Original Research Article

Bio-efficacy of certain chemicals against *Diaphorina citri* (Homoptera:Psyllidae)

ABSTRACT

Asiatic citrus psyllid, *Diaphorina citri* Kuwayama (Homoptera: Psyllidae) is identified as a major pest of citrus in subtropical and tropical Asia. Citrus greening disease or Huanglongbing is found to be the most serious disease of citrus in the world, causing the highest economic loss. *Diaphorina citri* Kuwayama is the only known vector of Huanglongbing. Intensive insecticide programs against ACP are generally ineffective for preventing the introduction and spread of HLB, especially in new plantings. Extensive pesticide applications are causing psyllid resistance, and probably damage to bees and beneficial insects. So, it is important to devise IPM schemes that minimize the amount of pesticides applied, especially neonicotinoids and other broad-spectrum materials. An integrated strategy involving both biological and chemical control tactics is required for sustainable management of the pest to reduce disease spread. Some biological agents which control the *D. citri* such as lady beetles, lacewings and spiders are all well known as predators. Therefore, the present investigation had been aimed to study the biology and efficacy of various chemicals, both, solely and in combination, viz., Bifenthrin, Lambda cyhalothrin, Azadirachtin (neem oil), Cypermethrin + Profenofos, Deltamethrin + Triazophos and Quinalphos under laboratory conditions against *D.citri* as management strategies of an insect pest must be based on thorough ecological studies of the concerned insect pest.

Key-words: Asian Citrus Psyllid, Huanglongbing, neonicotinoids

INTRODUCTION

Asiatic citrus psyllid, *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae) is identified as a major pest of citrus in subtropical and tropical Asia (Halbert and Manjunath, 2004). Citrus greening disease or Huanglongbing is found to be the most serious disease of citrus in the world, causing the highest economic loss (Aubert *et al*.,1996). Its status derives, not from the damage it causes, but from its functioning as the only known vector of Huanglongbing, a phloem-limited bacterial disease of international importance. Sap is sucked from the phloem of tender shoots and buds by both adults and nymphs, while adults also feed on the phloem of mature leaves. Severe infestations in orchards and gardens may cause withering, distortion, and loss of immature leaves with irregular-shaped canopies. Growth of sooty mould fungi on honeydew excreted by nymphs leads to blemishing of foliage and fruit, and can reduce photosynthesis (Wang *et al., 2002*). Some synthetic conventional insecticides like neem oil, petroleum oils and organics have been successfully used in reducing its population (Setamou et al., 2010). Foliar application of systemic insecticides viz., imidacloprid, thaimethoxam reduces 50 to 70 percent *D. citri* population. Even intensive insecticide programs against ACP are generally ineffective for preventing the introduction and spread of HLB, especially in new plantings (Hall *et al.*, 2013). Extensive pesticide applications are causing psyllid resistance, and probable damage to bees and beneficial insects. So, it is important to devise IPM schemes that minimize the amount of pesticides applied, especially neonicotinoids and other broad-spectrum materials (Tiwari *et al.* 2011). Possible strategies include trapping, biological control, repellents, attractants, and application of pesticides such as horticultural oils with low impact on beneficial insects and biological controls (Grafton-Cardwell *et al.* 2013). Infected trees may respond to heat and nutrients. Antibiotics such as ampicillin will kill the pathogen. Long range hopes are resistant species for replants, cross protection with non-pathogenic microbes, or treatment with bacterial antagonists (de Graca 1991; Hall *et al.* 2013; Zhang *et al.* 2013). IPM actions depend on infestation levels of psyllids, and the percentage of infected trees (Bové 2006; Halbert and Manjunath 2004). An integrated strategy involving both biological and chemical control tactics is required for sustainable management of the pest to reduce disease spread. Biological control has always been an important component of citrus insect pest management (McCoy, 1985). Some biological agents which control the *D. citri* such as lady beetles, lacewings and spiders are all well known as predators (Qureshi and Stansly, 2010 and Michaud, 2004). These and other predators were observed to inflict 80–100% mortality to *D. citri.* Two exotic hymenopteran parasitoids of ACP, *Diaphorencyrtis aligarhensis* (Encyrtidae) and *Tamaraxia radiata* (Eulophidae) were introduced in Florida (McFarland and Hoy, 2001). *Tamaraxia radiata* is now widely distributed in Florida citrus ecosystems (Hoy and Nguyen, 2001). Insecticides are presently a critical component of ACP management. The systemic neonicotinoid insecticides, thiamethoxam, imidacloprid and clothianidin and a new insecticide cyantraniliprole are

Comment [m1]: Missed in reference list allowed in Florida citrus but their use as soil applications is limited by rate restrictions to young trees (Qureshi *et al*., 2011). Therefore, the present investigation has been aimed to study the biology and efficacy of some chemicals against *D.citri*, as management strategies of an insect pest must be based on thorough ecological studies of the concerned insect pest. The study is supposed to provide essential bridging information for devising effective management strategies against *D. citri* by providing information in areas concerning with citrus production.

