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Contact toxicity of synthetic pyrethroid insecticides to honey bees *Apis cerana indica* Fab., *Apis mellifera* Linnaeus and *Trigona iridipennis* Smith in laboratory condition

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ABSTRACT: The toxicity of insecticides was assessed to worker honey bees of Indian bee *Apis cerana indica* Fab., Italian bee *Apis mellifera* Linnaeus and Stingless bee *Trigona iridipennis* Smith by contact toxicity method and observations made recorded 6, 12 and 24 Hours after treatment (HAT) and the per cent mortality were worked out. The different treatment of insecticides *viz.,* newer formulation of bifenthrin 10 EC at 40, 80, 120 and 160 a.i. ha^{-1}, Wilthrin® 10 EC at 80 a.i. ha^{-1} and Lambda-cyhalothrin 5 EC at 25 a.i. ha^{-1} was used to determine the toxicity level and each treatment was replicated three times. Results revealed that, bifenthrin 10 EC was highly toxic to workers of all three species of honey bees tested. At 24 HAT, bifenthrin 10 EC at 160 g a.i ha^{-1} was highly toxic to honey bee which was evident from the observation of Indian bees (93.33% mortality), Italian bees (90.00%) and stingless bees (96.67%).

KEYWORDS: Insecticides, toxicity, *Apis cerana indica*, *Apis mellifera, Trigona iridipennis*

INTRODUCTION

Honey bees are the most important pollinator of many field crops, vegetables and fruit crops (Husain *et al.*, 2014) and play an important role in the creation and conservation of biodiversity (Hegde, 1999) and increases the crop yield (Chan *et al.,* 2006). For decades, pesticides used for control of crop pests have caused honey bee mortality and morbidity (Johnson *et al.,* 2010). The population decline in honey bees was detected due to unintended exposure of agricultural pesticides (Nabti *et al.,* 2014). The present investigations were undertaken to assess the safety of newer formulation of synthetic pyrethroid insecticide bifenthrin 10 EC in comparison with Wilthrin® 10 EC and lambda-cyhalothrin 5 EC on three species of worker honey bees namely Indian bee *Apis cerana indica* Fab., Italian bee *Apis mellifera* Linnaeus and stingless bee, *Trigona iridipennis* Smith under laboratory conditions. If insecticides are used in an appropriate manner, they can control the target organisms without negatively affecting the pollinator populations and also conserving the ecosystem (Davis, 1989). Hence, considering the importance of honey bees are pollinating agent on agro ecosystem we evaluated the effect of insecticides on mortality of honey bee workers.

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MATERIALS AND METHODS

According to modification of Busvine (1980) the safety of bifenthrin 10 EC to the worker bees of different bee species *viz*., Indian bee, *A. cerana indica*, Italian bee, *A. mellifera* and stingless bee, *T. iridipennis* was carried out in the laboratory by indirect contact test using filter paper (Stanley *et.al.,* 2009). The different concentration of insecticides were prepared using distilled water *viz.,* newer formulation of bifenthrin 10 EC at 40, 80, 120 and 160 g a.i. ha^{-1}, Wilthrin® 10 EC at 80 g a.i. ha^{-1} and Lambda-cyhalothrin 5 EC at 25 g a.i. ha^{-1} and each treatment was replicated thrice. Plastic containers were used for the bioassay and there were adequate perforations in the upper lid in order to provide proper aeration for the bees. The filter paper discs were cut according to the size of the plastic container. Then the filter paper discs were sprayed with one ml of different concentration of insecticides dissolved in distilled water using atomizer. The wetted filter paper discs were allowed to shade dried by hanging for about 10 minutes. The shade dried filter papers were placed in the bioassay container and honey bees were released at the rate of 10 per container. The honey bees were kept in the refrigerator for one minute prior to release so as to calm them for an easy transfer. After exposure for one hour, the bees were allowed in perforated polythene bags and were provided with 40 per cent sucrose solution soaked in cotton wool as feed. The mortality of bees was recorded at 6, 12 and 24 h after treatment and the per cent mortality was worked out as following.

$$\text{Per cent mortality} = \frac{\text{Number of honey bees dead}}{\text{Total number of honey bees released}} \times 100$$

