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Field-efficacy of a novel ready-mix molecule pyriproxyfen 5% + fenpropathrin 15% EC against hopper complex of mango

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Abstract
Field efficacy of different (pyriproxyfen 5% + fenpropathrin 15% EC) treatment schedules was assessed against hopper complex populations on mango (cv. *Amrapali*) at Horticulture Research Station, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur during 2015 and 2016. Pyriproxyfen 5% + fenpropathrin 15% EC registered 70.49-84.53% mean reduction of mango hopper complex population at higher dosages while a single molecule of pyriproxyfen 10% EC and thiamethoxam 25% WDG revealed 59.51-69.38% mean reduction. Though pyriproxyfen 5% + fenpropathrin 15% EC @ 150 g a.i. ha^{-1} proved relatively toxic towards lacewing and spider (11.5 and 9.4% mean reduction respectively), but, the treatment at lower to medium dosages were safer (4.1-7.9% reduction) as compared to thiamethoxam 25% WDG (19.4 and 15.7% respectively) and dimethoate 30% EC (16.8 and 15.5% respectively). LT_{50} value of pyriproxyfen 5% + fenpropathrin 15% EC (21 hours) at 100 ppm concentration was statistically at par with pyriproxyfen 10% EC (20 hours) for *Apis mellifera* L. At 200, 500 and 1000 ppm concentration, LT_{50} values of pyriproxyfen 5% + fenpropathrin 15% EC (17, 13 and 9 hours respectively) differed significantly from thiamethoxam 25% WDG (12, 9 and 4 hours respectively) and dimethoate 30% EC (13, 9 and 5 hours respectively). The yield of fresh marketable mango also varied significantly among different treatment schedules of pyriproxyfen 5% + fenpropathrin 15% EC (29.5-42.2 kg $tree^{-1}$).

Keywords: Pyriproxyfen 5% + fenpropathrin 15% EC, mango hopper, honey bee toxicity, yield

Introduction
Mango (*Mangifera indica* L.) is a widely grown fruit crop in India which occupies first place in the world as its largest producer. Although the crop has got huge domestic requirement, a number of limiting factors have been attributed for its low productivity. Among them, insect pests [1], *viz.,* hopper complex viz. *Amritodus atkinsoni* Lethierry and *Idioscopus clypealis* Lethierry are the chief constraints in the production of mango; right from flowering to fruiting stages [2]. About 20-100% economic losses in mango by hopper burn of inflorescence has been reported [3]. During the non-crop period, they usually prefer to settle on the abaxial leaf surface at the dark and moist areas of the tree and cause secondary infestation by honey dew excretion which encourages the sooty mould fungus [4]. Management of hopper incidence on mango is mainly dependent on synthetic insecticides [4] as the old generation neonicotinoid imidacloprid or organophosphate molecule like dimethoate has been recommended [5]. Moreover, indiscriminate use of these conventional insecticides posed severe problems such as adverse effect on non-target organisms, development of resistance in target pest and pest resurgence. On the other hand, different pollinators like honey bees visit the mango orchards throughout the flowering period [6] and among them *Apis* spp. was found to be the dominant pollinator with a 30% contribution [7]. But, recent scientific findings linking neonicotinoids with honey bee colony losses [8] which may be a potential threat for the pollinators. Pesticide mixture either pre-mix or tank-mix formulation entails exposing individuals in a pest population to each of the active ingredient simultaneously which decreases labour cost by reduction of rounds of applications, higher mortality of different groups of arthropod pests having separate and distinct feeding habits and delayed resistance development against a particular pesticide by various pests [9]. Keeping these in mind, the present experiments were undertaken to evaluate field-effectiveness of a modern pre-mixed chemistry pyriproxyfen 5% + fenpropathrin 15% EC against mango hopper complex *vis.-a-vis.* its adverse effect on prevailing natural enemies and honey bee *Apis mellifera* L.