MATERIALS AND METHOD

To assess the efficacy of various chemicals, singly and in combination, viz., Bifenthrin, Lambda cyhalothrin, Azadirachtin (neem oil), Cypermethrin + Profenofos, Deltamethrin + Triazophos and Quinalphos, the experiments were conducted on adults of *D. citri* under laboratory conditions. There were six treatments. A control experiment (spray with distilled water) was run parallel with the main experiment and each was replicated thrice. The recommended doses of respective chemicals were prepared by adding distilled water in a conical flask (Table-A). All the prepared formulation of respective chemicals were used for the application on adults of *D. citri* under controlled conditions. The counted number of adults (10 individuals) were selected from stock culture maintained in BOD incubator and were exposed to above prepared formulations of respective chemicals by "Leaf dip bioassay" and mortality was observed after 12, 24 and 48 hours.

Comment [m2]: Do you mean Biochemical oxygen demand?? If so, the author must mention the whole words before initials

Table A: Types of chemicals used

Sl. No.	Formulations	Concentration used (µl/100ml)	Trade name	Source	Type
1.	Bifenthrin 10%	10 ,15, 20	Markar	Dhanuka Agritech Limited	EC
2.	Azadirachtin 0.15%, 1500ppm	300, 400, 500	Aastha Neem	Aastha Organics	EC
3.	Lambda cyhalothrin 5%	40, 70, 100	Baghban	Biomass Lab.	EC
4.	Cypermethrin 4% + Profenofos 40%	30, 40, 50	Hitcel	Excel Crop Care Ltd.	EC
5.	Deltamethrin 1% + Triazophos 35%	40, 70, 100	Deltex	Excel Crop Care Ltd.	EC
6.	Quinalphos 25%	100, 150, 200	Flash	Indofil Industries Limited	EC
~~7.~~	~~Control~~	-	-	-	-

Comment [m3]: Remove this item (entire row). In control treatment we spraying with distilled water

Leaf dip method:

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The citrus leaves were plucked from the tree and cleaned with moist cotton to remove the dirt particles, if any. After cleaning, the leaves were dipped in respective chemicals for one minute and then allowed to dry at room temperature for 15-20 minutes. Adults were released for feeding on separate leaves, after wrapping its tip with a moist cotton swab to prevent it from drying.

RESULTS AND DISCUSSION

The studies on bio-efficacy of chemicals (Bifenthrin, Neem oil, Lambda cyhalothrin, Cypermethrin + Profenophos, Deltamethrin + Triazophos and Quinalphos) against *D.citri* Kuwamaya were carried out under controlled conditions at Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh, Uttar Pradesh in 2019.

With regard to efficacy of chemicals, the total percent mortality and concentration (dose) of the chemicals was found to be positively correlated. Highest mortality was found after 48 hours of the treatment at the maximum concentration of each chemical. Amongst the three concentrations undertaken for each chemical, maximum per cent mortality occurred at the maximum concentration in each of them. Cypermethrin + Profenophos was overall found to be most effective at all the three concentrations at 12, 24, 48 hours with a total mortality of 75.56±15.03%. It was followed by Lambda cyhalothrin with 74.45±13.47 % total mortality which was at par with Quinalphos. This was followed by Deltamethrin+Triazophos and Bifenthrin with 71.11±11.70% and 70.00±18.56% total per cent mortality respectively. Least per cent mortality was observed by Neem oil at the maximum concentration, amongst all, which was 65.56±15.03% (Table 2). It was also concluded by the probit analysis that the LC_{50} value of Bifenthrin was found to be least, hence the most toxic and that of neem oil was found to be maximum, hence the least toxic, after 12 hours of time interval. Similar results were obtained after 24 hours and 48 hours of time interval (Table 2,3,4). Out of 30 adults, mortality (in numbers) was shown for each chemical at 12, 24, 48 hours (Figure- 1 to 6). Finally, it was inferred that insecticides proved to be more effective than botanical (neem oil). Effectiveness against *D.citri* adults was rated in the following order- cypermethrin+profenophos> lambda cyhalothrin=quinalphos> deltamethrin+triazophos> neem oil.

