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Deepika Chauhan
Department of Entomology, College of Horticulture, VCSG-Uttarakhand University of Horticulture & Forestry, Bharsar, Uttarakhand, India

Poonam Srivastava
Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Correspondence
Deepika Chauhan
Department of Entomology, College of Horticulture, VCSG-Uttarakhand University of Horticulture & Forestry, Bharsar, Uttarakhand, India

Evaluation of effectiveness of various insecticides for the management of citrus *Psylla, Diaphorina citri* Kuwayama

Deepika Chauhan and Poonam Srivastava

Abstract
The study was commenced with the objective to evaluate the effectiveness of various insecticides against citrus psylla, *Diaphorina citri* during the year 2014-2015 at Pantnagar. Insecticides employed for the evaluation are Novaluron 10 EC, acephate 75 % SP, thiamethoxam 25% WG, acetamiprid 20% SP, spinosad 45 % SC, imidacloprid 17.8% SL, neem (5%). The relative efficacy of each treatment was assessed on the basis of per cent reduction over control where the per cent reduction of nymphal population was recorded to be significantly highest with 91.78 per cent in imidacloprid recording lowest number of 0.66 nymphs/twig/plant at 11 days after 2nd application. During the year 2015 imidacloprid caused highest reduction in the population of psylla nymphs with highest per cent reduction of 74.62 per cent. After 1st application thiamethoxam was found most effective in reducing the population of adults of citrus psylla with highest per cent reduction (77.59 %).

Keywords: Effectiveness of various, management of citrus *Psylla*, Kuwayama

Introduction
Citrus fruits belong to the family Rutaceae that are raised all over the world and have various restorative properties like anti-tumor, anticancer and anti-inflammatory. India ranks 6th position in the production of citrus fruit cultivation in the world. In India citrus crop occupies an important place covering a part of about 10.78 L ha with an yearly production of 111.47 L tonnes and 10.3 MT/ha productivity (Indian Horticulture Database, 2014) [10]. It occupies 3rd position after mango and banana in the farming. Citrus life (Sanofer, 2014) [14]. Citrus spp. occupies about 13.90 per cent (27400 ha) of total fruit area in Uttarakhand. Garhwal region is the main citrus growing areas of Uttarakhand with 50.20 per cent (13755 ha) of the total citrus area in state (Gunwant *et al.*, 2013) [9]. It occupies an area of about 2.69 L ha with an annual production of 17.48L tonnes (Indian Horticulture Database, 2014) [10].

The production and quality of citrus is harshly influenced by numerous causes; insect pests being one of them. Enormous variety of soils and agro ecosystems in which citrus is nurtured in Asia are wealthy resources of pest fauna. In India 250 species of insects have been accounted on a variety of citrus species (Fletcher, 1921; Pruthi and Mani, 1945; Wadhi and Batra, 1964) [8, 11, 19]. A quantity of insect pests attack citrus plants both in the nurseries as well as in the orchards imposing serious economic losses. Majority of the insect pests arise at the fresh flush stage and injure the fresh growth thereby hindering the plant growth (Atwal, 1976) [1]. Among these, which infest and cause serious thrashings to the citrus, citrus psylla, *Diaphorina citri* Kuwayama is one of the most economically very important insects causing both direct and indirect harm. In addition it is also a vector of a virus (Citrus tristeza colesterovirus), which is accountable for the greening disease of citrus (Su *et al.*, 1991) [18]. It is pretencing a severe risk to citrus farming in the state. Nymphs and adults together suck the cell juice from flower blooms, leaves and young shoots and result in leaf deformation, curling and whole defoliation or discarding of flowers and leaves. Moreover the probable vector of citrus greening, sooty mould produced on the honey dew emitted by nymphs, indirectly imposes the vitality loss through condensed photosynthetic activity of leaves or lessens the market price of the fruits.

Different management approaches are pursued to evade possible hazard of citrus psylla which consists of cultural exercises, mechanical practices, biological control and chemical control.

Even if, cultural, mechanical and biological control practices are not easily applicable, labour demanding and not greatly effective in heavy attack due to different reasons. Application of insecticides is a key part in the management of *D. citri* as their high efficiency and rapid action has become accepted among the farmers. Management of this pest is utmost imperative in vegetative propagated plant species. Many insecticides like neem oil, insect growth regulators, petroleum oils, organics, mineral oils and neonicotinoids were tried against this pest and proved promoting results in diminising the population of psylla. As much as chemical control of citrus psylla is concerned, confidor (imidacloprid), evisect (thiocyclam) and the mineral oil considerably lessened the pest population as contrasted to untreated plants (Boulahia *et al.,* 1996) [3]. Foliar insecticides fenpropathrin, thimethoxam and systemic insecticide imidacloprid endowed successful control of citrus psylla (Carl *et al.,* 2005) [4]. Foliar spray with neonicotinoids like imidacloprid and thiamethoxam successfully decreased the citrus psylla population (Rao *et al.,* 2012) [13]. In this way the present research was performed for the assessment of various insecticides against citrus psylla for its management.

Materials and Methods

This experiment was conducted in citrus nursery at Horticulture Research Centre, Patharchatta, Pantnagar during the year 2014-2015 with eight treatments and three replications in randomized block design. For conducting this experiment total 24 plants were chosen at citrus orchard of HRC, Pantnagar. Each plant represented as one replication of each treatment. The insecticides of needed concentration were prepared in water just prior to spraying and apply following appropriate stirring with utmost concern to cover up the complete foliage during morning hours. The knapsack sprayer fixed with hollow cone nozzle was utilized to spray material. The experiment was accomplished during peak activity period of citrus psylla as commencement of new flush *i.e.* March-April.

Details of treatments

T1: Novaluron (RIMON)10 EC @ 0.55ml/lit
T2: Acephate (ASATAT 75 % SP) @ 1gm/lit
T3: Thiamethoxam (Actara 25% WG) @ 2gm/lit.
T4: Acetamiprid (Wapkil 20% SP) @ 2gm/lit.
T5: Spinosad (Success 45 % SC) 0.5ml/lit
T6: Imidacloprid (Imidacel 17.8%SL) @ 0.5 ml/lit
T7: Neem (5%) @ 5ml/lit
T8: Control

Observation Procedure: The following seven insecticides were applied along with one control to study their efficiency on this pest population. Pre-treatment data was evidenced on the basis of population of psylla from three diverse arbitrarily picked sites per replication. Observations on the number of citrus psylla (adults and nymphs) per twig, one day before spray and 0,3,7,11 and 14 days after each spraying was recorded on visual basis (Chauhan, 2015).

Statistical Analysis: The field facts collected from this experiment was subjected to statistical analysis as recommended for randomized block design. The means were separated using, Duncan Multiple Range Test (DMRT) (Duncan, 1955) [6] based SPSS16 (Statistical Product and Service Solutions) computer programme.

Results and Discussion

The efficacy of Novaluron (T1), acephate (T2), thiamethoxam (T3), acetamiprid (T4), spinosad (T5), imidacloprid (T6), neem (T7) and untreated control (T8) were evaluated against citrus psylla during the year 2014-15. The average number of both nymphs and adults of psylla and per cent reduction in population of psylla are summarized in subsequent heads. All the treatments were applied twice during both the years.

Impact of various treatments on the nymphal population and per cent reduction of citrus psylla nymphs during 2014

A perusal of data presented in Table 1 indicated significant variations in nymphal population of citrus psylla during the post treatment period at 3, 7, 11 and 14 days after treatment (DAT) in each of the two applications.

