International Archive of Applied Sciences and Technology
Int. Arch. App. Sci. Technol; Vol 10 [3] September 2019 : 76-80
© 2019 Society of Education, India
[ISO9001: 2008 Certified Organization]
www.soeagra.com/iaast.html

IAAST
ONLINE ISSN 2277- 1565
PRINT ISSN 0976 - 4828

CODEN: IAASCA ORIGINAL ARTICLE

DOI: .10.15515/iaast.0976-4828.10.3.7680

Variable susceptibility of honeybee species *Trigona irridipennis* (smith) and *Apis mellifera* (linn.) to Dimethoate 30%EC

M. Saravanan*, T.Jeyalakshmi, and J. Kannadasan,
Department of Entomology, International Institute of Biotechnology and Toxicology, IIABT, Kancheepuram District,Padappai-601 301. , Tamil Nadu, India)
*Corresponding Author:Email: saravzoology@gmail.com

ABSTRACT
In order to assess the toxicity difference between two honeybee species, a laboratory assay was conducted through oral exposure with, Dimethoate 30% EC to the common honeybee species, Apis mellifera and the stingless bee Trigona irridipennis as per OECD guideline. Different concentrations of the test product were prepared in 50% sucrose solution and provided to the bees with a dosing volume of 200µL/10 bees. After a maximum period of 6 hours, the test diets were replaced with sucrose solution (50%). Based on the weight difference of the feeder unit before and after exposure, the amount of treated diet /group of 10 bees were calculated and expressed as µg dose (dimethoate 30% EC) per bee. Observations for toxic signs and mortality were observed at 24 and 48 hours after dosing. The results of the study indicated that Dimethoate 30% EC recorded LD_{50} of 0.020 and 0.017µg /bee to Trigon airridipennis, at 24 and 48 hrs after dosing, respectively. Similarly, LD_{95}-24h and 48h were observed to be 0.059 and 0.051 µg /bee, respectively. The LD_{50} for Apis mellifera was observed as 0.321 and 0.304µg/bee at 24 and 48 hrs after treatment, respectively and $LD_{95}$was observed as0.408 and 0.434µg/beeat 24 and 48 hrs after treatment. The test item is about twelvefold more toxic to Trigona irridipennis than Apis mellifera. The lower LD_{50} recorded by Trigona irridipennis results revealed that the sensitivity of the species to the insecticide when compared to Apis mellifera which is a globally recommended species for bee toxicity at laboratory.
Keywords: *Dimethoate 30% EC, Honeybee toxicity, Trigona irridipennis, Apis mellifer, LD_{50}, LD_{95},*

Received 26.03.2019 Revised 23.05.2019 Accepted 03.06.2019

CITATION OF THIS ARTICLE
M. Saravanan, T.Jeyalakshmi, and J. Kannadasan. Variable susceptibility of honeybee species *Trigona irridipennis* (smith) and *Apis mellifera* (linn.) to Dimethoate 30%EC. Int. Arch. App. Sci. Technol; Vol 10 [3] September 2019 : 76-80

INTRODUCTION

Honey bees owing to its pollinating activity cater about one-third of the world's food supply. More than 50 major crops depend on these insects for pollination. Among the various bee species, stingless bees to which several medical uses are attributed apart from being effective pollinator are known for its valuable bee product with a long consumption tradition. Conversely, the bees become victimized to the plant protection chemicals which are unavoidable for the crop protection.The route of exposure of pesticides to the honeybee workers being oral and contact and the effect of the insecticides varies with the bee species. The honeybee *Apis mellifera* is valuable for the economy due to its hive by-products (honey, pollen, royal jelly) which generate considerable income for beekeepers. Honeybees also contribute to plant biodiversity by pollinating wild plants. Honeybees and their products are potentially exposed to several contaminants present in the environment, such as chemical products released into the hive to fight diseases and parasites, and pesticides used in agriculture against pests [1].

