenthrin	Talstar	20 ml
T ₄	Thiamethoxam	Actara	10 g
T ₅	Imidacloprid	Imidacloprid	10 g

Statistical analysis. Analysis of variance (ANOVA) was implemented to determine percent control of insecticides against *D. citri*, by using statistical program Minitab15. Similarly, LT₅₀ from three replications in CRD was calculated by Minitab15 at the significance level of $P < 0.05$ (Evans and Rosenthal, 2003).

RESULTS

Table 2 shows that after 3 days the maximum % age control was found by Polytrin-C i.e. 96.91%, as followed by Imidacloprid i.e. 94.33%, Bifenthrin i.e. 93.83% and the minimum control was found by Actara i.e. 93.06%, having LSD value = 2.005. After 7 days the maximum % age control of citrus psylla was found by Polytrin-C i.e. 95.62%, followed by Bifenthrin i.e. 93.86%, Imidacloprid i.e. 92.79% and the minimum % age control was found by Actara i.e. 89.20%, having LSD value

= 5.10. After one month the range of effectiveness of insecticides against pest was same, but decreased the value of effectiveness.

Table 3 shows the LT₅₀ values for *D. citri* by exposing to the glass jars, treated with different concentration of insecticides and controlled jars. LT₅₀ was 4 hrs at 500 ppm concentration of Imidacloprid with fiducial limit (FL), p value and standard error 2.5-5.5, 0.96 and 0.74, respectively, and with the same concentration of Bifenthrin, the LT₅₀ was 5 hrs with FL, p value and standard error 2.7-5.7, 0.43 and 0.74, respectively. LT₅₀s were 38 hrs and 32 hrs of control treatment with and without leaves, respectively. And, at the concentration of 100 ppm, LT₅₀s were increased up to 20 hrs and 24 hrs of Imidacloprid and Bifenthrin, respectively.

Table 2 - Trial of insecticides against *D. citri* in orchard

Chemical	Pre-treatment (individuals/ leaf)	Percent control of <i>D. citri</i> post-treatment		
		3 days	7 days	30 days
Control	13.62	0.00 C	0.00 C	0.00 C
Polytrin-C 440 EC	12.17	96.91 A	95.62 A	83.27 A
Bifenthrin 10 EC	14.78	93.83 B	93.86 AB	80.07 AB
Actara 25 WP	16.86	93.06 B	89.20 B	73.88 B
Imidacloprid 70 WP	14.11	94.33 B	92.79 AB	81.44 AB

Table 3 - LT₅₀ of *D. citri* in Laboratory

Concentrations (ppm)	LT ₅₀ (hours), Fiducial limit (95%), <i>p</i> value, Standard error							
	Imidacloprid				Bifenthrin			
	LT ₅₀	FL	<i>p</i>	SE	LT ₅₀	FL	<i>p</i>	SE
500	4	2.5-5.5	0.96	0.74	5	2.7-5.7	0.43	0.74
400	7	4.5-7.9	0.99	0.87	8	5.5-9.0	0.90	0.89
300	9	7.3-14.1	0.58	1.72	12	8.2-14.4	0.85	1.56
200	12	10.9-17.9	0.84	1.77	14	10.7-18.7	0.98	2.05
100	20	16.5-26.8	0.71	2.63	24	15.9-29.5	0.92	3.45
Control with leaves	38	*	1.00	*	38	32.4-59.2	0.99	6.83
Control without leaves	32	*	0.20	1.79	32	22.3-29.6	0.18	1.85

DISCUSSION

Citrus psylla is the most harmful insect pest of citrus orchards all over the Pakistan (Abbas, 2001), which causes curling and defoliation of leaves, flowers and die back of branches leading to premature fruit dropping, by sucking cell sap (Shah and Saleem, 2000). There are three nymphal populations per year of citrus psylla at peak, observed in April, June and September (Sharma, 2008). But cold conditions have adverse effects on psyllid population due to high humidity and low

temperature especially in January (Arora *et al.*, 1997).

Four insecticides were used to control *D. citri* in the field, out of which Actara was less effective than other three ones. All insecticides reduced 90% population up to the first week after spraying (Rao and Shivankar, 2011), but the effectiveness was declined up to 70% after one month. Thus, two sprays of Polytrin-C, Imidacloprid and Bifenthrin at 15 days interval were found to be successful against citrus psylla (Shivankar *et al.*, 2000).

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Polytrin-C and Imidachloprid provided the almost complete control of the 7 days of application, confirmed by the findings of (Shivankar *et al.*, 2000; Sétamou *et al.*, 2010). Similarly, Actara was also much efficient against citrus psylla as discussed by (Ichinose *et al.*, 2010). From this field experiment, it was concluded that the population of *D. citri* was reduced up to 95% by Polytrin-C. All the insecticides, which we have applied, had statistically equal effect on the reduction of population of citrus psylla. Similarly, from this laboratory experiment, lethal effects of two insecticides were observed, which described that more than 50% population was diminished within 5 hrs at the rate of 500 ppm, as confirmed by Boina *et al.* (2009), but with decreasing insecticidal concentration up to 100 ppm, lethal time was increased up to 24 hrs. While, on the other hand, in the controlled conditions having fresh green leaves, LT₅₀ was calculated 38 hrs for adults.

CONCLUSION

Citrus psylla is fastidious pest of citrus orchards, which feed on sap, and causes damage directly (deformation of leaves, fruits) and indirectly (Huanglongbing disease). Management is being conducted to control this pest via different strategies; such as, chemical, cultural, biological. Chemical insecticides are very fast and accurate for control of insect pests, as compared to other

control measures. All over the world, various formulations of different chemicals are being used, to control citrus psylla. Citrus psylla also main problem of citrus industry in Pakistan, for which, different chemical insecticides are being applied to hinder its population from threshold level. Likewise, we tested four insecticides for management of *D. citri* in the orchard, and gave very fast results, but Polytrin-C was proven to be best than others, similarly potential of Bifenthrin and Imidacloprid was checked in the laboratory, where Imidacloprid proved better than Bifenthrin. But the effects of sprays were started to decrease after fifteen days in each situation, field as well as laboratory, so it is suggested that application should be regular in certain season according to environmental conditions, otherwise population could cross the economic injury level, where management practices are become fruitless.

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