Table 1: Effects of various insecticides on the nymphal population of citrus psylla during 2014

Treatments	Average number of nymphs/ twig/ plant*									
	Pre spray count	After 1st application				Pre spray count	After 2nd application			
		3 DAT	7 DAT	11 DAT	14 DAT		3 DAT	7 DAT	11 DAT	14 DAT
T1 (Novaluron)	30.66 (5.58)	24.33 (4.98)^{a}	14.66 (3.89)^{ab}	7.33 (2.79)^{ab}	8.66 (3.02)^{a}	10 (3.23)	5.66 (2.48)^{ab}	5 (2.34)^{b}	3.66 (2.03)^{b}	6.33 (2.60)^{b}
T2 (Acephate)	30 (5.52)	24.66 (5.01)^{a}	18.66 (4.37)^{c}	12.33 (3.58)^{d}	13 (3.67)^{c}	13 (3.67)	9 (3.07)^{cd}	11.33 (3.43)c	10.33 (3.27)^{d}	12 (3.52)^{d}
T3 (Thiamethoxam)	29 (5.43)	21.66 (4.70)^{a}	14.33 (3.85)^{ab}	7 (2.73)^{ab}	9.33 (3.13)^{ab}	9 (3.07)	5.66 (2.48)^{ab}	6.33 (2.60)^{b}	4.66 (2.26)^{b}	6.66 (2.66)^{bc}
T4 (Acetamiprid)	28.66 (5.39)	23.33 (4.87)^{a}	16 (4.06)^{b}	10.33 (3.29)^{c}	13.33 (3.71)^{c}	14.66 (3.89)	10 (3.23)^{d}	9.33 (3.12)^{c}	8 (2.91)^{c}	9.33 (3.13)^{cd}
T5 (Spinosad)	30 (5.51)	22 (4.74)^{a}	14 (3.80)^{ab}	8.66 (3.02)^{b}	11.66 (3.47)^{bc}	12 (3.53)	6.66 (2.67)^{bc}	6.33 (2.61)^{b}	4.66 (2.26)^{b}	6.66 (2.67)^{bc}
T6 (Imidacloprid)	28.66 (5.39)	20 (4.51)^{a}	12.33 (3.57)^{a}	5.66 (2.46)^{a}	7 (2.72)^{a}	7.66 (2.85)	3.33 (1.97)^{a}	0.66 (0.99)^{a}	0.66 (1.05)^{a}	2.33 (1.65)^{a}
T7 (Neem)	28 (5.31)	26.66 (5.20)^{ab}	20 (4.52)^{c}	15 (3.93)^{e}	20.33 (4.56)^{d}	21.6 (4.70)	14.33 (3.83)^{e}	11 (3.38)^{c}	9.66 (3.18)^{cd}	11 (3.38)^{d}
T8 (Control)	30.33 (5.54)	31.33 (5.64)^{b}	34.66 (5.93)^{d}	36.66 (6.09)^{f}	35.66 (6.01)^{e}	34.33 (5.90)	34.66 (5.92)^{f}	35 (5.95)^{d}	36 (6.04)^{e}	37.33 (6.15)^{e}
SEM±	0.173	0.145	0.092	0.084	0.123	0.069	0.110	0.146	0.138	0.150
CD at 5 %	0.527	0.440	0.280	0.256	0.373	0.210	0.335	0.443	0.420	0.456

After 3 days of I[st] application, all the treatments were found to be at par and significantly lowest number varied from 20.0-26.66 nymphs/ twig/ plant over untreated control (31.33 nymphs/ twig/ plant). Similarly after 7 days, significantly lowest nymph population was recorded in the treatment T6 with 12.33 nymphs/ twig/ plant. Second most effective treatments in reducing the population of psylla nymphs were treatments T5, T3, T1 and T4 with 14.00, 14.33 and 14.66 and 16.00 nymphs/ twig/ plant respectively whereas treatment T2 and T7 recorded 18.66 and 23.00 nymphs/twig which was significantly lower than control (34.66 nymphs/ twig/ plant).

The data recorded after 11days of 1[st] application indicated that the treatment T6 was found highly effective with the significantly lowest population of psyllids nymphs/ twig/ plant with 5.66 nymphs/ twig/ plant followed by treatment T3 and T1 with 7.00 and 7.33 nymphs/ twig/ plant. The similar trend was observed after 14 days with slightly increase in the population and the results revealed that the treatment T6 and T1 was most effective than other treatments with the significantly lowest nymph population with 7.00 and 8.66 nymphs/ twig/ plant followed by treatment T3 with 9.33 nymphs/ twig/ plant. Treatment T5, T2, T4 and T7 were recorded less effective in reducing the population of nymphs with 11.66, 13.00, 13.33 and 20.33 nymphs/ twig/ plant respectively. However untreated check recorded significantly highest number of 35.66 nymphs/ twig/ plant over other treatments.

Following second application, the observations showed the number of psyllid nymphs was decreased in all treatments but the pattern was similar as after first application.

After 3 days of 2[nd] application, treatment T6 proved significantly most effective treatment recording lowest number of 3.33 nymphs/ twig/ plant. After 7 days of second application, significantly lowest nymph population was recorded in the treatment T6 with only 0.66 nymphs/ twig/ plant. The treatments T1, T3 and T5 also showed a lower population with 5.00, 6.33 and 6.33 nymphs/ twig/ plant respectively. The treatment T1, T3, T5 and T6 were significantly superior from the treatment T2, T4 and T7 in reducing the population of nymphs.

At 11days, lowest population of psyllid nymphs 0.66 nymphs/ twig/ plant recorded in treatment T6 followed by T1, T3 and T5 were recorded with 3.66, 4.66, and 4.66 nymphs/ twig/ plant. Observations revealed that all the treatments effectively reduced the psyllid population over control till 14 days of treatment. Treatment T6, T1 and T5 were found effective in controlling the nymphal population with only 2.33, 6.33 and 6.66 nymphs/ twig/ plant respectively. However, treatment T2 and T7 were recorded least effective in reducing the population of nymphs with 12.00 and 11.00 nymphs/ twig/ plant respectively. Whereas, untreated check recorded significantly highest number 37.33 nymphs/ twig/ plant over other treatments.

The impact of various treatments on the per cent reduction of nymphal population of citrus psylla during the year 2014 was presented in table 2 and it was observed that all the treatment showed reduction in the nymph population over control. After 3 days of 1[st] application significantly highest reduction in nymph population was recorded in the treatment T6 and with 32.44 per cent followed by treatment T5 with 29.00 per cent reduction. After 7 days, it was observed that per cent reduction gradually increase in all treatments and treatment T6 recorded significantly highest per cent reduction of 62.35 in the nymph population followed by T5, T1, T3 and T4 it was observed 59.16, 58.15, 56.75 and 51.14 per cent whereas, lowest per cent reduction in nymphal population was recorded in treatments T2 and T7 with 39.78 and 37.49 respectively.

Similarly, after 11 days of 1[st] application significantly highest per cent reduction in nymph population was recorded in the treatment T6 with 82.71 per cent. After 14 days it was observed that treatment T6 still effectively controlled the nymph population with significantly highest reduction of 79.22 per cent followed by treatment T1 with 75.97 per cent reduction. Whereas, treatment T7 showed lowest 38.24 per cent reduction in the population of psylla nymphs.