RESULTS AND DISCUSSION

Indian bee, *A. cerana indica:*

The results of bifenthrin 10 EC on Indian bees, *A. cerana indica* is presented in Table 1. Bifenthrin 10 EC at 40 g a.i. ha^{-1} produced the least mortality

Table 1. Effect of bifenthrin 10 EC on Indian bees - *Apis cerana indica* Fabricius

Treatment	Dose (g a.i. ha^{-1})	6 HAT*		12 HAT*		24 HAT*		Mean (%)
		Per cent mortality	Corrected mortality (%)	Per cent mortality	Corrected mortality (%)	Per cent mortality	Corrected mortality (%)	
Bifenthrin 10 EC	40	26.67 (31.09) ^{b}	18.52	40.00 (39.23)^{b}	27.78	66.67 (54.74)^{b}	46.83	44.44
Bifenthrin 10 EC	80	30.00 (33.21)^{bc}	22.22	46.67 (43.09)^{bc}	35.65	73.33 (58.91)^{bc}	57.94	50.00
Bifenthrin 10 EC	120	36.67 (37.27)^{cd}	29.63	53.33 (46.91)^{c}	43.98	86.67 (68.58)^{d}	78.57	58.89
Bifenthrin 10 EC	160	43.33 (41.17)^{de}	37.04	66.67 (54.74)^{d}	60.19	93.33 (75.04)^{de}	88.89	67.78
Wilthrin® 10 EC	80	33.33 (35.26)^{bc}	25.93	50.00 (45.00)^{c}	39.81	76.67 (61.12)^{c}	63.49	53.33
Lambda-cyhalothrin 5 EC	25	50.0 (45.00)^{e}	44.44	70.00 (56.79)^{d}	64.35	96.67 (79.48)^{e}	95.24	72.22
Untreated check	-	10.00 (18.43)^{a}	0.00	16.67 (24.09)^{a}	0.00	36.67 (37.27)^{a}	0.00	21.11

*Mean of three observations; HAT- Hours After Treatment: Figures in parentheses are *arc sin*e values.
In a column means followed by a common letter are not significantly different at P = 0.05 by DMRT

Table 2. Effect of bifenthrin 10 EC on Italian bees - *Apis mellifera* Linnaeus

Treatment	Dose (g a.i. ha^{-1})	6 HAT*		12 HAT*		24 HAT*		Mean (%)
		Per cent mortality	Corrected mortality (%)	Per cent mortality	Corrected mortality (%)	Per cent mortality	Corrected mortality (%)	
Bifenthrin 10 EC	40	23.33 (28.88)^{b}	14.81	36.67 (37.27)^{b}	20.83	66.67 (54.74)^{b}	49.21	42.22
Bifenthrin 10 EC	80	26.67 (31.09)^{b}	18.52	40.00 (39.23)^{bc}	25.00	76.67 (61.12)^{bc}	64.29	47.78
Bifenthrin 10 EC	120	30.00 (33.21)^{bc}	22.22	46.67 (43.09)^{c}	33.33	83.33 (65.91)^{cde}	74.60	53.33
Bifenthrin 10 EC	160	36.67 (37.27)^{cd}	29.63	56.67 (48.83)^{d}	45.83	90.00 (71.57)^{de}	84.92	61.11
Wilthrin® 10 EC	80	26.67 (31.09)^{b}	18.52	43.33 (41.17)^{bc}	29.17	80.00 (63.43)^{cd}	69.84	50.00
Lambda-cyhalothrin 5 EC	25	43.33 (41.17)^{d}	37.04	63.33 (52.73)^{d}	54.17	93.33 (75.04)^{e}	89.68	66.67
Untreated check	-	10.00 (18.43)^{a}	0.00	20.00 (26.57)^{a}	0.00	33.33 (35.26)^{a}	0.00	21.11

*Mean of three observations; HAT- Hours After Treatment. Figures in parentheses are *arc sine* values.
In a column means followed by a common letter are not significantly different at P = 0.05 by DMRT.

of 26.67, 40.00 and 66.67 per cent at 6, 12, and 24 HAT, respectively. Recommended dose of bifenthrin 10 EC at 80 g a.i. ha^{-1} (30.00, 46.67 and 73.33%) was on par with Wilthrin® 10 EC at 80 g a.i. ha^{-1} (33.33, 50.00 and 76.67%) at 6, 12 and 24 HAT, respectively. After 24 h of exposure, all the insecticidal treatments had the highest mortality (>50%) compared to other intervals. The highest mortality was recorded in treatment lambda-cyhalothrin (50.00, 70.00 and 96.67%) at 6, 12 and 24 HAT, respectively.

