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Bio-efficacy of different insecticides evaluated against hopper, *Amritodus atkinsoni* Lethierry infesting mango

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Abstract
A field experiment was conducted at Anand Agricultural University, Anand during 2018 to assess the bio-efficacy of various insecticides against hopper *Amritodus atkinsoni* Lethierry infesting mango. Of the eight evaluated insecticides thiamethoxam 12.6% + lambda-cyhalothrin 9.5% ZC, thiamethoxam 25 WG and acephate 50% + imidacloprid 1.8% SP were found the most effective in reducing the incidence of *A. atkinsoni*. However, buprofezin 15% + acephate 35% WP, acetamiprid 20 SP and buprofezin 25 SC were found mediocre in their effectiveness. Maximum (145.44 q/ha) mango fruit yield was recorded from the trees treated with thiamethoxam + lambda-cyhalothrin which was at par with thiamethoxam (142.24 q/ha) and acephate + imidacloprid (137.45 q/ha). The highest (1: 14.84) NICBR was obtained with the treatment of thiamethoxam + lambda-cyhalothrin followed by thiamethoxam (1: 14.23), acephate + imidacloprid (1: 13.32) and buprofezin + acephate (1: 10.30).

Keywords: Mango, mango hoppers, Langra, *Amritodus atkinsoni*

Introduction
Mango (*Mangifera indica* Linnaeus) is the national fruit of India as it has originated in India and is known as "King of fruits" due to its excellent taste, wide adaptability, exemplary nutritive value, exotic flavour, richness in variety, attractive colour and popularity among other fruits. Andhra Pradesh, Uttar Pradesh, Bihar, Karnataka, Telangana, Tamil nadu, Maharashtra and Gujarat are major mango producing states of the country. Gujarat ranks 8th in area occupying 1,53,180 ha area, 5th in production (Anon., 2018) [1]. The crop is attacked by about 492 species of insects, 17 species of mites and 26 species of nematodes at the world level. Of these, 188 species of insects have been reported from India (Tandon and Verghese, 1985) [8]. Among all, *Idioscopus clypealis*, *I. niveosparsus*, *I. nagpurensis* and *Amritodus atkinsoni* are important species of hoppers infesting mango (Pena *et al.*, 1998) [4]. According to Rahman and Kuldeep (2007) [6] mango hoppers cause 20-100 per cent yield loss by giving rise to growth of sooty mould that reduces photosynthetic efficiency of leaves and market quality of fruits. Physical injury is also caused to leaves, panicles and shoots due to egg laying in the tissues. According to Rahman and Kuldeep (2007) [6] mango hoppers cause 20-100 per cent yield loss by giving rise to growth of sooty mould that reduces photosynthetic efficiency of leaves and market quality of fruits. Physical injury is also caused to leaves, panicles and shoots due to egg laying in the tissues.

Materials and Methods
For evaluation of various insecticides against hopper, *A. atkinsoni* infesting mango an experiment was conducted under field conditions on farm of B. A. College of Agriculture, Anand Agricultural University, Anand during 2018. The experiment was laid out in Completely Randomized Design with nine treatments *viz*., thiamethoxam 12.6% + lambda-cyhalothrin 9.5% ZC @ 0.0088%, thiamethoxam 25 WG @ 0.0075%, acephate 50% + imidacloprid 1.8% SP @ 0.100%, deltamethrin 1% + triazophos 35% EC @ 0.045%, buprofezin 15% + acephate 35% WP @ 0.125%, buprofezin 25 SC @ 0.05%, acetamiprid 20 SP @ 0.004%, sulfoxaflor 21.8 SC @ 0.0218 and control (no spray) along with three repetitions with a view to evaluate bio-efficacy of various insecticides against *A. atkinsoni*. Existing trees of mango cv. Langra at a spacing of 10 × 10 m having equal age, canopy and growth were selected. Treatment wise application of insecticides were given at ETL (5

(5 hoppers/panicle) on the trees by using foot sprayer with required concentration. Subsequently two sprays were given at 15 days interval. The observations were recorded before spraying as well as 1, 3, 5, 7, 10 and 15 days after each spray from 5 randomly selected panicles or inflorescences from each direction from each tree. The data obtained were analyzed by following standard statistical technique (Steel and Torrie, 1980) [10].

Results and Discussion

The population of hoppers was homogeneous before spray in all the treatments as treatments did not differ significantly. All the evaluated insecticides were significantly superior to control up to 15 days of spray.