Table 2: Efficacy of various treatments on the per cent reduction of nymphal population of citrus psylla during 2014

Treatments	Per cent reduction in nymphal population over control*									
	After 1st application				Overall Mean	After 2nd application				Overall Mean
	3 DAT	7 DAT	11 DAT	14 DAT		3 DAT	7 DAT	11 DAT	14 DAT	
T1 (Novaluron)	23.17 (28.77)^{c}	58.15 (49.99)^{f}	80.22 (63.59)^{g}	75.97 (60.64)^{g}	59.37	43.93 (41.51)^{f}	50.95 (45.54)^{g}	65.09 (53.78)^{g}	41.78 (40.26)^{e}	50.43
T2 (Acephate)	20.42 (26.86)^{e}	39.78 (39.10)^{c}	65.99 (54.32)^{c}	63.14 (52.61)^{d}	47.33	32.42 (34.71)^{b}	14.51 (22.39)^{b}	24.22 (29.48)^{b}	15.11 (22.87)^{b}	21.56
T3 (Thiamethoxam)	27.69 (31.74)^{f}	56.75 (48.87)^{e}	80.02 (63.44)^{f}	72.63 (58.45)^{f}	59.27	37.7 (37.87)^{e}	31.01 (33.83)^{c}	50.62 (45.35)^{d}	31.94 (34.41)^{c}	37.81
T4 (Acetamiprid)	21.19 (27.40)^{d}	51.14 (46.61)^{d}	70.18 (56.90)^{d}	60.44 (51.02)^{c}	50.73	32.43 (34.71)^{c}	37.57 (37.80)^{d}	47.96 (43.83)^{c}	41.47 (40.08)^{d}	39.85
T5 (Spinosad)	29 (32.58)^{g}	59.16 (50.27)^{g}	76.11 (60.74)^{e}	66.94 (54.90)^{e}	57.80	45.02 (42.14)^{g}	48.25 (43.99)^{e}	62.96 (52.51)^{f}	48.96 (44.40)^{f}	51.29
T6 (Imidacloprid)	32.44 (34.71)^{h}	62.35 (52.15)^{h}	82.71 (65.42)^{h}	79.22 (62.88)^{h}	64.18	56.94 (48.98)^{h}	91.54 (73.10)^{h}	91.78 (73.33)^{h}	72.02 (58.06)^{h}	78.07
T7 (Neem)	7.9 (11.25)^{b}	37.49 (37.75)^{b}	55.67 (48.25)^{b}	38.24 (38.19)^{b}	40.56	34.28 (35.83)^{d}	50.04 (45.02)^{f}	57.35 (49.22)^{e}	53.16 (46.81)^{g}	48.70
T8 (Control)	0 (0.00)a	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0.00	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0.00
SEM±	0.391	0.339	0.015	0.015	-	0.013	0.009	0.0085	0.009	-
CD at 5 %	0.829	1.02	0.048	0.0489	-	0.041	0.029	0.028	0.029	-

Following second application, it was observed that significantly highest per cent reduction in nymph population after 3 days of 2[nd] application showed that the per cent reduction in nymphal population was significantly higher in the treatment T6 with 56.94 followed by treatment T5 and T1 with 45.02 and 43.93 per cent respectively. After 7 days, significantly highest per cent reduction in nymph population was observed in treatment T6 (91.54) however T1 recorded

50.95 per cent reduction followed by treatment T7 and T5 with 50.04 and 48.25 per cent. Similarly at 11 days significantly highest reduction in nymph population with 91.78 per cent was obtained in the treatment T6. However, significantly lower 57.35, 50.62 and 47.96 per cent reduction was recorded in treatment T7, T3 and T4 respectively which was significantly higher from the treatment T2.

A highest per cent reduction in nymph population (72.02 %) was recorded in the treatment T6 after 14 days whereas treatment T7 also showed significant higher per cent reduction of 53.16 per cent followed by treatment T5, T1 and T4 with 48.96, 41.78 and 41.47 per cent reduction.

Impact of various treatments on the nymphal population and per cent reduction of citrus psylla nymphs during 2014

The Impact of various treatments on the population of psylla nymphs during 2015 was presented in table 3. The results revealed that all the treatments were significantly effective in lowering the population of citrus psylla nymphs as compared to control.

After 3 days of Ist application, among all the treatments, treatment T6 was recorded as highly effective with lowest number of 26.33 nymphs/ twig/ plant followed by treatment T5, However, untreated control (T8) with highest number of 42.66 nymphs/ twig/ plant. Similarly, after 7 days of 1st application significantly lowest nymphal population was recorded in the treatment T6 with 18.33 nymphs/ twig/ plant followed by treatment T5 with 19.33 nymphs/ twig/ plant. The highest number of psyllid nymphs was observed in untreated control with 44.66 nymphs/ twig/ plant.

At 11days after 1st application, the lowest population of psylla nymphs was observed in treatments T6 with 8.33 nymphs/ twig/ plant respectively which was significantly lower from the treatment T1, T3 and T5 ranging from 12.33-14.33 nymphs/ twig/ plant.

The effect of various treatments after 14 days of 1stapplication showed that T6 effectively lower down the nymph population with lowest number of 10.00 nymphs/ twig/ plant which was followed by the treatment T5, T3 and T1 with 13.33, 13.33 and 13.66 nymphs/ twig/ plant which were significantly at par while treatment T2, T4 and T7 recorded comparatively less effective in reducing the nymph population with 18.66, 20.33 and 20.66 nymphs/ twig/ plant. However, untreated check recorded significantly highest number 45.00 nymphs/ twig/ plant as compared to other treatments.

The nymphal population of citrus psylla reduced after first application in all treatments except in control and thereafter a low population was recorded after the second application. Data present in the table 3 revealed that treatment T6 treated plants had minimum number psyllid nymphs followed by T3 with 5.00 nymphs/ twig/ plant after 3 days of 2nd application. However highest population was obtained from T8 untreated control with 45.33 nymphs/ twig/ plant which was significantly higher from other treatments. The average number of citrus psylla nymphs was significantly lower in treatments T6 and T3 compared with other treatments. After 7 days, significantly lowest nymph population was recorded in the treatment T6 with 3.33 followed by T1, T3 and T5 with 5.66, 6.33 and 6.33 nymphs/ twig/ plant respectively with no significant difference. At 11 and 14 days, the treatment T6 effectively lower down the population of psylla nymphs with 2.66 and 4.33 nymphs/ twig/ plant respectively. The treatment T1 also showed a good control with 4.66 and 6.00 nymphs/ twig/ plant at 11 and 14 days after treatment. Whereas the average number of psylla nymphs observed after 11 and 14 days in treatment T3 were 4.66 and 7.00 nymphs/ twig/ plant, 5.33 and 7.66 nymphs/ twig/ plant in treatment T5. However, untreated control (T8) exhibited highest number of 46.33 and 47.66 nymphs/ twig/ plant after 11 and 14 days of application respectively.