The stingless bee has size smallerto the honey bee *Apis mellifera* L., 1758 and its colonies are maintained in "meliponaries", that are similar to apiaries. The hive of *Trigona irridipennis* is comprised of comb shaped overlapping disks surrounded by pots of food and its managed is similar to that of the honey bee. Besides its ecological importance as pollinators of native plants in India, *T.irridipennis* is considered a promising pollinator species for rearing on a large scale, to use in protected or field crops, due its ease of maintaining strong hives, which can be easily transported and multiplied. As trace amounts of Dimethoate 30% EC may be present in the
pollen and nectar of the treated plants, the intoxication of bees through feeding is one possibility. Thus, the aim of this work were to determine thevariable susceptibility of lethal concentration (LD_{50} and LD_{95} at 24 h and 48 h) of the insecticide Dimethoate 30%EC for *Trigona irridipennis* foragers and to assess whether the *Trigona irridipennis* honey bee is a good model for toxicological studies, considering the diversity of Indian stinglessbees. However, due to the accessibility of crops or the proximity of crops to native field areas, *T.irridioennis* is vulnerable to anthropic actions. One cause of increased mortality rates of these bees is insecticide poisoning [2]. This stingless bee has size similar to the honey bee *A. mellifera* L., 1758 and its colonies are maintained in the *A. mellifera* honey bee is a good model for toxicological studies, considering the diversity of Indian stingless bees.Hence knowledge and understanding of toxicity of the commonly used plant protection chemicals on different medically important bee species is essential which may help us to alter the usage pattern of insecticides in the field.

MATERIALS AND METHODS

The oral toxicitystudy was performed as described in the European and Mediterranean Plant Protection Organization [EPPO 1998) and The Organization for Economic Co-operation and Development (OECD 1998) Guidelines for the Testing of Chemicals, Honey bees, Acute Oral Toxicity Test (OECD 213 1998), forager adult worker bees of the same species wereused for oral toxicity. Honeybees were obtained from adequately fed, healthy, disease-free, andqueen-right colonies. Treated honeybees were held in metal cages with the size of 10 cm x 15cm x 8cm (length × width × height). Removable glass sheet in front side and perforated with ventilation holes were used in parts of the cage. Treatment doses were preparedby usingsucrosesolution in water (50% w/v). The honeybees were starved for up to 2 hours before the initiation of the test. Three replications (cages) were used in each treatment and the control. In each cage, 10 worker honeybees were transferred from hive by creating smoke using coconut coir. Before main test, arange finding test was conducted with three concentrations (0.078, 0.108 and 0.128) for *Apis mellifera* and five concentrations (0.005, 0.012, 0.015, 0.033 and 0.045) for *Trigona irridipennis* using Dimethoate 30%EC and control (50% sucrose solution). Based on the range finding test, dosages for main experiment was fixed as 0.220, 0.304 and 0.361µg /bee for *Apis mellifera* and 0.013, 0.035, 0.042, 0.093 and 0.128 µg /beefor *T. Irridipennis*. Since mortality of honeybees did not exceeded more than 10% between doses, he experiments were not prolonged. After a 6 hour of dosing the feeder unit were removed from the cages and post weighed. All honeybees were fed with sucrose solution in water (50% w/v), *ad libitum*. Honeybee mortality wasrecordedat 24, and 48h after the start of the test. The tests were performed in a dark room at a temperature of 25±2° C and55 - 65% relative humidity [3-5]. Probit analysis was used to calculate the LD_{50} and $LD_{95}$of the test item using statistical package SAS 9.3.

RESULTS AND DISCUSSION

Theresults of the Dimethoate 30%EC indicatedthat the Dimethoate 30%EC doses viz., 0.078, 0.304 and 0.361µg/bee recordedmortalitiesof 0, 37&77% at 24h and 7, 47 &80%at 48h after treatment respectively for *Apismellifera*. Whereas in *T. irridipennis* the doses0.013µg/bee and 0.035µg /bee recorded 36.7&66.7% at 24 hrs and 46.7& 80.0% at 48 hrs. At 24hrs, 93.3% and 100% mortality were observed at the maximum doses of0.042 and 0.093µg /bee respectively Figure 1&2.The $LD_{50}$of Dimethoate 30% ECat24 and 48 hafter treatment to *T. irridipennis* was0.019and 0.016µg/bee, respectively.Similarly, the$LD_{95}$was calculated as0.059 and 0.052 µg/beeat 24 and 48 h after treatment, respectively.The LD_{50} of Dimethoate 30% EC to *A.mellifera* bees was 0.322 and 0.305µg

/bee at 24 and 48 h of treatment,respectively.TheLD_{95} was observed as 0.408 and 0.433µg /bee at 24 and 48 h after treatment, respectively. The resultsshowing that *T. Irridipennis*are more sensitive to Dimethoate 30%EC than the Africanized honey bees *A. mellifera* Table 1& 2.