Italian bee, *A. mellifera* :

Similar to Indian bees, the insecticides tested were significantly toxic to Italian bees (Table 2). The per cent mortality of bees were ranged between 10.00 to 43.33 at 6 HAT and 20.00 to 63.33 at 12 HAT. After 24 h treatment, the bifenthrin 10 EC at 40 g a.i ha^{-1} recorded 66.67 per cent mortality followed by bifenthrin 10 EC at 80 g a.i ha^{-1} (76.67%), Wilthrin® 10 EC at 80 g a.i ha^{-1} (80.00%), bifenthrin 10 EC at 120 g a.i ha^{-1} (83.33%) and bifenthrin 10 EC at 160 g a.i ha^{-1} (90.00%). The maximum mortality of 93.33 per cent was observed in lambda-cyhalothrin 5 EC at 25 g a.i. ha^{-1} at 24 HAT.

Stingless bee, *T. iridipennis:*

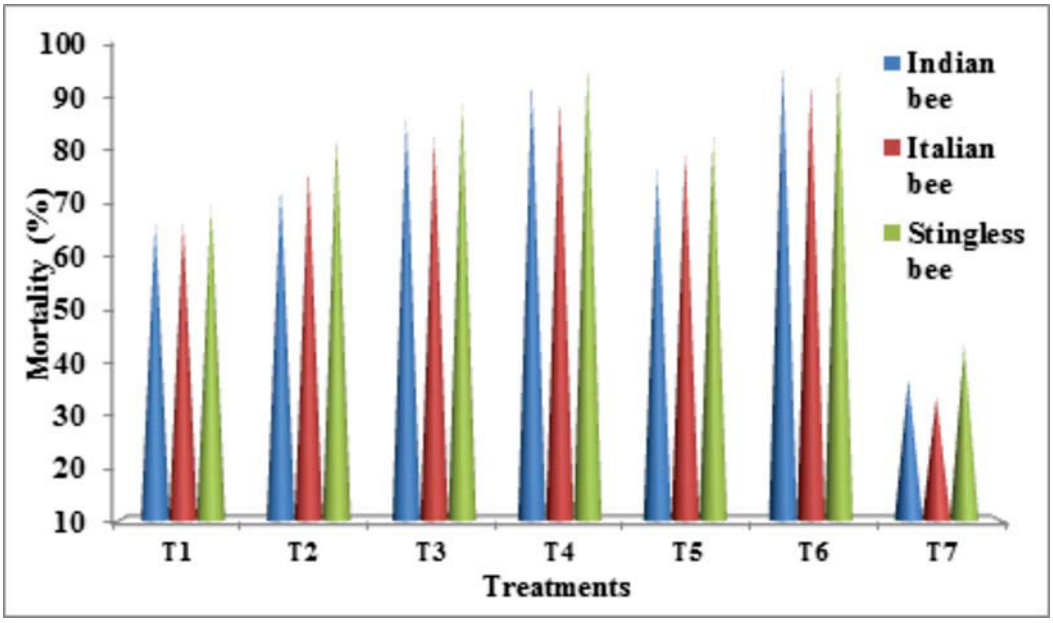
In case of stingless bees also, significant mortality was observed with bifenthrin 10 EC. The bifenthrin 10 EC at 40, 80, 120 and 160 g a.i. ha^{-1} recorded 26.67, 36.67, 50.00 and 56.67 per cent mortality at 6 HAT, respectively (Table 3). At 24 HAT, the honey bee mortality was observed in bifenthrin 10 EC at 40 g a.i ha^{-1} (70.00%) followed by bifenthrin 10 EC at 80 g a.i ha^{-1} (83.33%) which was on par with Wilthrin® 10 EC at 80 g a.i ha^{-1} (83.33%) and maximum per cent mortality was observed in lambda-cyhalothrin 5 EC at 25 g a.i ha^{-1} (96.67%).