Chakravarthi *et al.*, 1998 tested nine insecticides and observed that profenofos, triazophos and imidacloprid gave complete control after 7 days of spraying, whereas, azadirachtin

(0.03%) and neem (*Azadirachta indica*) oil also achieved higher level of control (around 90%). Chakravarthy, 1998 also observed that triazophos @ 0.025 % and profenophos @ 0.025 % were effective and persistent in action as compared to botanicals like neem oil (1.0 %), pongamia oil (1.0%) and animal origin insecticide, fish oil rosin soap (0.2%) which were only effective for a short period after their application. Sharma, 2008 tested the bio-efficacy of different insecticides viz, dimethoate (0.075%), oxydemeton methyl (0.075%), imidacloprid (0.008%), chlorpyriphos (0.1%), triazophos (0.1%), thiamethoxam (0.008%), and quinalphos (0.075%) showed significantly high (91-100%) nymphal reduction of citrus psylla. Rao and Shivankar, 2011 reported that neem soap @ 5 g/litre, pongamia soap @ 5 g/litre, neem oil @ 6.76 ml/litre and azadirachtin (10000 ppm) @ 3.65 ml/litre were found most effective than *Bacillus thuringiensis, Verticilium lecanii* and sweet flag against second instar nymphs of *D. citri* at 15 days after application. Dalvaniya *et al*., (2015) reported that among the treatments, imidacloprid 17.8 SL @ 3.0 ml/10 litres water was most effective with minimum population of *D. citri* at one, three, seven and 10 days after spray, followed by diafenthiuron 50 EC @ 4.0 ml/10 litres water and thiamethoxam 25 WDG @ 3.20 g/10L of water.

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Comment [m6]: Missed in reference list

CONCLUSION

With regard to mode of exposure, leaf dip method was preferred to be used over any other mode. It was found that insecticides proved to be more effective than botanical (neem oil). Amongst insecticides, Cypermethrin + Profenophos was overall found the most effective at all the three concentrations at 12, 24, 48 hours with a total ~~per cent~~ mortality of 75.56±15.03%. Out of 12, 24 and 48 hours after treatment, highest mortality was found after 48 hours at all the concentrations taken. Amongst the three concentrations undertaken for each chemical, maximum mortality occurred at the maximum concentration in each of them. Least per cent mortality was observed by Neem oil at the maximum concentration, amongst all, which was 65.56±15.03%. Out of 30 adults, mortality (in numbers) was shown for each chemical at 12, 24, 48 hours. LC_{50} value of Bifenthrin was found to be least, hence the most toxic and that of neem oil was found to be maximum, hence the least toxic, after 12 hours of time interval. Similar results were obtained after 24 hours and 48 hours of time interval. Effectiveness against *D.citri* adults was finally rated in the following order-

Comment [m7]: percent

cypermethrin+profenophos> lambda cyhalothrin=quinalphos> deltamethrin+triazophos> neem oil.

The corrected Effectiveness as follows:

Bifenthrin (12.38) > Lambda (17.54) > Cypermethrin+Profenophos (26.44) > Deltamethrin+Trizophos (33.20) > Quinalphos (73.35) > Neem (302.08)

REFERENCES

Comment [m8]: double strikeout yellow references are not mentioned in the body text-must be removed.

Ahmed, S., Ahmad, N. and Khan, R. R. (2004). Studies on population dynamics and chemical control of citrus psylla, *Diaphorina citri*. *International J. Agric. Biol.*, 6 (6): 970-973.

Ashihara, W. (2004). Survival of Asian citrus psyllid, *Diaphorina citri* Kuwayama adults under winter temperature conditions in central and south Kyushu. Japanese Journal of Applied Entomology and Zoology 48: 207-11.

Aubert, B., Grisoni, M., Villemin, M., Rossolin, G. (1996). Proceedings of 13th Conference of International Organization of Citrus Virologists (IOCV).