Materials and Methods

A field experiment was conducted in a completely randomized block design with seven treatments viz. T1: pyriproxyfen 5% + fenpropathrin 15% EC (Sumitomo Chemical India Pvt. Ltd.) @ 50 g a.i. ha^{-1}, T2: pyriproxyfen 5% + fenpropathrin 15% EC @ 100 g a.i. ha^{-1}, T3: pyriproxyfen 5% + fenpropathrin 15% EC @ 150 g a.i. ha^{-1}, T4: pyriproxyfen 10% EC (Parijat Industries India Pvt. Ltd.) @ 100 g a.i. ha^{-1}, T5: thiamethoxam 25% WDG (Syngenta) @ 50 g a.i. ha^{-1}, T6: dimethoate 30% EC (Jay Shree Rasayan Udyog Ltd.) @ 500 g a.i. ha^{-1} and T7: untreated control and replicated thrice at Horticulture Research Station, Mondouri under Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal during January to May of 2015 and 2016 on 10 years old orchard of variety "*Amrapali*". Three rounds of spray were done during every year at pre-flowering, 50-60% flowering and buttoning stages respectively with a high volume rocker sprayer at 10-litre spray volume per tree. Data were recorded 24 hours before the treatment as pre-treatment count and 3, 7, 10 and 14 days after each application as post-treatment count for the pest while, at 15 days of each spray for the natural enemies *viz*. lacewing and spider complex respectively. Hopper populations were counted during morning hours between 6-8 A.M. from randomly selected and tagged 10 twigs of each tree. Polythene bags (30 cm × 60 cm) with a cotton swab containing 80% chloroform were tied beneath the tagged twigs in order to assess the reduction of hopper complex by individual counting from each bag. Percent mortality of nymphs and adults of hopper complex and motile stages of natural enemies was enumerated by the formula [10]:

$$\text{Percent mortality} = \frac{(\text{pre spray data}) - (\text{post spray data})}{(\text{pre spray data})} \times 100$$

Insecticidal toxicity to honey bee *Apis mellifera* in terms of LT_{50} was conducted in ecotoxicological research laboratory under Directorate of Research, Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya during 2016. Bees were kept inside a wire cage of 2.5 ft × 2.5 ft dimension and fed on 50% sucrose solution. Different concentrations of the insecticides (1000, 500, 200, 100 and 0 ppm) were prepared in acetone where 5 ml of each insecticide concentrations were added in separate glass jar and 20 adult honey bee workers were introduced in each jar after air drying along with one control jar of acetone which was replicated five times. All the treated and untreated jars were placed at 25 ± 1 ^{0}C temperature and 60 ± 5% relative humidity inside an incubator. Mortality was determined after 3, 6, 12 and 24 hours and continued. The dose-mortality relationship was evaluated by Probit analysis [11].

The yield of fresh marketable mango was recorded in kg $tree^{-1}$ in each treatment. The data on the hopper population, prevailing predators and yield were subjected to analysis of variance by using SPSS (version 18.0: Inc., Chicago, IL, USA) software after making necessary transformation wherever required.

Results and Discussion

Efficacy against mango hopper complex

Data on the overall performance of different treatment schedules (pyriproxyfen 5% + fenpropathrin 15% EC) on hopper complex populations and yield of mango (cv. *Amrapali*) for the years 2015 and 2016 are presented in table 1 and 2. The results indicated significant differences among all the treatments in both the years of study. The mean percent reduction of hopper population for different treatments was found to be significantly superior to untreated control during the two years. The data revealed that the insecticidal treatment with pyriproxyfen 5% + fenpropathrin 15% EC @ 150 g a.i. ha^{-1} was highly effective in reducing the hopper population to the tune of 84.53 per cent during 2015 and 73.23 per cent during 2016. The treatment (pyriproxyfen 5% + fenpropathrin 15% EC @ 100 g a.i. ha^{-1}) was also effective and reduced the hopper population during 2015 and 2016 by 81.71 per cent and 70.49 per cent, respectively. The least effective treatment among the tested insecticide treatments was pyriproxyfen 5% + fenpropathrin 15% EC @ 50 g a.i. ha^{-1} with mean population reduction of 54.49 and 46.95 per cent during the two years.