The insecticidal effects on non-target organisms can be cat-egorized as harmless (<50% mortality), slightly harmful (50 to 79% mortality), moderately harmful (80 to 89% mortality) and harmful (>90% mortality) when test-ed at the field recommended

Table 3. Effect of bifenthrin 10 EC on stingless bees - *Trigona iridipennis* Smith

Treatment	Dose (g a.i. ha^{-1})	6 HAT*		12 HAT*		24 HAT*		Mean (%)
		Per cent mortality	Corrected mortality (%)	Per cent mortality	Corrected mortality (%)	Per cent mortality	Corrected mortality (%)	
Bifenthrin 10 EC	40	26.67 (31.09)^{ab}	11.57	46.67 (43.09)^{b}	30.36	70.00 (56.79)^{b}	46.67	47.78
Bifenthrin 10 EC	80	36.67 (37.27)^{bc}	24.07	53.33 (46.91)^{b}	38.69	83.33 (65.91)^{c}	71.11	57.78
Bifenthrin 10 EC	120	50.00 (45.00)^{cde}	39.81	66.67 (54.74)^{cd}	56.55	90.00 (71.57)^{cd}	83.33	68.89
Bifenthrin 10 EC	160	56.67 (48.83)^{de}	47.69	76.67 (61.12)^{de}	69.64	96.67 (79.48)^{d}	93.33	76.67
Wilthrin® 10 EC	80	40.00 (39.23)^{bcd}	27.31	56.67 (48.83)^{bc}	43.45	83.33 (65.91)^{c}	70.00	60.00
Lambda-cyhalothrin 5 EC	25	60.00 (50.77)^{e}	51.39	80.00 (63.43)^{e}	74.40	96.67 (79.48)^{d}	94.44	78.89
Untreated check	-	16.67 (24.09)^{a}	0.00	23.33 (28.88)^{a}	0. 00	43.33 (41.17)^{a}	0.00	27.78

*Mean of three observations; HAT- Hours After Treatment. Figures in parentheses are *arc sine* values. In a column means followed by a common letter are not significantly different at P = 0.05 by DMRT.



T_1- Bifenthrin 10 EC 40 g a.i. ha^{-1}
T_2- Bifenthrin 10 EC 80 g a.i. ha^{-1}
T_3- Bifenthrin 10 EC 120 g a.i. ha^{-1}
T_4- Bifenthrin 10 EC 160 g a.i. ha^{-1}
T_5- Wilthrin® 10 EC 80 g a.i. ha^{-1}
T_6- Lambda- cyhalothrin 5 EC 25 g a.i. ha^{-1}
T_7- Untreated check

Fig. 1. Effect of bifenthrin 10 EC on three species of honey bees at 24 Hours after Treatment (HAT)

dose (Nasreen *et al*., 2007). In the present studies the effect of bifenthrin 10 EC was harmful to all three species of worker honey bees. The higher dose of bifenthrin 10 EC at 160 g a.i. $ha^{-1}$was highly toxic to honey bees which was evident from the observations of Indian bee (93.33% mortality), Italian bee (90.00%) and stingless bee (96.67%) at 24 h after treatment (Fig 1). Lambda-cyhalothrin was also equally toxic to honey bees as that of bifenthrin. After 24 h of exposure, all the insecticidal treatments had the highest mortality (>40%) compared to other intervals. The present findings agree with Thomazoni *et al.* (2009) who reported cent per cent mortality to honey bee workers in Talstar® 100 EC at 1000 ml ha^{-1}. Earlier, Ellis *et al.* (1997) also found honey bees exhibiting greater susceptibility to bifenthrin under laboratory conditions. Gough and Wilkinson (1984) observed that lambda-cyhalothrin had higher contact toxicity to honey bees. Husain *et al.* (2014) observed bifenthrin was highly toxic to honey bees (*A. dorsata, A. florea* and *A. mellifera*) with low LT_{50}. Also Rigotti (2005) found that pyrethroids caused cent per cent mortality of honey bee adults under laboratory condition. Similarly, Dai *et al.* (2010) observed that pyrethroids including bifenthrin were highly toxic to honey bees. Since bifenthrin 10 EC at recommended doses proved toxic to bees, the application should be resorted to in hours of low bee activity in field.

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