Comment [N9]: When and Where

Aubert, B. and Quilici, S. (1988). Monitoring adult psyllas on yellow traps in Reunion Island. Proceedings of the 10th Conference of the International Organization of Citrus Virologists, 17–21 November 1986, Valencia, Spain (ed. by LW Timmer, SM Garnsey & L Navarro), pp. 249-254. International Organization of Citrus Virologists, University of California, Riverside, CA, USA.

Arora, P. K. and Sharma, D. K. (2011). Bio-efficacy of some neonicotinoids against citrus psylla (*Diaphorina citri* Kuwayama) on kinnow mandarin. Journal 0f Insect Science,24 (4):399-401.

Batra, R. C., Bindra, O.S. and Sohi, B. S. (1972). Spraying schedule for controlling insect pest of citrus. Punjab Horticulture Journal, 11 (4): 237-239.

Bindra, O. S., Sohi, B. S. and Barta, R. C. (1973). Note on the comparative efficacy of some contact and systemic insecticides for the control of citrus psylla in Punjab. Indian Journal of Agricultural Science, 43 (12): 1087-1088.

Borad, P. K., Patel, M. J., Vaghela, N. M., Patel, M. G., Vaishnav, P. R., Patel, B. H. and Patel, J. R. 2001a. Bio-efficacy of some new insecticides against pests of kagzi lime. Indian Journal of Entomology, 63 (2): 147150.

Boulahia, S. K., Jerraya, A. and Zaidi, H. (1996). Chemical treatment trial against the citrus leaf miner, *Phyllocnistis citrella*. Fruits Paris, 4 (51):223- 228.

Bové, J.M. (2006). Huanglongbing: a destructive, newly emerging, century old disease of citrus. J. Plant Pathol. 88(1):7-37.

Chakravarthi, V.P., P. Savithri, P.R. Prasad and P.P. Reddy, 1998. Efficacy of various insecticides against citrus psylla, Diaphorina citri kuwayama (Psyllidae: Hemiptera). Advances in IMP Hort. Crops, Banglore, India, l: 32–3

Chakravarthy, 1998

Dahiya, K. K., Lakra, R. K., Dahiya, A. S. and Singh, S. P. (1994). Bio-efficacy of some insecticides against citrus psylla (*Diaphorina citri*, Kuwayama.) (Psyllidae: Hemiptera). Crop Research, (Hisar) 8:137-140.

Dalvaniya, D.G., Patel, P.S., Pareek, A. and Panickar, B. (2015). Efficacy of some insecticides against citrus psylla, *Diaphorina citri* Kuwayama on kagzi lime. Journal of Entomological Research, 39 (2): 141-144.

De Graca, J.V. (1991). Citrus greening disease. Annu. Rev. Phytopathol. 29:109-136.

Ebeling, W. (1959). Subtropical fruit pests. *Subtropical Fruit Pests.*, (Revd. edition).

Farland, Mc., Clint, D., Hoy and Marjorie, A. (2001). Survival of *Diaphorina citri* (Homoptera: Psyllidae), and its two parasitoids, *Tamarixia radiata* (Hymenoptera: Eulophidae) and *Diaphorencyrtus aligarhensis* (Hymenoptera: Encyrtidae), under different relative humidities and temperature regimes. Florida Entomologist, 84: 227-33.

Grafton-Cardwell, E.E., Stelinski, L.L. and Stansly, P.A. (2013). Biology and management of Asian citrus psyllid, vector of huanglongbing pathogens. Annu. Rev. Entomol. 58:413-432.

Halbert, S.E. and Manjunath, K.L. (2004). Asian citrus psyllid and greening disease of citrus: a literature review and assessment of risk in Florida. Fla. Entomol. 87(3):330-353.

Comment [N10]: missed

Hall, D. G. and Albrigo, L.G. (2007). Estimating the relative abundance of flush shoots in citrus, with implications on monitoring insects associated with flush. HortScience. 42: 364-368.

Hall, D.G., Richardson, M.L. Ammar, E.D. and Halbert, S.E. (2013). Asian citrus psyllid, *Diaphorina citri*, vector of huanglongbing disease. Entomol. Exper. Appl. 146:207-223.

Hall, D.G. (2008). Biological control of *Diaphorina citri*. North American Plant Protection Organization, Proceedings of the Taller Internacional Sobre Huanglongbing y el Psilido Asiatico de los Citricos, del 7 al 9 de Mayo de 2008, Hermosillo, Sonora, p. 7. Available at http://www.concitver.com/huanglongbingYPsilidoAsiatico/Memor%C3%ADa-8%20Hall.pdf.