This difference in the responses of various bee species to insecticide exposure was previously described by [6]. Changes in pesticide susceptibility among bee species were also observed by several authors [7]. Most of the results indicating that the honey bee *A. mellifera* was more tolerant to insecticides in comparison with species of stingless bees.

Figure 1Comparison of Acute oral toxicity of Dimethoate 30% EC to *A. mellifera* and *T.irridipennis*

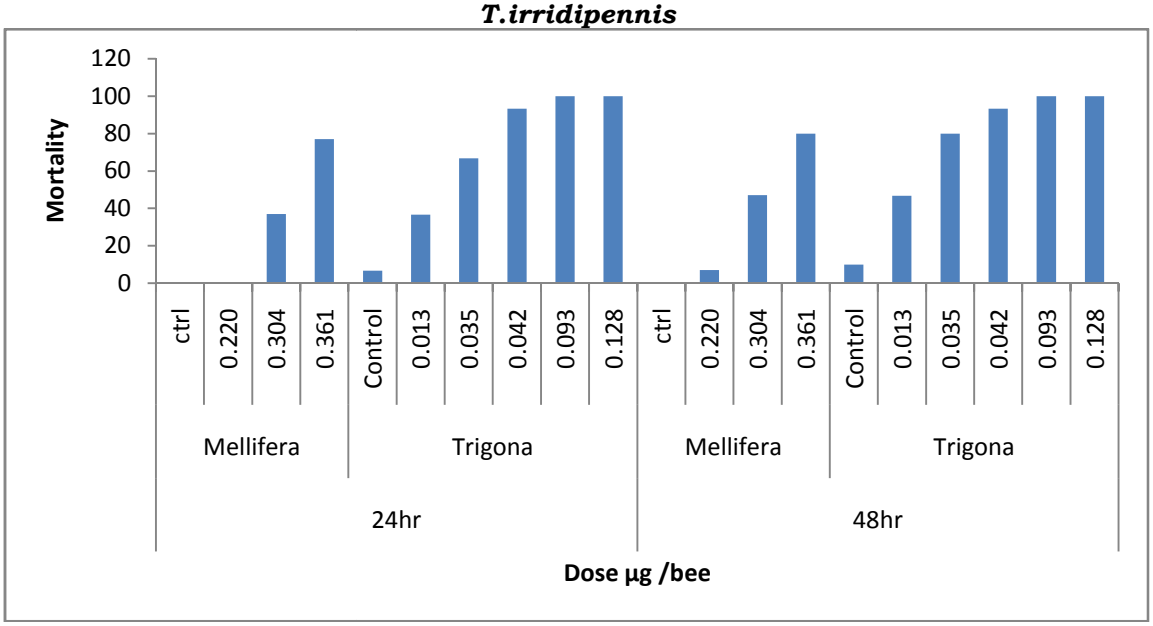
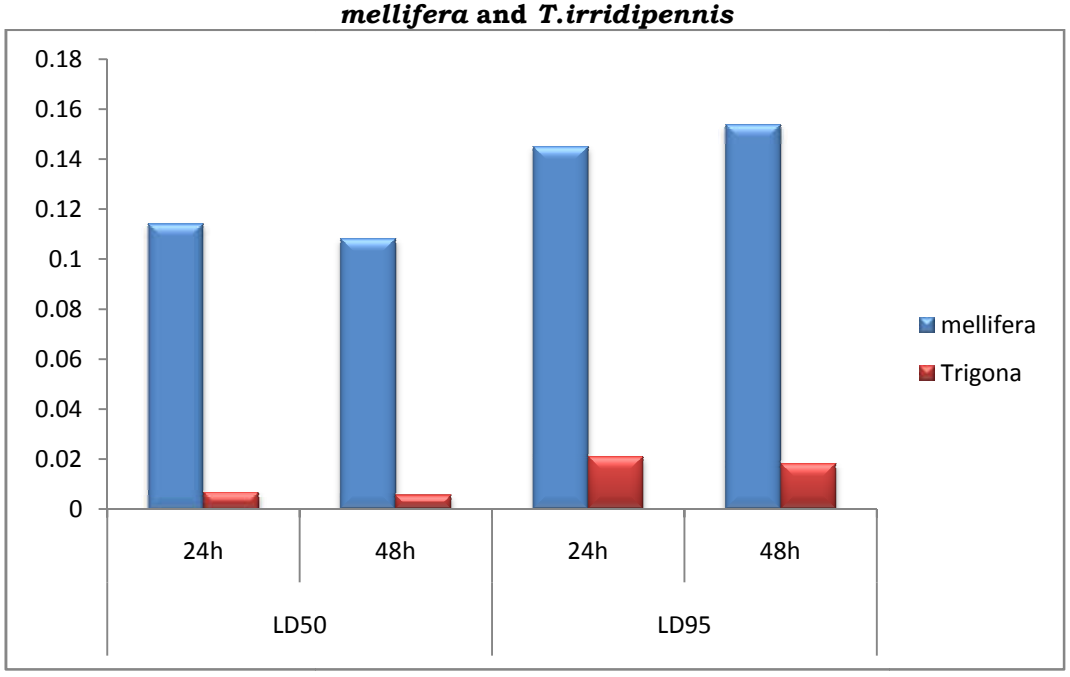