Table 3: Effects of various insecticides on the nymphal population of citrus psylla during 2015

Treatments	Average number of nymphs/ twig/ plant*									
	Pre spray count	After 1st application				Pre spray count	After 2nd application			
		3 DAT	7 DAT	11 DAT	14 DAT		3 DAT	7 DAT	11 DAT	14 DAT
T1 (Novaluron)	41 (6.51)	28.66 (5.34)^{a}	20.66 (4.59)^{ab}	12.33 (3.57)^{b}	13.66 (3.75)^{a}	13.33 (3.71)	9.66 (3.18)^{c}	5.66 (2.48)^{b}	4.66 (2.27)^{a}	6 (2.54)^{ab}
T2 (Acephate)	40.66 (6.41)	30 (5.51)^{a}	23.66 (4.90)^{ab}	19 (4.40)^{c}	18.66 (4.37)b	18.66 (4.37)	14 (3.80)^{d}	11.33 (3.43)^{c}	11 (3.37)^{c}	12 (3.53)^{c}
T3 (Thiamethoxam)	41.33 (6.46)	29 (5.43)^{a}	23 (4.83)^{ab}	14 (3.80)^{b}	13.33 (3.71)^{a}	13.33 (3.71)	7.66 (2.85)^{ab}	6.33 (2.60)^{b}	4.66 (2.27)^{a}	7 (2.72)^{b}
T4 (Acetamiprid)	41.33 (6.45)	36 (6.02)^{b}	24.33 (4.96)^{ab}	18.66 (4.36)^{c}	20.33 (4.53)^{b}	21 (4.61)	14.33 (3.82)^{d}	9.33 (3.12)^{c}	8.33 (2.95)^{b}	10.33 (3.28)^{c}
T5 (Spinosad)	41.33 (6.46)	27.66 (5.30)^{a}	19.33 (4.44)^{ab}	14.33 (3.84)^{b}	13.33 (3.71)^{a}	13.66 (3.76)	9.33 (3.13)^{c}	6.33 (2.61)^{b}	5.33 (2.41)^{a}	7.66 (2.84)^{b}
T6 (Imidacloprid)	40.33 (6.38)	26.33 (5.34)^{a}	18.33 (4.33)^{a}	8.33 (2.96)^{a}	10 (3.23)^{a}	10.33 (3.29)	5 (2.33)^{a}	3.33 (1.95)^{a}	2.66 (1.77)^{a}	4.33 (2.19)^{a}
T7 (Neem)	42.66 (6.56)	36.33 (6.06)^{b}	25.66 (5.10)^{b}	22.33 (4.76)^{c}	20.66 (4.59)^{b}	22 (4.74)	17.66 (4.25)^{d}	16.33 (4.10)^{d}	15 (3.93)^{d}	17 (4.17)^{d}
T8 (Control)	43 (6.59)	42.66 (6.56)^{c}	44.66 (6.71)^{c}	46.33 (6.84)^{d}	45 (6.74)^{c}	45.66 (6.79)	45.33 (6.76)^{e}	46.66 (6.86)^{e}	46.33 (6.84)^{e}	47.66 (6.98)^{e}
SEM ±	0.143	0.176	0.205	0.155	0.160	0.117	0.139	0.106	0.135	0.130
CD at 5 %	0.434	0.544	0.622	0.471	0.486	0.355	0.423	0.323	0.410	0.394

Result present in the table 4 revealed that after 3 days of 1st application, the per cent reduction of psylla nymph population was highest in the treatment T6 with 34.19 per cent followed by T5 with 32.54 per cent. However, treatment T1, T3 and T2 were recorded with significantly lower reduction in nymph population with 29.60, 29.27 and 25.62 per cent respectively as compared to T7 and T8 with 14.14 and 12.2 per cent. The treatment T6 caused significantly higher reduction over all the treatment.

After 7 days of 1st application, the observation recorded showed that the highest reduction in nymph population of 56.23 per cent was observed in the treatment T6. The per cent

reduction in nymph population was significantly higher (P<0.05) in treatment T6 and T1 than T3, T2, T4 and T7. The data obtained after 11 days showed that the highest reduction in nymphal population was found 80.02 per cent in the treatment T6. Treatment T3 and T5 also caused significant reduction in the population of psylla nymphs with 68.56 and 58.09 per cent respectively. Whereas, treatment T1, T4 and T2 were recorded with 67.59, 58.09 and 56.62 per cent reduction respectively and were statistically different with each other. Similarly, after 14 days of 1st application treatments T6 and T5 were still observed significantly most effective in reducing the nymph population with 76.30 per cent over other treatments. Treatment T3 was found to be the second most effective treatment with 69.18 per cent reduction in population of nymphs of citrus psylla.

Table 4: Efficacy of various treatments on the per cent reduction of nymphal population of citrus psylla during 2015

Treatments	Per cent reduction in nymphal population over control*									
	After 1st application				Mean	After 2nd application				Mean
	3 DAT	7 DAT	11 DAT	14 DAT		3 DAT	7 DAT	11 DAT	14 DAT	
T1 (Novaluron)	29.6 (32.96)^{f}	51.4 (45.80)^{f}	67.59 (55.29)^{e}	68.16 (55.64)^{e}	54.16	27 (31.30)^{g}	58.44 (49.85)^{g}	65.54 (54.05)^{f}	56.87 (48.94)^{g}	51.96
T2 (Acephate)	25.62 (30.40)^{d}	43.97 (41.50)^{d}	56.62 (48.80)^{e}	56.14 (48.52)^{d}	45.58	24.42 (29.61)^{c}	40.58 (39.57)^{c}	41.9 (40.16)^{c}	38.38 (38.28)^{c}	36.32
T3 (Thiamethoxam)	29.27 (32.75)^{e}	46.41 (42.94)^{e}	68.56 (55.89)^{g}	69.18 (56.27)^{f}	53.35	42.11 (40.46)^{d}	53.53 (47.02)^{d}	65.54 (54.05)^{g}	49.69 (44.82)^{e}	52.71
T4 (Acetamiprid)	12.2 (20.44)^{b}	43.32 (41.16)^{c}	58.09 (49.65)^{d}	52.99 (46.71)^{b}	41.65	31.26 (33.99)^{f}	56.52 (48.74)^{d}	60.9 (51.11)^{d}	52.87 (46.64)^{f}	50.38
T5 (Spinosad)	32.54 (34.78)^{g}	54.96 (47.84)^{g}	67.81 (55.43)^{f}	76.3 (60.86)^{g}	77.95	31.2 (33.95)^{e}	54.65 (47.66)^{e}	61.54 (51.67)^{e}	46.27 (42.86)^{d}	48.41
T6 (Imidacloprid)	34.19 (35.78)^{h}	56.23 (48.57)^{h}	80.02 (63.44)^{h}	76.3 (60.42)^{g}	61.68	51.24 (45.71)^{h}	68.45 (55.82)^{h}	74.62 (59.74)^{h}	59.84 (50.68)^{h}	63.53
T7 (Neem)	14.15 (22.09)^{c}	42.08 (40.44)^{b}	51.41 (45.80)^{b}	53.72 (47.13)^{c}	40.34	19.14 (25.94)^{b}	27.36 (31.53)^{b}	32.8 (34.93)^{b}	25.96 (30.63)^{b}	26.31
T8 (Control)	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0.00	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)a	0.00
SEM±	0.022	0.009	0.024	0.156	-	0.141	0.014	0.066	0.053	-
CD at 5 %	0.068	0.029	0.040	0.482	-	0.435	0.310	0.204	0.321	-

Following 2nd application after 3 days of 2nd application highest reduction in nymph population was recorded in the treatment T6 and T3 with 51.24 and 42.11 per cent. At 7 days of 2nd application it was observed that significant highest per cent reduction in nymph population was observed in T6 with 68.45 as compared with T1 with 58.44 whereas treatments T4, T5 and T3 were recorded with 56.52, 54.65 and 53.53 per cent reduction in psyllid nymph. However, lower reduction of 27.36 per cent was observed in the treatment T7 respectively.