Hoy, M.A., Nguyen, R. (2001). Classical biological control of Asian citrus psylla. Citrus Indust 81: 48–50.

Indian Journal of Agricultural Sciences, Evaluation of some botanicals references against citrus leaf-miner (*Phyllocnistis citrella*) and psylla (*Diaphorina citri*) on kagzi lime (*Citrus aurantifolia*, 71 (3): 177-179.

Jha, G. K., Suresh, A., Punera, B., & Supriya, P. (2019). Growth of horticulture sector in India: Trends and prospects. *Indian Journal of Agricultural Sciences*, *89*(2), 314-321.

Kumar, P., Singh, H. M. and Singh, A. K. (2005). Evaluation of insecticides and seed kernel extracts against citrus references psylla, *Diaphorina citri*. Annals of Plant Protection Sciences, 13 (2): 478-480.

McCoy, C.W. (1985). Citrus: current status of biological control in Florida. In: Hoy, M.A., Herzog, D.C. (Eds.), Biological Control in Agricultural IPM Systems. Academic, Orlando, FL, pp. 481–499.

McFarland CD & Hoy MA (2001) Survival of *Diaphorina citri* (Homoptera: Psyllidae) and its two parasitoids, *Tamarixia radiata* (Hymenoptera: Eulophidae) and *Diaphorencyrtus aligarhensis* (Hymenoptera: Encyrtidae), under different relative humidities and temperature regimes. Florida Entomologist 84: 227–233.

Michaud JP (2004) Natural mortality of Asian citrus psyllid (Homoptera: Psyllidae) in central Florida. BiolCont 29: 260–269.

Naveen Vikram Singh and Yadav, G.S. 2018. Bio-ecology and Management of Citrus psylla, *Diaphorina citri* Kuwayama on Citrus – A Review. International Journal of Current Microbiology and Applied Sciences. 7 (04): 3091- 3107.

Patel, C. C. (2007). Study on population dynamics, biology and management of citrus psylla, *Diaphorina citri* Kuwayama. M.Sc. (Ag.) Entomology thesis submitted to AAU, Anand.

Patt, J. M., and Setamou, M. (2010). Responses of the Asian citrus psyllid to volatiles emitted by the flushing shoots of its rutaceous host plants. *Environmental Entomology*, *39*(2), 618-624.

Qureshi, J.A., Stansly, P.A. (2008). Rate, placement and timing of aldicarb applications to control Asian citrus psyllid, *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae), in oranges. Pest Manag Sci 64: 1159– 1169.

Qureshi, J.A., Stansly, P.A. (2010). Dormant season foliar sprays of broad spectrum insecticides: An effective component of integrated management for *Diaphorina citri* (Hemiptera: Psyllidae) in citrus orchards. Crop Prot 29: 860–866.

Qureshi, J.A., Kostyk, B.C., Stansly, P.A. (2011). Effectiveness of selective insecticides to control Asian citrus psyllid and citrus leafminer during leaf flushing. Proc Fla State Hort Soc 124: 85–89.

Randhava, G. S. (1974). Horticulture – Importance of pest control. *Pesticides Annual*, 8 : 85-89.

Rao and Shivankar, 2011

Sarada, G., Gopal K., Nagalaxmi, T., Venkatramna, K.T., Mukundalaxmi, L., Gourishankar, T. and Gopi, V. 2014. Management of citrus psylla (*Diaphorina citri* Kuwayama) using bio rational insecticides. *Journal of Ecology and Environmental Sciences*, **3** (2): 9- 11.

Sharma, D. R. 2008. Population dynamics in relation to abiotic factor and management of citrus psylla in Punjab. *Indian Journal of Hort*iculture, **65** (4): 17-422.

Shivankar, V. J., Rao, C. N. and Singh, S. (2005). Studies of citrus psylla, *Diaphorina citri* Kuwayama: A review, Agricultual Review 21: 199-204.

Skelley, L.H. & Hoy, M.A. (2004). A synchronous rearing method for the Asian citrus psyllid and its parasitoids in quarantine. Biological Control 29: 14–23.

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(Tiwari *et al.* 2011).

Viraktamath, C. A. and Bhumannavar, B. S. (2002). Biology, ecology and management of *Diaphorina citri* Kuwayama (Hemiptera: psyllidae). Pest Management of Horticultural Ecosystem 7: 1-27.5.