It is evident from the data in table 1 that the pre-count of hopper population was non-significant showing even distribution of hoppers before spraying. On third day of observation, all the treatments were significantly reduced the population of hopper over untreated control. Application of pyriproxyfen 5% + fenpropathrin 15% EC @ 150 g a.i. ha^{-1} recorded highest reduction in per cent population of mango hopper 52.26, 62.65, 84.54 and 88.92 on 3rd, 7th 10th and 14th day after first spray, respectively and significantly higher over pyriproxyfen 5% + fenpropathrin 15% EC @ 50 and 100 g a.i. ha^{-1}, pyriproxyfen 10% EC @ 100 g a.i. ha^{-1}, thiamethoxam 25% WDG @ 50 g a.i. ha^{-1} and dimethoate 30% EC @ 500 g a.i. ha^{-1}. The same trend was observed after second and third spray from 3 to 14 days after spray where the highest reduction in per cent population was recorded in the treatment pyriproxyfen 5% + fenpropathrin 15% EC @ 150 g a.i. ha^{-1} and at par with pyriproxyfen 5% + fenpropathrin 15% EC @ 100 g a.i. ha^{-1} (table 1).

In the second year of study (table 2), the mean population of hopper ranged from 17.30 to 24.90 per 5 twigs during the pre-treatment period. Three days after application all the treatments have significantly reduced the population of hopper over untreated control. Spraying with pyriproxyfen 5% + fenpropathrin 15% EC 15 EC @ 150 g a.i. ha^{-1} recorded highest reduction in per cent population of mango hopper (36.55, 43.11, 49.13 and 51.19 at 3rd, 7th, 10th and 14th day after first spray, respectively) and significantly higher over pyriproxyfen 5% + fenpropathrin 15% EC @ 50 and 100 g a.i. ha^{-1}, pyriproxyfen 10% EC @ 100 g a.i. ha^{-1}, thiamethoxam 25% WDG @ 50 g a.i. ha^{-1} and dimethoate 30% EC @ 500 g a.i. ha^{-1}. The same trend was observed after second and third spray from 3 to 14 days after spray where the highest reduction in per cent population of the hopper was recorded in the treatment pyriproxyfen 5% + fenpropathrin 15% EC @ 150 g a.i. ha^{-1}. The next lowest population of hopper was recorded in the treatment pyriproxyfen 5% + fenpropathrin 15% EC @ 100 g a.i. ha^{-1} (table 2).

Pyriproxyfen acts like juvenile hormone analog and affects the hormonal balance in insects and inhibits embryogenesis, egg hatch, metamorphosis, and adult eclosion, and causes the death of the insects [12,13,14]. Fenpropathrin interferes with nerve impulse transmission by acting on sodium channels in insects. Field tests to evaluate the efficacy of some novel insecticides at different doses against whitefly and jassids infesting brinjal indicated that thiamethoxam 25 WG @ 25 g a.i. ha^{-1} was found most effective, followed by pyriproxyfen 5% + fenpropathrin 15% @ 150 g a.i. ha^{-1} and pyriproxyfen 10 EC @ 200 g a.i. ha^{-1} [15]. Foliar application with fenpropathrin and dimethoate were found to be highly effective for the control of aphids on canola, *Brassica napus*

L. [16]. Superior efficacy of fenpropathrin has been reported in bringing down the sucking insect pest population of cotton followed by dimethoate, imidacloprid and standard check acetamiprid [17]. Field-effectiveness of some novel insecticides against *Lipaphis erysimi* in mustard registered highest aphid mortalities in case of flonicamid followed by pyriproxyfen, imidacloprid and thiacloprid after first and second round of sprayings [18]. Roy *et al*. [19] also documented the excellent efficacy of pyriproxyfen 5% + fenpropathrin 15% EC against bean aphid corroborates the present findings.

Yield potentiality

All the treatments were significantly superior in increasing fruit yield as compared to untreated control during the two years (table 1 and 2). During 2015, significantly higher fruit yield (42.20 kg tree^{-1}) was recorded for treatment with pyriproxyfen 5% + fenpropathrin 15% EC @ 150 g a.i. ha^{-1} as compared to the other treatment schedules. However, no significant differences in fruit yield were recorded for insecticidal treatments with pyriproxyfen 5% + fenpropathrin 15% EC @ 100 and 150 g a.i. ha^{-1} during the year 2016.