After 11 days the observation showed that the treatment T6 with 74.62 per cent followed by T1 and T3 with 65.54 per cent caused highest reduction in population of psyllid nymphs. The observation recorded after 14 days of 2nd application showed that the treatment T6 recording 59.84 per cent reduction which was followed by treatment T1 with 56.87 per cen. The data on the efficacy of different insecticides against nymphs of citrus psylla proved that imidacloprid 17.8% SL (T6) was consistently most effective by recording significantly highest reduction in population of nymphs of citrus psylla at 3 days, 7 days, 11 days and 14 days after 1st and 2nd application. Next in order of effectiveness was novaluron (T1), thiamethoxam (T3), Spinosad (T5) and acetamiprid (T4) followed by acephate (T2) and at last neem (T7). During the way of investigation, imidacloprid outrivaled well over all others insecticides investigated in reducing infestation of citrus psylla the motive being its broad range systemic action along with an exclusive exceptional translaminar action.

Impact of various treatments on the population and per cent reduction of citrus psylla adults during 2014

The impact of various treatments on the population of citrus psylla adults were evaluated and average number of adults/ twig/ plant is presented in table 5.

After 3 days of 1st application it was observed that the lowest number of psylla adults was recorded in treatment T6 with 11.66 adults/ twig/ plant followed by treatments T5, T4, T3, T1, T2 and T7 with 12.33, 12.66, 12.66, 13.66, 14.66 and 15.33 adults/ twig/ plant respectively over treatment T8 (untreated check). Similarly after 7 days of 1st application, highest efficacy with significantly lowest population of adults of citrus psylla was observed in the treatment T6 with 7.66 adults/ twig/ plant followed by treatment T3 and T5 with 8.66 and 9.00 adults/ twig/ plant which were statistically on par with each other. The observation at 11 days showed that treatment T3 treated plants recorded significantly lowest population of adults with 5.33 adults/ twig/ plant than other treatments. Treatment T4, T6 and T5 were also found effective in reducing the population of psylla adults with 6.00, 6.33 and 7.00 adults/ twig/ plant and being statistically on par with each other. Treatment T3, T4, T6 T5 and T2 were found effective in controlling the nymphal population with only 6.33, 8.00, 8.00, 8.366 and 10.33 nymphs/ twig/ plant respectively after 14 days of 1st application however, treatment T7 was recorded least effective in reducing the population of nymphs with and 17.33 nymphs/ twig/ plant respectively.

Following 2nd spray it was observed that population of psylla adults gradually decreased in all the treatments as compared to control. The data indicated that during 2nd application treatments T3, T5, T4, T6 and T1 reduced the population of adults of citrus psylla, However, in treatment T2 and T7, the population was least effected and varied from 8.33-13.33 adults/ twig/ plant as compared to control where no reduction in the population was observed.

Table 5: Effects of some insecticides on the adult population of citrus psylla during 2014

Treatments	Average number of adults/ twig/ plant*									
	Pre spray count	After 1st application				Pre spray count	After 2nd application			
		3 DAT	7 DAT	11 DAT	14 DAT		3 DAT	7 DAT	11 DAT	14 DAT
T1 (Novaluron)	19.33 (4.45)	13.66 (3.76)^{ab}	10 (3.23)^{bc}	7.66 (2.85)^{bc}	9 (3.07)^{ab}	11.33 (3.43)	8.33 (2.97)^{bc}	5.33 (2.41)^{ab}	3 (1.87)^{c}	5 (2.32)^{b}
T2 (Acephate)	19.66 (4.48)	14.66 (3.89)^{b}	11.33 (3.43)^{c}	9 (3..07)^{c}	10.33 (3.28)^{bc}	11.33 (3.43)	9 (3.07)^{c}	7 (2.73)^{b}	5.33 (2.41)^{d}	8.33 (2.96)^{c}
T3 (Thiamethoxam)	21 (4.63)	12.66 (3.62)^{ab}	8.66 (3.02)^{ab}	5.33 (2.41)^{a}	6.33 (2.60)^{a}	9 (3.07)	5 (2.32)^{a}	3 (1.85)^{a}	0.66 (1.05)^{a}	2.33 (1.67)^{a}
T4 (Acetamiprid)	19.33 (4.45)	12.66 (3.62)^{ab}	9.66 (3.13)^{bc}	6 (2.54)^{ab}	8 (2.90)^{ab}	11.33 (3.43)	7.66 (2.84)^{abc}	4.66 (2.27)^{ab}	2.66 (1.77)^{bc}	3 (1.82)^{ab}
T5 (Spinosad)	19 (4.41)	12.33 (3.57)^{a}	9.00 (3.07)^{b}	7 (2.72)^{ab}	8.66 (3.01)^{ab}	10.66 (3.32)	6.33 (2.56)^{abc}	3.33 (1.79)^{a}	1.33 (1.34)^{ab}	2.33 (1.64)^{b}
T6 (Imidacloprid)	19.66 (4.48)	11.66 (3.48)^{a}	7.66 (2.84)^{ab}	6.33 (2.61)^{ab}	8 (2.91)^{ab}	10 (3.23)	5.66 (2.40)^{ab}	3 (1.85)^{a}	1.33 (1.34)^{ab}	3 (1.85)^{ab}
T7 (Neem)	20.66 (4.59)	15.33 (3.97)^{b}	14.33 (3.85)^{c}	9.33 (3.12)^{c}	17.33 (4.22)^{d}	15.33 (3.97)	13 (3.66)^{d}	10.66 (3.32)^{c}	10.33 (3.28)^{e}	13.33 (3.71)^{d}
T8 (Control)	20 (4.52)	20 (4.52)^{c}	21.33 (4.67)^{d}	22.66 (4.81)^{d}	25 (5.04)^{e}	27.33 (5.27)	27.66 (5.30)^{e}	28 (5.33)^{d}	27.66 (5.30)^{f}	29.33 (5.40)^{e}
SEM±	0.103	0.101	0.063	0.098	0.147	0.125	0.173	0.212	0.146	0.160
CD at 5 %	0.312	0.309	0.192	0.299	0.447	0.380	0.525	0.644	0.445	0.487

The impact of various treatments on the per cent reduction of adult population of citrus psylla over control during the year 2014 was presented in Table 6. After 3 days of 1st application it was observed from the data that highest reduction in adult psylla population was recorded in the treatment T3 with 39.71 per cent followed by treatment T6 with 38.63 per cent however being statistically different with each other. After 7 days, it was observed that treatment T6 and T3 recorded highest per cent reduction of 62.19 and 61.33 in the adult population. However, treatment T5, T4 and T1 had 57.07, 53.14 and 51.49 per cent reduction in adult population, whereas, lowest reduction in the population of adults was recorded in treatment T7 with 25.70 per cent. However, after 11 days of 1st application significantly highest per cent reduction in adult population was recorded in the treatment T3 with 77.59 per cent than T4 and T6 with 72.6 and 71.58 per cent. After 14 days it was observed that per cent reduction was decreased in all treatments T3 (75.88), T6 (67.44), T4 (66.89), T5 (63.53) and T1 (62.75). The treatment T7 showed lowest reduction in population of psylla adults with 32.89 per cent.