Wang, H, Chen, G, Lin, H and Gong, J., 2002 bacterial genome of citrus plants in response to *Candidatus Liberibacter* asiaticus-infection and). Studies on the population dynamics of citrus pests and diseases and control methods. *South China Fruits*, 31(4): 13–15.

Wankhade, S.M., Kadam, U.K., Patil, S.K. and Bansode, G.M. (2015). Studies on the seasonal incidence and management of citrus psylla (*Diaphorina citri* Kuwayama) in sweet orange. Indian Journal of Agricultural Research, 49 (4): 321-326.

Xu, C., Xia, Y., & Ke, C. (1994). Study on the biology and control of citrus psylla. *Acta Phytophylacica Sinica*, *21*(1), 53-56.

Zhang, M., Powell, C.A., Benyhon, L.S. et al. (2013). Deciphering the antibiotic treatments.

Comment [N12]: missed

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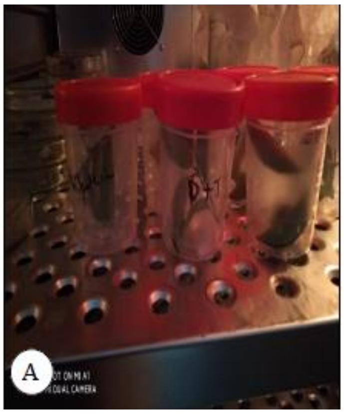

Plate 1 A: Plastic container (100ml) with treated leaves in BOD

Plate 1 B: Insecticides used and micro pipette

Table-1: Bio-efficacy of different insecticides at different concentrations and time intervals:

Insecticides	Recommended concentration	Mortality (Mean ± SD)			Total Mortality (%)
		12 hours	24 hours	48 hours	
Bifenthrin	10µl/100ml	1.67±0.58e	3.00±1.00^{d}	4.00±1.00^{f}	28.89±11.70^{c}
	15µl/100ml	2.33±1.53de	3.67±1.53^{c}	5.00±2.00^{e}	36.67±13.34^{c}
	20µl/100ml	5.33±1.53ab	6.67±1.53^{a}	9.00±1.00^{a}	70.00±18.56^{a}
Cypermethrin + Profenophos	30µl/100ml	3.00±2.00cd	5.33±1.53^{b}	6.00±1.73^{d}	47.78±15.75^{b}
	40µl/100ml	3.33±2.08cd	6.67±2.52^{a}	8.00±1.73^{b}	60.00±24.04^{a}
	50µl/100ml	6.00±1.00a	7.67±1.53^{a}	8.33±1.00^{a}	75.56±15.03^{a}
Lambda cyhalothrin	40µL/100ml	2.67±0.58de	4.00±1.00^{c}	7.00±1.00^{c}	45.56±22.19^{b}
	70µl/100ml	3.33±1.53cd	5.33±0.58^{b}	7.67±1.53^{c}	54.44±21.69^{b}
	100µl/100ml	6.00±1.00a	7.67±0.58^{a}	8.67±0.58^{a}	74.45±13.47^{a}
Deltamethrin +Triazophos	40µl/100ml	3.00±1.00cd	4.67±1.15^{c}	5.67±1.53^{d}	44.45±13.47^{b}
	70µl/100ml	4.00±1.00bc	5.00±1.00^{b}	7.33±0.58^{c}	54.44±17.10^{b}
	100µl/100ml	6.00±1.00a	7.00±1.00^{a}	8.33±1.15^{a}	71.11±11.70^{a}
Quinalphos	100µl/100ml	3.33±0.58cd	4.00±1.00^{c}	6.33±0.58^{d}	45.55±15.75^{b}
	150µl/100ml	4.33±1.53bc	6.00±1.00^{b}	8.00±1.00^{b}	61.11±18.36^{a}
	200µl/100ml	6.00±1.73a	7.67±1.53^{a}	8.67±1.53^{a}	74.45±13.47^{a}
Neem oil	300µl/100ml	1.67±0.58e	3.67±0.58^{c}	5.00±1.00^{e}	47.78±30.06^{b}
	400µl/100ml	2.33±0.58de	4.67±1.53^{c}	6.67±0.58^{c}	45.56±21.69^{b}
	500µl/100ml	5.00±1.00ab	6.67±1.53^{a}	8.00±1.00^{b}	65.56±15.03^{a}
LSD		*1.221*	*1.277*	1.184	*17.522*
DF		*17,53*	*17,53*	17,53	*17,53*
F		*6.05*	*7.02*	10.34	*3.4*
P		*0.0*	*0.0*	0.0	*0.001*

Alphabetical letters for significance must be rechecking for all columns.
P-value changed to (0.000), *i.e.*, 3digits after the decimal point.