First spray

The lowest (3.85/panicle) population of hoppers was recorded from trees treated with thiamethoxam + lambda-cyhalothrin which was at par with thiamethoxam (3.86/panicle) and acephate + imidacloprid (3.96/panicle) at one day after first spray (Table 1). Among the evaluated insecticides, the highest (9.08/panicle) population of *A. atkinsoni* was observed in trees treated with deltamethrin + triazophos and it was at par with buprofezin + acephate (6.20/panicle), buprofezin (6.39/panicle), acetamiprid (6.31/panicle) and sulfoxaflor (9.21/panicle). Similarly, efficacy data exhibited analogous trend at three days after spray.

Population of *A. atkinsoni* was found minimum (2.83/panicle) from trees treated with thiamethoxam + lambda-cyhalothrin which was at par with thiamethoxam (2.91/panicle) and acephate + imidacloprid (3.06/panicle) after five days of spray. Whereas, buprofezin + acephate (4.47/panicle) at par with acetamiprid (5.60/panicle) and buprofezin (5.73/panicle) significantly affected the pest population. The maximum (8.85/ panicle) population of hoppers was found from trees treated with deltamethrin + triazophos and it was at par sulfoxaflor (8.71/panicle). More or less undisting-uishable results were obtained at seven days.

Similarly, ten days after first spray, thiamethoxam (2.01/panicle), thiamethoxam + lambda-cyhalothrin (2.08/panicle) and acephate + imidacloprid (2.12/panicle) were found most effective and at par with each other while, buprofezin + acephate (3.77/panicle), buprofezin (4.27/panicle) and acetamiprid (4.55/panicle) also exhibited significant efficacy. The treatments deltamethrin + triazophos (7.43/panicle) and sulfoxaflor (6.96/panicle) were least effective.

Again fifteen days after first spray, thiamethoxam showed the lowest (3.13/ panicle) population of hoppers and it was at par with thiamethoxam + lambda-cyhalothrin (3.23/ panicle) and acephate + imidacloprid (3.35/panicle). Among the tested insecticides buprofezin + acephate (5.64/panicle), acetamiprid (5.77/panicle) and buprofezin (6.12/panicle) revealed significantly lower *A. atkinsoni* population. The trees treated with deltamethrin + triazophos recorded the maximum (9.04/panicle) population of hoppers and it was at par with sulfoxaflor (8.85/panicle).

Pooled over periods results (Table 1) of first spray revealed that thiamethoxam + lambda-cyhalothrin (2.91/panicle), thiamethoxam (2.93/panicle) and acephate + imidacloprid (3.06/panicle) were found significantly superior among all the evaluated insecticides. However, the insecticidal treatments of buprofezin + acephate, acetamiprid and buprofezin were also effective with hoppers population of 5.27, 5.54 and 5.62/ panicle. The trees treated with deltamethrin + triazophos recorded the highest (8.54/panicle) population of hoppers and it was at par with sulfoxaflor (8.36/panicle).

Second spray

One day after second spray (Table 2), thiamethoxam + lambda-cyhalothrin (2.03/ panicle), thiamethoxam (2.19/panicle) and acephate + imidacloprid (2.24/panicle) were effective in reducing the hoppers population. While, buprofezin + acephate (3.58/panicle), acetamiprid (3.64/panicle) and buprofezin (3.78/panicle) also significantly reduced the pest population. Maximum (6.87/panicle) hoppers population was recorded from the trees treated with deltamethrin + triazophos and it was at par with sulfoxaflor (6.78/panicle).

Population of hoppers, *A. atkinsoni* was noticed the lowest (1.85/panicle) in trees treated with thiamethoxam + lambda-cyhalothrin which was at par with thiamethoxam (1.92/panicle) and acephate + imidacloprid (1.96/panicle) after three days of spray. Whereas, buprofezin + acephate (3.37/panicle), acetamiprid (3.49/ panicle) and buprofezin (3.78/panicle) also revealed significantly lower activity of *A. atkinsoni*. Among the evaluated insecticides, the highest (6.64/panicle) population of *A. atkinsoni* was recorded from the trees treated with deltamethrin + triazophos and it was at par with sulfoxaflor (6.20/panicle). Comparatively similar results were observed at five and seven days after second spray.