Table 6: Efficacy of various treatments on the per cent reduction of adult population of citrus psylla during 2014

Treatments	Per cent reduction in adult population over control*									
	After 1st application				Overall Mean	After 2nd application				Overall Mean
	3 DAT	7 DAT	11 DAT	14 DAT		3 DAT	7 DAT	11 DAT	14 DAT	
T1 (Novaluron)	29.33 (32.7)^{c}	51.49 (45.85)^{c}	65.02 (53.74)^{d}	62.75 (52.38)^{c}	**52.14**	27.35 (31.53)^{d}	54.08 (47.34)^{d}	73.83 (59.23)^{d}	58.87 (50.10)^{d}	**53.53**
T2 (Acephate)	25.43 (30.28)^{b}	45.96 (42.68)^{b}	59.59 (50.52)^{b}	57.96 (49.58)^{c}	47.23	21.51 (27.63)^{c}	39.69 (39.05)^{c}	53.51 (47.01)^{c}	31.49 (34.13)^{c}	36.55
T3(Thiamethoxam)	39.71 (39.06)^{h}	61.33 (51.54)^{g}	77.59 (61.74)^{h}	75.88 (60.58)^{c}	63.62	45.1 (42.18)^{h}	67.46 (55.21)^{f}	93.41 (75.12)^{h}	75.87 (60.57)^{g}	70.46
T4 (Acetamiprid)	34.5 (35.97)^{e}	53.14 (46.81)^{d}	72.6 (58.43)^{g}	66.89 (54.87)^{c}	56.78	33.19 (35.17)^{e}	59.85 (50.68)^{e}	76.8 (61.20)^{f}	75.32 (60.21)^{f}	61.29
T5 (Spinosad)	37.28 (37.63)^{g}	57.07 (49.06)^{h}	67.48 (55.23)^{e}	63.53 (52.84)^{c}	57.95	41.32 (40.00)^{f}	69.5 (56.47)^{g}	87.67 (69.44)^{g}	79.63 (63.17)^{h}	69.53
T6 (Imidacloprid)	38.63 (38.42)^{f}	62.19 (52.05)^{f}	71.58 (57.78)^{f}	67.44 (55.21)^{c}	58.34	44.07 (41.59)^{g}	70.71 (57.23)^{h}	86.85 (68.73)^{e}	72.04 (58.07)^{e}	68.41
T7 (Neem)	30.63 (33.60)^{d}	25.70 (30.53)^{e}	34.96 (35.60)^{c}	32.89 (33.76)^{b}	49.47	16.21 (23.74)^{b}	32.12 (34.52)^{b}	33.41 (35.31)^{b}	18.97 (25.81)^{b}	25.17
T8 (Control)	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0.00	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0.00
SEM±	0.017	0.013	0.019	0.003	-	0.002	0.003	0.03	0.040	-
CD at 5 %	0.047	0.040	0,061	0.009	-	0.008	0.05	0.10	0.103	-

Following second application, the observation recorded after 3 days of 2nd application showed that the per cent reduction in adult population was highest in the treatment T3 and T6 with 45.1 and 44.07 per cent followed by treatment T5 with 41.32 per cent whereas in treatment T4 and T1 significant reduction was 33.19 and 27.35 per cent. The treatment T7 showed a lowest reduction in adults population with 16.21 per cent. After 7 days, treatment T6 recorded highest 70.71 per cent reduction in the population of adult psylla. The data recorded after 11 and 14 days indicate that treatment T3 caused highest reduction with 93.41 and 75.87 per cent reductions in adult population. Similarly treatment T5 and T6 also showed good control with 87.67, 79.63 and 86.85, 72.04 per cent reduction followed by treatment T4 and T1 with 76.8, 75.32 and 73.83, 58.87 per cent after 11 and 14 days respectively. However, significantly lower 53.51, 31.49 per cent and 33.41, 18.97 per cent reduction was recorded in treatment T2 and T7

respectively. All the treatments showed the significant difference in the per cent reduction in pest population.

Impact of various treatments on the population and per cent reduction of citrus psylla adults during 2015

The data presented in table 7 revealed that all the treatments were effective in reducing the population of psylla adults after both application.

After 3 days of I[st] application, treatment T6 proved most effective with lowest number of 10.00 adults/ twig/ plant followed by treatment T1, T3 and T5 with 16.66, 17 and 17.33 adults/ twig/ plant. Similarly, after 7 days, significantly lowest adult psylla population was recorded in the treatment T6 with 5.66 adults/ twig/ plant than the population of psylla adults observed in the treatment T1, T3 and T5 was 9.33, 10.0 and 11.0 adults/ twig/ plant respectively and being statistically on par with each other. Whereas, in treatment T2 and T7 the population of psylla observed was 18.0 and 15.33 adults/ twig/ plant respectively which was significantly lower than untreated control having 22.0 adults/ twig/ plant. The treatment T6 was significantly superior (P<0.05) from the treatment T2 and T7 in reducing the population of nymphs.

At 11days after 1[st] application, the treatment T6 significantly completely controlled the psyllid adult followed by treatment T1, T3, T5 and T4 recorded 5.66, 5.66, 7.0 and 9.33 adults/ twig/ plant respectively. However, untreated control (T8) exhibited significantly highest number of 22.33 adults/ twig/ plant than other treatments. The average adult population was significantly lower in treatment T6, T1 and T3 as compared to T4, T2 and T7.

Table 7: Effects of varios insecticides on the adult population of citrus psylla during 2015

Treatments	Average number of adults/ twig/ plant*									
	Pre spray count	After 1st application				Pre spray count	After 2nd application			
		3 DAT	7 DAT	11 DAT	14 DAT		3 DAT	7 DAT	11 DAT	14 DAT
T1 (Novaluron)	23 (4.94)	16.66 (4.14)^{b}	9.33 (3.13)^{c}	5.66 (2.48)^{c}	9 (3.08)^{bc}	11 (3.38)	7.33 (2.79)^{ab}	4 (2.08)^{a}	2.66 (1.64)^{ab}	3.66 (2.01)^{a}
T2 (Acephate)	23.66 (4.90)	19.33 (4.52)^{c}	18 (4.30)^{d}	12 (3.53)e	13 (3.67)^{d}	16 (4.06)	12 (3.53)^{c}	8 (2.91)^{a}	7 (2.73)^{c}	8.66 (3.02)^{bc}
T3(Thiamethoxam)	23 (4.84)	17 (4.18)^{b}	10 (3.23)^{a}	5.66 (2.48)^{b}	6.66 (2.67)^{a}	10 (3.23)	5.33 (2.38)^{a}	2.33 (1.56)^{a}	1.33 (1.34)^{a}	1.33 (1.28)^{a}
T4 (Acetamiprid)	23.66 (4.91)	19 (4.41)^{c}	12.66 (3.62)^{b}	9.33 (3.13)^{cd}	10 (3.23)^{c}	13 (3.67)	9.33 (3.13)^{b}	4.66 (2.27)^{b}	4.33 (2.19)^{b}	7 (2.73)^{b}
T5 (Spinosad)	22 (4.74)	17.33 (4.22)^{b}	11 (3.38)^{ab}	7 (2.73)^{bc}	5.33 (2.79)^{ab}	10.33 (3.28)	5.66 (2.46)^{a}	2.66 (1.64)^{a}	1.33 (1.26)^{a}	2.66 (1.73)^{a}
T6 (Imidacloprid)	21 (4.63)	10 (3.23)^{a}	5.66 (2.48)^{a}	0.00 (0.00)^{a}	2.33 (1.68)^{a}	9.66 (3.18)	5 (2.37)^{a}	1.66 (1.44)^{a}	1.33 (1.28)^{a}	2.33 (1.67)^{a}
T7 (Neem)	20.33 (4.56)	19.66 (4.49)^{c}	15.33 (3.97)^{c}	10.66 (3.33)^{de}	13.33 (3.71)^{d}	17.33 (4.22)	12.66 (3.62)^{c}	9.33 (3.12)^{b}	8.33 (2.97)^{c}	10.33 (3.28)^{c}
T8 (Control)	20.66 (4.59)	21.66 (4.70)^{d}	22 (4.74)^{e}	22.33 (4.77)^{f}	24 (4.94)^{e}	25 (5.04)	25.33 (5.08)^{d}	26 (5.14)^{c}	26.66 (5.21)^{d}	27 (5.24)^{d}
SEM±	0.104	0.067	0.103	0.075	0.093	0.086	0.102	0.273	0.251	0.174
CD AT 5 %	0.317	0.203	0.313	0.230	0.282	0.261	0.492	0.830	0.762	0.533