Table-2: Effect of insecticides on citrus psylla, *Diphorina citri* after 12 hours:

Insecticides	Chi-Square	LC_{50} µl/100ml	Log(con.) Value	Correlation coefficient	R^2	Regression equation
Bifenthrin	1.48	20.55	1.31	0.94	0.88	y = 1.10x -7.17
Cypermethrin + Profenophos	1.40	45.85	1.66	0.91	0.83	y = 0.45x - 5.67
Lambda cyhalothrin	1.37	87.86	1.94	0.95	0.89	y = 0.17x + 0.33
Deltamethrin +Triazophos	0.50	81.09	1.91	0.98	0.96	y = 0.15x + 2.50
Quinalphos	0.23	162.62	2.21	0.99	0.98	y = 0.08x + 1.67
Neem oil	0.98	525.99	2.72	0.95	0.89	y = 0.05x - 11.0

Table-3: Effect of insecticides on citrus psylla, *Diphorina citri* after 24 hours:

Insecticides	Chi-Square	LC_{50} µl/100ml	Log(con.) Value	Correlation coefficient	R^2	Regression equation
Bifenthrin	1.67	16.14	1.21	0.94	0.88	y = 1.10x - 3.17
Cypermethrin + Profenophos	0.00	28.16	1.45	1.00	0.99	y = 0.35x + 5.67
Lambda cyhalothrin	0.82	54.79	1.74	0.99	0.98	y = 0.19x + 4.17
Deltamethrin +Triazophos	1.02	51.67	1.71	0.92	0.86	y = 0.12x + 8.50
Quinalphos	0.05	121.38	2.08	1.00	1.00	y = 0.12x + 1.17
Neem oil	0.39	391.49	2.59	0.98	0.96	y = 0.045x - 3.00

Table-4: Effect of insecticides on citrus psylla, *Diphorina citri* after 48 hours:

Insecticides	Chi-Square	LC_{50} µl/100ml	Log(con.) Value	Correlation coefficient	R^2	Regression equation
Bifenthrin	4.44	12.38	1.09	0.95	0.89	y = 1.50x - 4.50
Cypermethrin + Profenophos	0.00	26.44	1.42	0.98	0.96	y = 0.45x + 5.00
Lambda cyhalothrin	0.23	17.54	1.24	0.99	0.99	y = 0.09x + 17.5
Deltamethrin +Triazophos	0.01	33.20	1.52	0.99	0.98	y = 0.14x +12.0
Quinalphos	0.02	73.35	1.87	0.97	0.94	y = 0.07x +12.5
Neem oil	0.02	302.08	2.48	1.00	1.00	y = 0.05x +1.67