The lowest (0.91/panicle) population of hoppers was registered from trees treated with thiamethoxam + lambda-cyhalothrin and it was at par with thiamethoxam (0.94/panicle) and acephate + imidacloprid (1.03/panicle) at ten days after second spray. These four insecticides were found to be significantly superior to rest of the insecticides. The trees treated with buprofezin + acephate (2.19/panicle), acetamiprid (2.36/panicle) and buprofezin (2.66/panicle) also recorded significantly lower population of hoppers. Amidst the evaluated insecticides, the maximum (4.38/panicle) population of *A. atkinsoni* was recorded from trees treated with deltamethrin + triazophos and it was at par with sulfoxaflor (4.07/panicle). More or less equal trend in efficacy was observed at fifteen days after second spray.

Looking to the data on pooled over periods of second spray (Table 2), the lowest (1.58/panicle) population of hoppers was recorded from trees with the treatment of thiamethoxam + lambda-cyhalothrin which was at par with thiamethoxam (1.65/panicle) and acephate + imidacloprid (1.70/panicle). Buprofezin + acephate (3.12/panicle), acetamiprid (3.29/panicle) and buprofezin (3.49/panicle) were next effective and remained at par with each other recording lower count of hopper. While, trees treated with deltamethrin + triazophos recorded the highest (5.91/panicle) population of hoppers and it was at par with sulfoxaflor (5.87/panicle).

Third spray

The minimum (0.96/panicle) incidence of mango hoppers was observed in trees treated with thiamethoxam + lambda-cyhalothrin which was at par with thiamethoxam (1.00/panicle) at one day after third spray (Table 3). These two doses found significantly superior over rest of the insecticides. While, the treatments of acephate + imidacloprid (1.12/panicle), buprofezin + acephate (2.05/panicle), acetamiprid (2.30/panicle) and buprofezin (2.45/panicle) also reduced hoppers activity. Of the evaluated insecticides, the maximum (4.05/panicle) population of *A. atkinsoni* was recorded from deltamethrin + triazophos trees treated and it was at par with sulfoxaflor (3.84/panicle).

Similarly, three days after spray, thiamethoxam + lambda-cyhalothrin registered the lowest (0.78/panicle) incidence of hoppers which was at par with thiamethoxam (0.83/panicle) and acephate + imidacloprid (0.90/panicle). However, the trees treated with buprofezin + acephate (1.84/panicle), acetamiprid (1.91/panicle) and buprofezin (2.28/panicle) also recorded lower incidence of mango hoppers. Whereas, the deltamethrin + triazophos treated trees recorded the highest (3.78/panicle) population of hoppers and it was at par with sulfoxaflor (3.65/panicle). Resembling trend was observed in efficacy of insecticidal treatments at five days after spray.

Based on the number of mango hoppers recorded at seven days after third spray, thiamethoxam + lambda-cyhalothrin (0.32/panicle) was found most effective followed by thiamethoxam (0.38/panicle) and acephate + imidacloprid (0.53/panicle). While, at par reduction in activity of hoppers was also obtained from the treatments of buprofezin + acephate (1.18/panicle), acetamiprid (1.45/panicle) and buprofezin (1.75/panicle). The treatments deltamethrin + triazophos (2.78/ panicle) and sulfoxaflor (2.69/panicle) were least effective. Likewise, similar results were observed at ten days after third spray.

At 15 days after spray cent per cent reduction was observed from trees treated with thiamethoxam which was at par with thiamethoxam + lambda-cyhalothrin (0.05/panicle) and acephate + imidacloprid (0.08/panicle) after 15 days of spray. The treatments of buprofezin + acephate (0.91/panicle), buprofezin (0.99/panicle) and acetamiprid (1.08/panicle) were at par and found next in their effectiveness. Among the evaluated insecticides, the maximum (2.35/panicle) population of mango hoppers were recorded from trees treated with sulfoxaflor which was at par with deltamethrin + triazophos (2.01/panicle). The data of pooled over periods results (Table 3) of third spray asserted that thiamethoxam + lambda-cyhalothrin (0.45/panicle) was found significantly superior among all and remained at par with thiamethoxam (0.48/panicle) and acephate + imidacloprid (0.58/panicle). Whereas, significant results were obtained from buprofezin + acephate (1.42/panicle), buprofezin (1.61/panicle) and acetamiprid (1.83/panicle). The treatment of deltamethrin + triazophos recorded the highest (3.07/panicle) population of hoppers and it was at par sulfoxaflor (3.06/panicle).