Relative effects on natural enemies

The effect of different treatments was recorded on prevailing natural enemies in mango eco-system has been depicted in figure 1. During 2015, thiamethoxam 25% WDG showed highest percent reduction of *Chrysoperla zastrowi sillemi* (Esben-Petersen) and spider complex population (19.4% and 15.7%) respectively. Pyriproxyfen 5% + fenpropathrin 15% EC @ 50 and 100 g a.i. ha^{-1} and dimethoate 30% EC @ 500 g a.i. ha^{-1} exhibited less than 10% mortality of *C. carnea* and spider complex population during 2015. Similar results were also encountered with least non-target toxicity of pyriproxyfen 5% + fenpropathrin 15% EC @ 50 g a.i. ha^{-1} to *C. zastrowi sillemi* and spider complex population during 2016. Flonicamid followed by pyriproxyfen found as safer against *Coccinella septempunctata* (8.4-10.0% and 9.1-12.3% reduction) and *Episyrphus baltiatus* (5.2-8.4% and 6.8-10.0% reduction) in contrast to neonicotinoids (13.7-30.3% reduction) and organophosphates (18.1-41.7% reduction) [18]. The negative impact of thiamethoxam 25 WG on adult emergence, adult longevity and fecundity of *C. carnea* [20] supports the present findings. Toxicity of thiamethoxam was low to moderate to aphid parasitoid, *Aphelinus gossypii* Timberlake and was high to *Delphastus pusillus* Leconte, a white fly predator [21]. Thiamethoxam @ 50 g a.i. ha^{-1} resulted in 25.8 per cent mortality of *Oxyopes javanus* Thorell seven days after treatment in cotton [22]. Safety of pyriproxyfen to the survival of *C. carnea* adults [23] is in conformity with the present findings. Previous studies indicated a relatively higher population of predators against the insecticidal treatments of pyriproxyfen and buprofezin + fenpropathrin in the cotton ecosystem [24] are in parity with the present findings.

Honey bee toxicity

Table 3 revealed the LT_{50} values for *A. mellifera* by exposing to glass jars, treated with different insecticides concentrations. LT_{50} was 9 hrs at 1000 ppm concentration of pyriproxyfen 5% + fenpropathrin 15% EC with a fiducial limit, *p* value and standard error were 8.7-9.6, 0.67 and 0.52, respectively. LT_{50} was 10 hrs at 1000 ppm concentration of pyriproxyfen 10% EC with a fiducial limit, *p* value and standard error were 9.4-11.0, 0.42 and 0.40, respectively. LT_{50} was 4 hrs at 1000 ppm concentration of thiamethoxam 25% WDG with fiducial limit, *p* value and standard error was 2.8-5.6, 0.20 and 0.61, respectively; and LT_{50} was 5 hrs at 1000 ppm concentration of dimethoate 30% EC with fiducial limit, *p* value and standard error was 4.1-6.3, 0.09 and 0.30, respectively. LT_{50} was 96 hrs of control treatment. At 100 ppm concentration, LT_{50} increased to 21 hrs, 20 hrs, 17 hrs and 19 hrs of pyriproxyfen 5% + fenpropathrin 15% EC, pyriproxyfen 10% EC, thiamethoxam 25% WDG and dimethoate 30% EC with standard error 1.45, 1.10, 1.05 and 1.20, respectively (table 3). *Apis mellifera* was found as least affected by azadirachtin (LT_{50} 10-20 hours) followed by flonicamid (LT_{50} 9-19 hours) and pyriproxyfen (LT_{50} 8-18 hours) between 1000-100 ppm concentrations in laboratory bio-assay in contrast to thiamethoxam (LT_{50} 3-8 hours) [18]. LD_{50} of pyriproxyfen for the honey bee is more than 100 micro g/ bee [25]; hence considered as non-toxic towards it, which fully supports the present finding. The highly toxic nature of thiamethoxam both via ingestion and direct contact along with acetamiprid has been demonstrated which could irreversibly affect honey bee survival in the field [26]. However, significant mortality of *A. mellifera* from residual activity of fenpropathrin and dimethoate, when applied to citrus at 3 and 7 days after the application has been reported [27].