The effect of various treatments showed that the efficacy of treatment T6 persisted and continuously reduced the population of adults of citrus psylla even after 14 days of 1[st]application with minimum number of 2.33 adults/ twig/ plant. The average number of adults/ twig/ plant were significantly lower (P>0.05) in the treatment T6, T5 and T3 as compared to T2 and T7.

Following second application among all the treatments, after 3 days, treatment T6 proved significantly most effective treatment recording lowest number of 5.00 adults/ twig/ plant followed by treatment T3, T5 and T1 with 5.33, 5.66 and 7.33 psylla adults/ twig/ plant. After 7, 11 and 14 days of second application it was observed that all the treatments gradually decreased the population of citrus psylla. Treatments T6, T3 and T5 recorded less than 3.00 psylla adults/ twig/ plant and treatment T2 and T4 recorded less than 5.00 and 7.00 adults/ twig/ plant. Whereas, the number of adult psylla observed in treatment T2 and T7 was recorded less than 9.00 and 11.00 adults/ twig/ plant respectively. The treatment T6, T3, T5 and T1 were significantly superior (P<0.05) from the treatment T2 and T7 in reducing the population of adults. Although, there was no reduction in the population and it gradually increased in untreated check with higher number of psylla varying from 26.0 - 27.0 psylla adults/ twig/ plant.

Result present in the table 8 revealed that after 3 days of 1[st] application, the per cent reduction in population of psylla adults was highest in the treatment T6 with 54.57 per cent. However, treatment T1, T3, T5, T4, T2 and T7 were recorded with non-significantly lower reduction in adult population with 32.83, 29.49, 24.86, 23.4, 19.83 and 19.62 per cent respectively. After 7 days of 1[st] application, the observation recorded showed that the highest reduction in adult population of 75.06 per cent was observed in the treatment T6. The treatment T1, T3, T5, T4, T2 and T7 were recorded with 61.90, 59.16, 53.04, 49.75, 32.29 and 38.29 per cent reduction in psyllid adult population respectively. The per cent reduction in adult population was higher (P<0.05) in treatment T6 and T1 than T2, T4, T5 and T7.

After 11 days of 1[st] application the observation showed that the treatment T6 with 100.00 per cent, treatment T1 and T3 both with 77.23 and treatment T5 with 70.56 per cent caused highest reduction in population of psyllid adults. The observation recorded after 14 days of 1[st] application showed that treatment T6 recorded significantly highest reduction in the population of psylla adults with 90.44 per cent than the treatment T5 with 79.14 per cent reduction. The treatment T3 and T1 treated plants recorded 75.07 and 66.31 per cent reduction in nymph population whereas the treatment T7 was recorded with significantly lower reduction of 50.81 per cent.

Following 2[nd] application after 3 days, treatment T6 and T3 were proved to be the most effective and reduced the population of psylla adults. But at 7 days of 2[nd] application the treatment T3 was found most effective with 77.59 per cent reduction followed by treatment T5, T6, T4, T1 and T2 also

caused reduction in the adult population with 75.24, 68.07, 65.33, 65.03 and 51.92 per cent respectively. However, lower reduction of 48.23 was observed in the treatment T7. The data indicated that after 11 and 14 days, treatment T3 caused higher 87.52 and 87.68 reduction in adult population of psylla. Similarly treatment T5 and T6 also showed good control with 87.92, 76.15 and 87.08, 77.66 per cent followed by treatment T1 and T4 with 77.32, 69.19 and 68.76, 50.14 per cent after 11 and 14 days respectively. However, significantly lower 58.97, 49.88 per cent and 54.92, 44.80 per cent reduction was recorded in treatment T2 and T7 respectively.

Table 8: Efficacy of various treatments on the per cent reduction of adult population of citrus psylla during 2015

Treatments	Per cent reduction in adult population over control*									
	After 1st application				Overall Mean	After 2nd application				Overall Mean
	3 DAT	7 DAT	11 DAT	14 DAT		3 DAT	7 DAT	11 DAT	14 DAT	
T1 (Novaluron)	32.83 (34.95)^{b}	61.90 (57.17)^{c}	77.23 (63.82)^{e}	66.31 (54.51)^{e}	59.56	34.23 (35.80)^{d}	65.03 (53.74)^{d}	77.32 (61.56)^{e}	69.19 (56.28)^{e}	61.44
T2 (Acephate)	19.83 (22.44)^{c}	48.46 (45.29)^{b}	53.07 (46.76)^{b}	52.7 (46.54)^{c}	43.51	25.97 (30.63)^{c}	51.92 (46.10)^{c}	58.97 (50.16)^{c}	49.88 (44.93)^{c}	46.68
T3(Thiamethoxam)	29.49 (32.89)^{h}	59.16 (50.27)^{h}	77.23 (61.49)^{g}	75.07 (60.04)^{f}	60.23	47.39 (43.50)^{h}	77.59 (61.74)^{h}	87.52 (69.31)^{g}	87.68 (69.45)^{h}	75.04
T4 (Acetamiprid)	23.4 (28.92)^{e}	49.75 (44.85)^{e}	63.51 (52.83)^{d}	63.61 (52.89)^{d}	50.06	29.16 (32.68)^{e}	65.53 (54.04)^{e}	68.76 (56.01)^{d}	50.14 (45.08)^{d}	53.39
T5 (Spinosad)	24.86 (29.90)^{f}	53.04 (46.74)^{f}	70.56 (57.14)^{f}	79.14 (62.82)^{g}	56.9	45.92 (42.65)^{g}	75.24 (60.15)^{g}	87.92 (69.66)^{h}	76.15 (60.76)^{f}	71.30
T6 (Imidacloprid)	54.57 (48.03)^{g}	75.06 (70.03)^{g}	100.0 (100.0)^{h}	90.44 (88.26)^{h}	80.01	48.91 (44.37)^{f}	68.07 (55.59)^{f}	87.08 (68.93)^{f}	77.66 (61.79)^{g}	70.43
T7 (Neem)	19.62 (16.32)^{d}	38.29 (38.22)^{d}	57.72 (49.44)^{c}	50.81 (45.46)^{b}	37.52	27.89 (31.87)^{b}	48.23 (44.00)^{b}	54.92 (47.82)^{b}	44.8 (41.84)b	43.96
T8 (Control)	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0.00	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0 (0.00)^{a}	0.00
SEM±	0.014	0.009	0.015	0.026	-	0.013	0.023	0.033	0.094	-
CD at 5 %	0.045	0.030	0.048	0.081	-	0.05	0.07	0.101	0.136	-