Overall pooled

Overall data (Table 3 and Figure 1) revealed that thiamethoxam + lambda-cyhalothrin (1.52/panicle) was found significantly superior among all the evaluated insecticides except thiamethoxam (1.56/panicle) and acephate + imidacloprid (1.66/panicle). Buprofezin + acephate (3.10/panicle), acetamiprid (3.31/ panicle) and buprofezin (3.50/panicle) were the next effective treatments. While, deltamethrin + triazophos recorded the maximum (5.63/panicle) population of *A. atkinsoni* and it was at par with sulfoxaflor (5.56/panicle).

Effect on mango fruit yield

The data on mango fruit yield were recorded from various insecticidal treatments as well as in control during study and are presented in Table 4 and depicted in Figure 2.

Maximum (145.44 q/ha) mango fruit yield was recorded from trees treated with thiamethoxam + lambda-cyhalothrin which was at par with thiamethoxam (142.24 q/ha) and acephate + imidacloprid (137.45 q/ha). While, the treatments buprofezin + acephate (121.64 q/ha), acetamiprid (112.57 q/ha) and buprofezin (106.58 q/ha) were ordinary in mango yield performance. Among the tested insecticides, the lowest (93.59 q/ha) yield of mango fruits was recorded from trees treated with deltamethrin + triazophos and it was at par with sulfoxaflor (99.05 q/ha).

Increase in yield over control in mango was worked out for different insecticidal treatments and indicated that maximum (57.12%) increase in yield over control was found from trees treated with thiamethoxam + lambda-cyhalothrin, followed by thiamethoxam (56.16%) and acephate + imidacloprid (54.63%). Trees treated with buprofezin + acephate (48.73%), acetamiprid (44.60%) and buprofezin (41.49%) provided with average increase in the yield. Whereas, among the tested insecticides, minimum (33.37%) increase in yield was found from trees treated with deltamethrin + triazophos followed by sulfoxaflor (37.04%).

Economics

Of the various insecticides evaluated against mango hoppers, *A. atkinsoni* economics indicated that the highest (1:14. 84) returns were obtained with the treatment of thiamethoxam + lambda-cyhalothrin followed by thiamethoxam (1: 14.23), acephate + imidacloprid (1: 13.32) and buprofezin + acephate (1: 10.30). The NICBR calculated with treatments of acetamiprid, buprofezin and sulfoxaflor which was 1: 8.57, 1: 7.43 and 1: 6.00, respectively. The poor NICBR (1: 4.95) was recorded with the treatment of deltamethrin + triazophos.

Poornima *et al.* (2018) [5] reported that thiamethoxam 25 WG @ 0.3 g/L was found the most significant in suppressing the hopper population (1.15/inflorescence) after 14 days of the third spray, while lambda-cyhalothrin 5 EC @ 0.5 ml/L and imidacloprid 17.8 SL @ 0.25 m/L were next best treatments (4.75 and 5.58/inflorescence). Buprofezin 25 SC @ 1.25 ml/L was found to be the most effective in reducing the population of mango hopper (Manjunath *et al.*, 2017) [3]. Chaudhari *et al.* (2017) [2] showed that imidacloprid 17.8 SL @ 0.007% and thiamethoxam 25 WG @ 0.0025% were found effective and registered 95.35 and 93.99 per cent mean mortality, respectively. Sarode and Mohite (2016) revealed that imidacloprid was found the most effective in reducing mango hoppers which was at par with thiamethoxam and lambda-cyhalothrin.

Table 1: Bio-efficacy of insecticides against hoppers, *A. atkinsoni* infesting mango after first spray

Tr. No.	Treatments	Conc. in%	No. of hoppers/ panicle days after spray							
			Before spray	1	3	5	7	10	15	Pooled over periods
T_1	Thiamethoxam 12.6% + Lambda-cyhalothrin 9.5% - 22.1 ZC	0.0088	2.99a (8.42)	2.09d (3.85)	1.95d (3.31)	1.83e (2.83)	1.68e (2.32)	1.61ef (2.08)	1.93d (3.23)	1.85d (2.91)
T_2	Thiamethoxam 25 WG	0.0075	3.03a (8.69)	2.09d (3.86)	1.99d (3.44)	1.85e (2.91)	1.71e (2.41)	1.59f (2.01)	1.91d (3.13)	1.85d (2.93)
T_3	Deltamethrin 1% + Triazophos 35% - 36 EC	0.045	3.29a (10.34)	3.10ab (9.08)	3.11b (9.17)	3.06b (8.85)	2.87b (7.74)	2.82b (7.43)	3.09b (9.04)	3.01b (8.54)
T_4	Buprofezin 25 SC	0.05	2.75a (7.08)	2.62bc (6.39)	2.57bc (6.13)	2.50bc (5.73)	2.40bcd (5.25)	2.18d (4.27)	2.57bc (6.12)	2.47c (5.62)