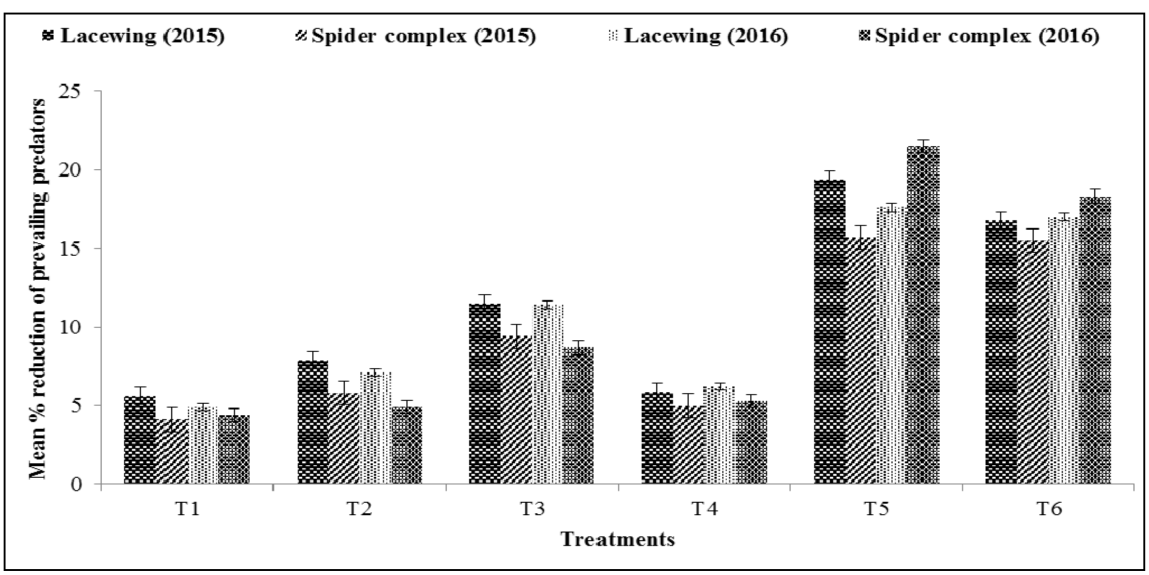

Fig 1: Relative effect of different treatment schedules of pyriproxyfen 5% + fenpropathrin 15% EC against prevailing predatory fauna in mango ecosystem during 2015 and 2016.

Table 1: Efficacy of different treatment schedules of pyriproxyfen 5% + fenpropathrin 15% EC against hopper complex of mango (cv. Amrapali) during 2015