DAT- Days after treatments, ***** Mean of three replications, Values in parentheses are $\sqrt{x+0.5}$ transformed values
In a column means followed by a common letter(s) are not significantly different by DMRT (P=0.05)

The data on the bioefficacy of different insecticides against psylla adults proved that imidacloprid 17.8% SL (T6) and thiamethoxam (T3) was consistently most effective by recording significantly highest reduction in population of adults of citrus psylla at 3 days, 7 days, 11 days and 14 days after 1st and 2nd application followed by acetamiprid 20 % SP (T4), spinosad (T5), novaluron (T1), acephate (T2) and neem (T7).

During the course of investigation, imidacloprid and thiamethoxam proved best over all other systemic insecticides tested in reducing infestation of citrus psylla with its broad spectrum translaminar activity.

The above results are in agreement with the findings of Farmanullah *et al.* (2004) who studied the efficacy of six different insecticides for the control of citrus psylla and observed that the overall mean population was lowest 3.63 and 2.65 adults per six inches tender shoots in thiamethoxam 25WG treated plants after 1st and 2nd application respectively. Per cent decrease of psylla population in comparison to control after the first and second spray was also highest (72.20 and 83.54) in thiamethoxam 25WG as compared to other insecticides. Powell *et al.* (2007) [12] also reported that the biannual or more frequent applications of Admire (imidacloprid) significantly reduced psyllid numbers, percentage of trees infestations, and the percentage of flushes infested.

The present finding is in line with the findings of Boina *et al.* (2009) [2] who reported that feeding by psylla adults on plants treated daily with a sublethal concentration (0.1microgm/L) of imidacloprid significantly decreased adult longevity (8 days), fecundity (33%) and fertility (6%) and developmental rate compared with untreated controls. Furthermore, psylla adults that fed on citrus leaves treated systemically with lethal and sublethal concentrations of imidacloprid excreted significantly less honeydew compared with controls in a concentration-dependent manner suggesting antifeedant activity of Imidacloprid.

In accordance with the present finding Setamou *et al.* (2010) [16] accounted that the neonicotinoid insecticide imidacloprid, when applied to grapefruit, *Citrus paradisi* trees to establish its effects in the control of citrus psyllid, major positive correlations were achieved between imidacloprid titers in leaf tissue and the percentage of control levels achieved. The present findings are supported with the observations of Shivankar and Rao (2010) [17] who reported that citrus psylla can be chemically controlled by using imidachloprid @ 0.3 ml at bud burst stage followed by second spray after 10-15 days.

Sarada *et al.* (2014) [15] proved that out of the tested insecticides azadirachtin 1% (0.04%) and novaluron10EC (0.005%) positioned as the most excellent insecticides for decreasing the psyllid infestation in sweet orange. Novaluron being an insect growth regulator and azadirachtin, a botanical insecticide are both efficient for the successful management of psyllids in citrus ecosystem.

Conclusion

Amongst the insecticides tested against citrus psylla greater efficacy was shown by imidacloprid, thiamethoxam and novaluron as compared to others.

References

1. Atwal AS. Agricultural pests of India and south-east Asia. Kalyani Publishers, New Delhi. 1976, 195-213.

2. Boina DR, Salyani M, Stelinski LL. Chemical control of the Asian citrus psyllid, Diaphorina citri Kuwayama. Proc. Fla. State Hort. Soc. 2009; 122:176-180.
3. Boulahia SK, Jerraya A, Zaidi H. Chemical treatment trials against the citrus leaf miner, Phyllocnistis citrella. Fruits Paris. 1996; 4(51):223-228.
4. Carl C, Rogers CME. Chemical control and management approaches of the Asian Citrus psylla, Diaphorina citri Kuwayama (Homoptera: Psyllidae) in Florida Citrus. ProcFla State Hort Soc. 2005; 118:49-53.
5. Chauhan D. Studies on population dynamics of citrus psylla and biological attributes of lemon butterfly alongwith their management. Thesis, Ph.D. G.B. pant University of Agriculture and Technology. Pantnagar, 2016, 285.
6. Duncan DB. Multiple range and multiple F- tests. Biometrics. 1955; 11:1-42.
7. Farmanullah HB, Gul R. Evaluation of six different groups of insecticides for the control of citrus psylla Diaphorina citri (Hemiptera: Psyllidae). Evoluation. 2005; 27(1):17-23.
8. Fletcher TB. Life-histories of Indian Insects: Microlepidoptera. Memoirs of the Department of Agriculture in India. Ent. Ser. 1921; 6:1-9.
9. Gunwant V, Raturi M, Hussain M. Marketing of sweet orange (Malta) in India. Int. J Emer. Res. Manage. Tech. 2013; 2:3-5.
10. India, Ministry of Agriculture. Indian Horticulture Database. New Delhi, IG Printer Pvt. Ltd. 2014, 302.
11. Pruthi HS, Mani MS. Our knowledge of the insect and mine pests of the citrus in India and their control. Imperial Council Agricultural Research Sciences Monograph. 1945; 16:1-42.
12. Powell CA, Burton MS, Pelosi Ram, Ritenour MA, Bullock RC. Effects of insecticides on Asian citrus psyllid (Hemiptera: Psyllidae) populations in a Florida citrus grove. Online Plant Health Progress. DOI: 10.1094/PHP-2007-1101-01-RS.
13. Rao CN, Shivankar VJ, Sandnyadeole, Dhengre VN. Efficacy of certain new insecticides and method of application against Asian Citrus Psyllid, Diaphorina citri Kuwayama. National Dialogue on Citrus Improvement, Production and Utilization, 2012, 249.
14. Sanofer A. Role of citrus fruits in health. J Pharma. Sci. Res. 2014; 6(2):121-123.
15. Sarada G, Gopal K, Nagalakshmi K, Venkataramana KT, Mukundalakshmi L, Gouri Sankar T, *et al.* Management of Citrus psylla (Diaphorina citri Kuwayyama) using bio-rational insecticides. Indian J Ecol. Environ. Sci. 2014; 21(3):199-204.
16. Setamou M, Rodriguez D, Saldana R, Schwarzlose G, Palrang D, Nelson SD. Efficacy and uptake of soil-applied imidacloprid in the control of Asian citrus psyllid and a citrus leafminer, two foliar-feeding citrus pests. J Econ. Entomol. 2010; 103:1711-1719.
17. Shivankar VJ, Rao CN. Psyllids and their management. Pest. Manag. Horti. Ecosyst. 2010; 16(1):1-4.
18. Su HJ, Chen CN. Implementation of IPM of citrus virus and greening (Likubin) diseases. Proceed. Intl. Workshop TARI, Taichung, Taiwan. 1991; 1:3-11.
19. Wadhi SR, Batra HN. Pests of tropical and subtropical fruit trees. Entomology in India (Ed.: Pant, N.C.). The Entomological Society of India, New Delhi, 1964, 227-260.