T_5	Acephate 50% + Imidacloprid 1.8% - 51.8 SP	0.100	2.81a (7.41)	2.11cd (3.96)	2.01d (3.52)	1.89de (3.06)	1.74e (2.53)	1.62ef (2.12)	1.96d (3.35)	1.89d (3.06)
T_6	Buprofezin 15% + Acephate 35% - 50 WP	0.125	2.80a (7.33)	2.59bc (6.20)	2.54c (5.95)	2.44cd (4.47)	2.30d (4.79)	2.07de (3.77)	2.48c (5.64)	2.40c (5.27)
T_7	Acetamiprid 20 SP	0.004	3.19a (9.68)	2.61bc (6.31)	2.55bc (6.02)	2.47bc (5.60)	2.36cd (5.08)	2.25cd (4.55)	2.50c (5.77)	2.46c (5.54
T_8	Sulfoxaflor 21.8 SC	0.0218	3.12a (9.21)	3.11ab (9.17)	3.09bc (9.07)	3.04b (8.71)	2.83bc (7.51)	2.73bc (6.96)	3.06b (8.85)	2.98b (8.36)
T_9	Control	-	3.27a (10.18)	3.59a (12.40)	3.67a (12.99)	3.61a (12.52)	3.53a (11.96)	3.60a (12.49)	3.68a (13.01)	3.61a (12.56)
S. Em. ± T		-	0.20	0.16	0.17	0.18	0.14	0.15	0.16	0.07
P		-	-	-	-	-	-	-	-	0.05
T x P		-	-	-	-	-	-	-	-	0.16
C.V.%		-	11.34	10.30	11.05	12.06	10.44	11.25	10.48	10.95

Notes: Figures in parentheses are retransformed values of $\sqrt{x + 0.5}$
Treatment mean with letter(s) in common are non-significant by DNMRT at 5% level of significance

Table 2: Bio-efficacy of insecticides against hoppers, *A. atkinsoni* infesting mango after second spray

Tr. No.	Treatments	Conc. in%	No. of hoppers/ panicle days after spray						
			1	3	5	7	10	15	Pooled over periods
T_1	Thiamethoxam 12.6% + Lambda-cyhalothrin 9.5% - 22.1 ZC	0.0088	1.59e (2.03)	1.53e (1.85)	1.50f (1.76)	1.33e (1.26)	1.19e (0.91)	1.51e (1.77)	1.44d (1.58)
T_2	Thiamethoxam 25 WG	0.0075	1.64de (2.19)	1.56de (1.92)	1.46f (1.63)	1.35de (1.31)	1.20e (0.94)	1.59e (2.04)	1.47d (1.65)
T_3	Deltamethrin 1% + Triazophos 35% - 36 EC	0.045	2.72b (6.87)	2.67b (6.64)	2.43bc (5.40)	2.41b (5.32)	2.21b (4.38)	2.75b (7.05)	2.53b (5.91)
T_4	Buprofezin 25 SC	0.05	2.07c (3.78)	2.04c (3.66)	2.00cd (3.51)	1.91c (3.15)	1.78cd (2.66)	2.19c (4.30)	2.00c (3.49)
T_5	Acephate 50% + Imidacloprid 1.8% - 51.8 SP	0.100	1.66de (2.24)	1.57de (1.96)	1.53ef (1.83)	1.29e (1.16)	1.24e (1.03)	1.63de (2.14)	1.48d (1.70)
T_6	Buprofezin 15% + Acephate 35% - 50 WP	0.125	2.02cd (3.58)	1.97cd (3.37)	1.94de (3.26)	1.78cd (2.67)	1.64d (2.19)	2.07cd (3.80)	1.90c (3.12)
T_7	Acetamiprid 20 SP	0.004	2.03cd (3.64)	2.00c (3.49)	1.96de (3.35)	1.86c (2.97)	1.69d (2.36)	2.14c (4.07)	1.95c (3.29)
T_8	Sulfoxaflor 21.8 SC	0.0218	2.70b (6.78)	2.59b (6.20)	2.54b (5.97)	2.46b (5.55)	2.14bc (4.07)	2.18c (4.23)	2.52b (5.87)
T_9	Control	-	3.74a (13.47)	3.53a (11.98)	3.61a (12.55)	3.47a (11.51)	3.41a (11.12)	3.33a (10.61)	3.51a (11.85)
S. Em. ± T		-	0.12	0.13	0.13	0.14	0.11	0.15	0.05
P		-	-	-	-	-	-	-	0.04
T x P		-	-	-	-	-	-	-	0.13
C.V.%		-	9.32	10.39	11.04	12.35	10.72	11.51	10.91