Treatments	Dose (g a.i. ha⁻¹)	PTC (no. of motile stages 5 twigs⁻¹)	% reduction/increase (+) of hopper complex at different days after first spray				% reduction/increase (+) of hopper complex at different days after second spray				% reduction/increase (+) of hopper complex at different days after third spray				Mean % reduction of hopper population during the year 2015	Mean yield of fresh marketable mango (kg tree⁻¹)
			3 d	7 d	10 d	14 d	3 d	7 d	10 d	14 d	3 d	7 d	10 d	14 d		
T1	50	15.80 (4.04)#	36.66 (37.26)*	39.32 (38.83)	46.20 (42.82)	52.66 (46.53)	42.59 (40.74)	49.50 (44.71)	58.36 (49.81)	62.04 (51.97)	59.35 (50.39)	62.80 (52.42)	70.20 (56.91)	74.19 (59.47)	54.49 (47.58)*	29.5 (5.48)#
T2	100	19.26 (4.45)	45.50 (42.42)	58.74 (50.03)	79.91 (63.37)	85.84 (67.90)	66.48 (54.62)	77.40 (61.62)	89.12 (70.74)	95.36 (77.56)	86.72 (68.63)	95.50 (77.75)	100.00 (90.00)	100.00 (90.00)	81.71 (64.68)	40.9 (6.43)
T3	150	18.53 (4.36)	52.56 (46.47)	62.65 (52.33)	84.54 (66.85)	88.92 (70.56)	69.33 (56.37)	81.35 (64.42)	91.48 (73.03)	97.09 (80.18)	88.43 (70.11)	98.00 (81.87)	100.00 (90.00)	100.00 (90.00)	84.53 (66.84)	42.2 (6.53)
T4	100	13.95 (3.80)	39.30 (38.82)	51.25 (45.72)	69.67 (56.58)	74.55 (59.70)	54.52 (47.59)	63.19 (52.65)	72.78 (58.55)	79.10 (62.80)	71.22 (57.56)	80.11 (63.51)	87.60 (69.38)	89.25 (70.86)	69.38 (56.40)	33.8 (5.86)
T5	50	16.23 (4.09)	44.39 (41.78)	52.55 (46.46)	66.40 (54.57)	71.44 (57.70)	49.30 (44.60)	58.92 (50.14)	66.40 (54.57)	68.33 (55.75)	60.56 (51.10)	67.54 (55.27)	73.57 (59.06)	76.15 (60.77)	62.96 (52.51)	32.5 (5.75)
T6	500	21.04 (4.64)	49.08 (44.47)	59.49 (50.47)	64.29 (53.30)	62.19 (52.06)	51.56 (45.89)	64.95 (53.70)	70.59 (57.16)	61.39 (51.58)	63.81 (53.02)	72.21 (58.19)	68.44 (55.82)	65.37 (53.95)	62.78 (52.41)	30.1 (5.53)
UTC	-	18.88 (4.40)	+12.11 (0.00)	+18.04 (0.00)	+19.73 (0.00)	+16.34 (0.00)	+14.27 (0.00)	+21.41 (0.00)	+28.50 (0.00)	+24.20 (0.00)	+9.10 (0.00)	+11.32 (0.00)	+10.77 (0.00)	+14.22 (0.00)	+ 16.67 (0.00)	21.6 (4.70)
S.Em±		NS	0.06	0.11	0.45	0.39	0.14	0.82	0.32	0.27	0.11	0.30	0.44	0.69	0.26	0.34
CD (p=0.05)		NS	0.55	0.76	1.31	1.20	0.48	1.64	1.03	0.95	0.70	0.88	1.13	1.72	0.59	1.59

UTC= Untreated control; PTC= Pre Treatment Count; d= Days; #Data in these parentheses are √n + 0.5 values; *Data in these parentheses are Sin^{-1} transformed values

Table 2: Efficacy of different treatment schedules of pyriproxyfen 5% + fenpropathrin 15% EC against hopper complex of mango (cv. Amrapali) during 2016