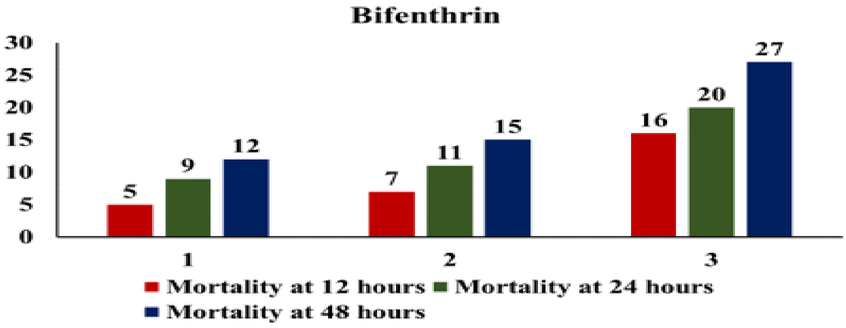

Fig 1: Efficacy of Bifenthrin

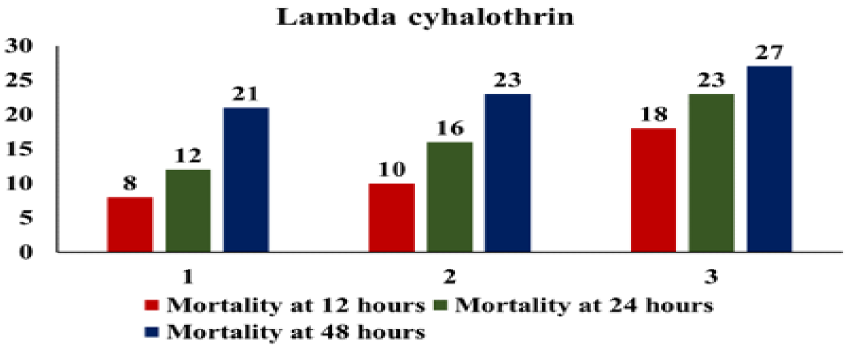

Fig 2: Efficacy of Lambda cyhalothrin

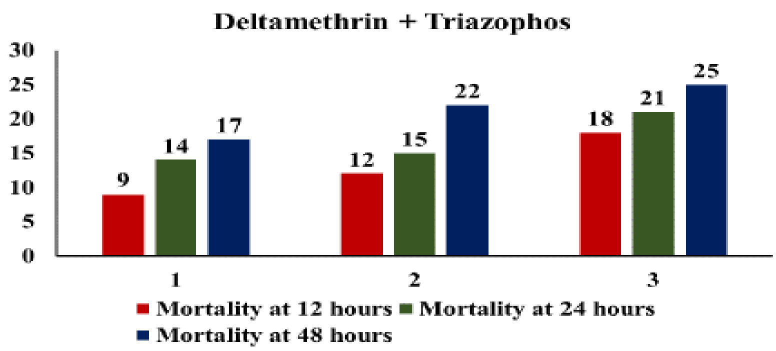

Fig 3: Efficacy of Deltamethrin+Triazophos

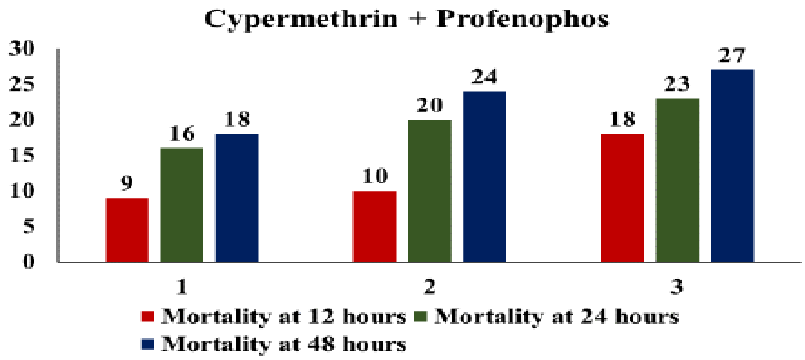

Fig 4: Efficacy of Cypermethrin+Profenophos

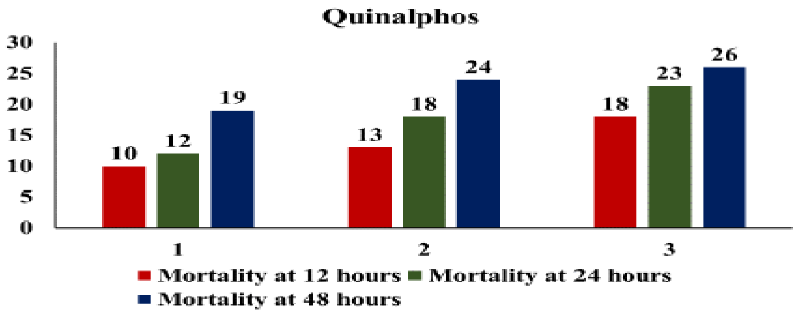

Fig 5: Efficacy of Quinalphos

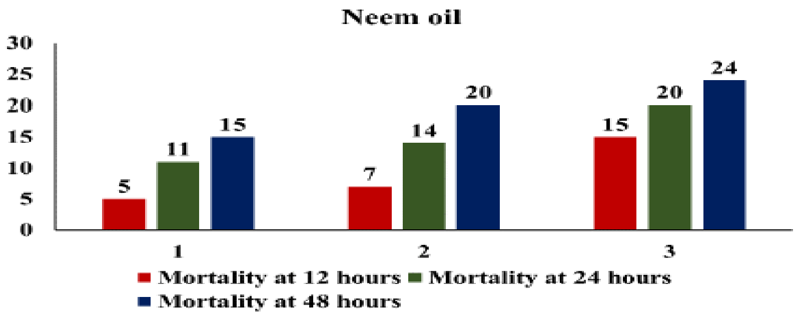

Fig 6: Efficacy of Neem oil