Notes: Figures in parentheses are retransformed values of $\sqrt{x + 0.5}$
Treatment mean with letter(s) in common are non-significant by DNMRT at 5% level of significance

Table 3: Bio-efficacy of insecticides against hoppers, *A. atkinsoni* infesting mango after third spray

Tr. No.	Treatments	Conc. in%	No. of hoppers/ panicle days after spray							
			1	3	5	7	10	15	Pooled over periods	Pooled over periods and sprays
T_1	Thiamethoxam 12.6% + Lambda-cyhalothrin 9.5% - 22.1 ZC	0.0088	1.21e (0.96)	1.13f (0.78)	1.04f (0.58)	0.90e (0.32)	0.82e (0.17)	0.74e (0.05)	0.97e (0.45)	1.42e (1.52)
T_2	Thiamethoxam 25 WG	0.0075	1.22e (1.00)	1.15f (0.83)	1.06f (0.63)	0.94e (0.38)	0.85e (0.22)	0.71e (0.00)	0.99e (0.48)	1.44e (1.56)
T_3	Deltamethrin 1% + Triazophos 35% - 36 EC	0.045	2.13b (4.05)	2.07b (3.78)	2.01b (3.55)	1.81b (2.78)	1.72bc (2.47)	1.59bc (2.01)	1.89b (3.07)	2.48b (5.63)
T_4	Buprofezin 25 SC	0.05	1.72c (2.45)	1.67cd (2.28)	1.59cd (2.03)	1.50cd (1.75)	1.46cd (1.62)	1.22d (0.99)	1.53c (1.83)	2.00c (3.50)
T_5	Acephate 50% + Imidacloprid 1.8% - 51.8 SP	0.100	1.27de (1.11)	1.18ef (0.90)	1.10ef (0.70)	1.02e (0.53)	0.91e (0.32)	0.76e (0.08)	1.04e (0.58)	1.47e (1.66)
T_6	Buprofezin 15% + Acephate 35% - 50 WP	0.125	1.60cd (2.05)	1.53de (1.84)	1.45de (1.60)	1.30d (1.18)	1.25d (1.07)	1.19d (0.91)	1.39d (1.42)	1.90d (3.10)
T_7	Acetamiprid 20 SP	0.004	1.67c (2.30)	1.55d (1.91)	1.49d (1.71)	1.40d (1.45)	1.34d (1.31)	1.26cd (1.08)	1.45cd (1.61)	1.95cd (3.31)
T_8	Sulfoxaflor 21.8 SC	0.0218	2.08b (3.84)	2.04bc (3.65)	1.95bc (3.29)	1.79bc (2.69)	1.78b (2.66)	1.69b (2.35)	1.89b (3.06)	2.46b (5.56)
T_9	Control	-	3.41a (11.11)	3.47a (11.56)	3.54a (12.05)	3.64a (12.71)	3.69a (13.14)	3.54a (12.00)	3.55a (12.08)	3.56a (12.17)
S. Em. ± T		-	0.10	0.11	0.12	0.09	0.09	0.10	0.04	0.03
P		-	-	-	-	-	-	-	0.03	0.02

T x P	-	-	-	-	-	-	-	0.10	0.07
C.V.%	-	10.14	11.18	11.81	9.55	10.31	12.46	10.94	11.09

Notes: Figures in parentheses are retransformed values of $\sqrt{x + 0.5}$
Treatment mean with letter(s) in common are non-significant by DNMRT at 5% level of significance