Treatments	Dose (g a.i. ha⁻¹)	PTC (no. of motile stages 5 twigs⁻¹)	% reduction/increase (+) of hopper complex at different days after first spray				% reduction/increase (+) of hopper complex at different days after second spray				% reduction/increase (+) of hopper complex at different days after third spray				Mean % reduction of hopper population during the year 2016	Mean yield of fresh marketable mango (kg tree⁻¹)
			3 d	7 d	10 d	14 d	3 d	7 d	10 d	14 d	3 d	7 d	10 d	14 d		
T1	50	18.59 (4.37)#	28.20 (32.08)*	32.80 (34.94)	37.31 (37.65)	39.40 (38.88)	35.83 (36.77)	42.58 (40.73)	50.79 (45.45)	52.67 (46.53)	53.49 (47.00)	59.55 (50.51)	66.45 (54.60)	64.30 (53.31)	46.95 (43.25)*	31.8 (5.68)#
T2	100	24.30 (4.98)	33.59 (35.42)	39.19 (38.76)	47.10 (43.34)	50.22 (45.13)	55.23 (48.00)	69.53 (56.50)	84.17 (66.56)	87.11 (68.96)	85.30 (67.46)	94.40 (76.31)	100.00 (90.00)	100.00 (90.00)	70.49 (57.10)	39.6 (6.33)
T3	150	22.94 (4.84)	36.55 (37.20)	43.11 (41.04)	49.13 (44.50)	51.19 (45.68)	59.69 (50.59)	73.81 (59.22)	86.25 (68.23)	90.06 (71.62)	91.80 (73.36)	97.21 (80.39)	100.00 (90.00)	100.00 (90.00)	73.23 (58.84)	41.1 (6.45)
T4	100	18.33 (4.34)	30.57 (33.57)	35.89 (36.80)	44.18 (41.66)	45.37 (42.34)	48.18 (43.96)	61.82 (51.84)	75.33 (60.22)	79.75 (63.26)	76.22 (60.81)	83.28 (65.86)	87.30 (69.12)	78.68 (62.50)	62.21 (52.07)	34.5 (5.92)
T5	50	20.18 (4.55)	32.19 (34.57)	38.31 (38.24)	41.98 (40.39)	40.12 (39.30)	44.12 (41.62)	55.60 (48.22)	71.29 (57.60)	73.18 (58.81)	75.85 (60.57)	84.11 (66.51)	85.52 (67.63)	71.80 (57.93)	59.51 (50.48)	32.8 (5.77)
T6	500	23.59 (4.91)	35.06 (36.31)	40.12 (39.30)	38.58 (38.40)	34.09 (35.72)	40.56 (39.56)	53.72 (47.13)	50.50 (45.29)	45.89 (42.64)	54.66 (47.67)	65.70 (54.15)	62.67 (52.34)	55.43 (48.12)	48.08 (43.90)	29.5 (5.48)
UTC	-	17.30 (4.22)	+9.12 (0.00)	+17.20 (0.00)	+12.33 (0.00)	+14.88 (0.00)	+19.22 (0.00)	+26.44 (0.00)	+22.40 (0.00)	+20.37 (0.00)	+24.54 (0.00)	+18.20 (0.00)	+15.95 (0.00)	+21.44 (0.00)	+18.51 (0.00)	22.9 (4.84)
S.Em±		NS	0.19	0.32	0.04	0.09	0.18	0.25	0.19	0.44	0.35	0.23	0.34	0.39	0.42	0.56
CD (p=0.05)		NS	0.48	1.21	0.11	0.37	0.56	0.78	0.62	1.48	1.20	0.88	1.04	0.95	1.17	1.12

UTC= Untreated control; PTC= Pre Treatment Count; d= Days; #Data in these parentheses are √n + 0.5 values; *Data in these parentheses are Sin^{-1} transformed values

Table 3: Bio-assay in terms of LT_{50} for honey bee *Apis mellifera* under laboratory condition against different treatments used to manage mango hopper complex

Treatments	LT50 (Hours), Fiducial Limit (95%), p value, Standard Error															
	1000 ppm				500 ppm				200 ppm				100 ppm			
	LT50	F.L.	p	S.E.	LT50	F.L.	p	S.E.	LT50	F.L.	p	S.E.	LT50	F.L.	p	S.E.
Pyriproxyfen 5% + fenpropathrin 15% EC	9	8.7-9.6	0.67	0.52	13	12.5-13.2	0.16	1.10	17	16.6-17.8	0.01	1.50	21	20.8-22.0	0.02	1.45
Pyriproxyfen 10% EC	10	9.4-11.0	0.42	0.40	12	11.2-12.9	0.10	0.70	18	17.3-18.7	0.00	0.90	20	19.5-20.5	0.13	1.10
Thiamethoxam 25% WDG	4	2.8-5.6	0.20	0.61	9	7.3-10.5	0.08	0.60	12	11.0-13.3	0.00	0.81	17	16.2-17.9	0.00	1.05
Dimethoate 30% EC	5	4.1-6.3	0.09	0.30	9	7.1-10.9	0.44	0.78	13	11.9-13.5	0.02	0.95	19	18.6-19.7	0.08	1.20
Untreated control	96	-	-	-	98	-	-	-	95	-	-	-	99	-	-	-

LT_{50} = Lethal $Time_{50}$, F.L. = Fiducial Limit, S.E. = Standard Error.

Conclusion

Hence, it can be concluded that the test chemistry pyriproxyfen 5% + fenpropathrin 15% EC at medium dose i.e. 100 g a.i. ha^{-1} can be recommended to the farmers as an IPM compatible ready-mix molecule for the sustainable management of hopper complex of mango from the entomological, eco-toxicological and economic point of view. It will also enhance the choice of farming community in selecting chemicals from different groups in near future.

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