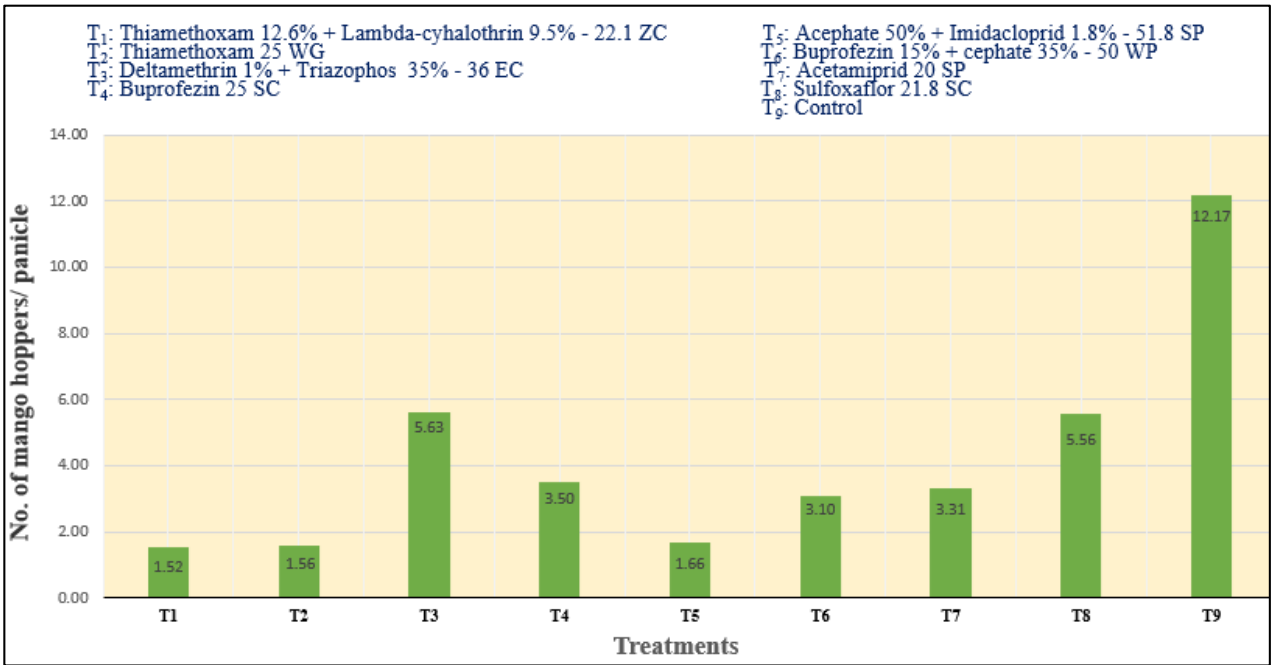

Fig 1: Bio-efficacy of different insecticides against hoppers, *A. atkinsoni* infesting mango (Pooled over sprays)

Table 4: Effect of various insecticide on mango fruit yield

Sr. No.	Treatments	Yield (q/ha)	Increase in yield over control (%)
T_1	Thiamethoxam 12.6% + Lambda-cyhalothrin 9.5% - 22.1 ZC	145.44a	57.12
T_2	Thiamethoxam 25 WG	142.24ab	56.16
T_3	Deltamethrin 1% + Triazophos 35% - 36 EC	93.59d	33.37
T_4	Buprofezin 25 SC	106.58cd	41.49
T_5	Acephate 50% + Imidacloprid 1.8% - 51.8 SP	137.45ab	54.63
T_6	Buprofezin 15% + Acephate 35% - 50 WP	121.64bc	48.73
T_7	Acetamiprid 20 SP	112.57cd	44.60
T_8	Sulfoxaflor 21.8 SC	99.05d	37.04
T_9	Control	62.36e	-
S. Em. +		6.77	-
C. V. (%)		10.34	-

Note: Treatment mean with letter(s) in common are non-significant by DNMRT at 5% level of significance

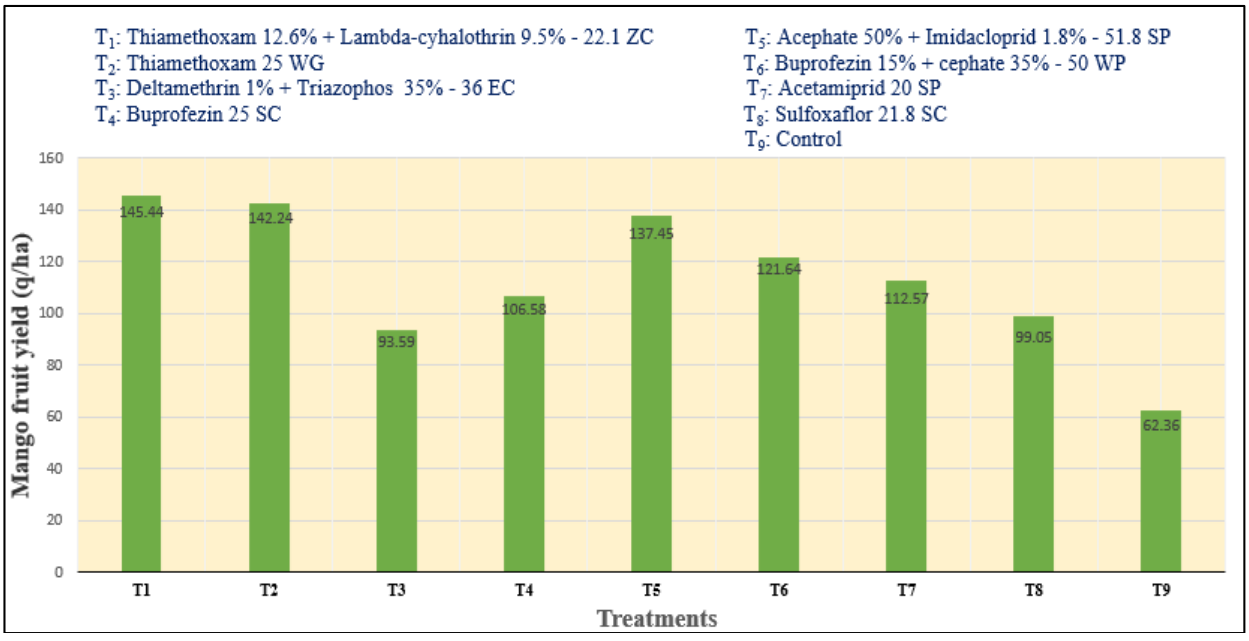

Fig 2: Effect of different insecticidal treatments on mango fruit yield

Rathod and Borad (2013) [7] also concluded that imidacloprid (0.0053%), thiamethoxam (0.0075%) and acetamiprid (0.005%) were effective in checking population of hoppers. As per the report of Samanta *et al.* (2009) [9] lowest mean hopper population (4.53) and highest yield (180 fruits/tree & 72 kg/tree) as well as highest cost-benefit ratio (2.89) were recorded in thiamethoxam 0.016%. Thus, the above reports are more or less tally with the present findings. Sulfoxaflor, being a new chemical could not be compared with the earlier findings.

Conclusion

From the foregoing results it can be concluded that among the eight insecticides evaluated, thiamethoxam + lambda-cyhalothrin, thiamethoxam and acephate + imidacloprid were found the most effective in reducing the incidence of *A. atkinsoni* infesting mango with the mango fruit yield of treatments 145.44, 142.24 and 137.45 q/ha, respectively. Looking to the NICBR, the highest (1: 14.84) return obtained with the treatment of thiamethoxam + lambda-cyhalothrin followed by thiamethoxam (1: 14.23) and acephate + imidacloprid (1: 13.32).

References

1. Anonymous. Ministry of Agriculture & Farmers Welfare, Govt. of India, 2018.
2. Chaudhari AU, Sridharan S, Sundar Singh SD. Management of mango hopper with newer molecules and biopesticides under ultra-high density planting system. Journal of Entomology and Zoology Studies. 2017; 5(6):454-458.
3. Manjunatha R, Viraktamath S, Vastrad AS, Mallapur C P, Mathad JC, Halappa B. Efficacy of different eco-friendly modules against mango leafhoppers. Journal of Entomological Research, 2017; 41(2):163-166.
4. Pena JE, Mohyuddin AI, Wysoki M. A review of the pest management situation in mango agroecosystem. Phytoparasitica. 1998; 26:1-20.
5. Poornima MH, Gopali JB, Venkateshalu, Patil S. Efficacy of new molecules against mango hoppers under high density planting system. Journal of Experimental Zoology. 2018; 21(1):123-126.
6. Rahman AS, Kuldeep. Mango hopper: bioecology and management: A review. Agric. Rev. 2007; 28(1):49-55.
7. Rathod ST, Borad PK. Bioefficacy of newer and conventional insecticides against mango hoppers, *Amritodes atkinsoni* (Leth.). Pesticide Research Journal, 2013; 25(1):77-79.
8. Tandon PL, Verghese A. World list of insect, mite and other pests of mango. Technical Document, No. 5, IIHR, Bangalore. 1985; 6(3):122-131.
9. Samanta A, Gosh A, Hembram TK, Patra S, Somchowdhury AK. Efficacy of insecticides against mango hoppers and fruit yield. Annals of Plant Protection Sciences. 2009; 17(1):225-274.
10. Steel RGD, Torrie JH. Principles and procedures of statistics. Publ. McGraw Hill Book Company, New York, 1980, 137.