Figure2 Comparison of oral LD_{50} and $LD_{95}$of Dimethoate 30% EC to foragers to*A. mellifera* and *T.irridipennis*



Furthermore, studies with the *A. mellifera* honey bee showed that sublethal doses of Dimethoate 30% EC can also be of concern because changes in behavior, such as in feeding and foraging, can affect the entire colony [8]. These findings reinforcedthe notion that wild bees are a pollinating group at high risk for pesticide exposure and toxicity [9].The highest

concentrations of Dimethoate 30% EC used in this work (0.304 and 0.361µg a.i/bee based on consumption) resulted in mortality rates of 37.0 % and 77.0 %, respectively, following 24 h of exposure. After 48 h, at the highest concentrations of Dimethoate 30% EC resulted in 80 % mortality.Where as in *T. Irridipennis*0.042µg /bee and 0.093µg /bee 93.3% and 100% mortality after 48hrs in both the concentrations observed 100% mortality.When the lethal or behavioral effects of insecticides are replicated in bees under laboratory conditions, the greaterimpact of the pesticide under natural conditions is highlighted. Thus, it is important to establish limits on pesticideuse, considering the consequences on biodiversity, economic losses from beekeepers and crop producers, and theawareness of society concerning the pesticides in environmental [10]. The use of diverse pollinator species in toxicological studies allows a better understanding of the spectrum of bee responses. This is especially important when compared the results of non-Apis bee with those of the current model *A. mellifera* [9]. In this way, new studies on *T.irridepennis* behavior contamination with sublethal doses of Dimethoate 30%EC are being conducted.It is concluded from the present study that the non-Apis species, *T.irridepennis* is more sensitive to xenobiotic than the common honeybee species, *Apis mellifera*. Hence, the stingless bee, *T.irridepennis* can also be used as a good model for ecotoxicological studies.

Table 1:Toxicity effect of Dimethoate (30% EC)on *Apis mellifera* and *Trigona irridipennis* after 24 hrs treatment

Species	Dose	% of Mortality* (mg/L) ± SE	LC_{50}±SE (mg/L)	UCL-LCL (mg/L)	LC_{95}±SE (mg/L)	UCL-LCL (mg/L)	x^2 (df=1)
Apis mellifera (Control)	Control	0.0 ± 0.0	0.114	0.121 - 0.108	0.145	0.178 – 0.134	0.6404
	0.078	0.0 ± 0.0					
	0.108	36.7 ± 8.8					
	0.128	76.7 ± 3.3					
Trigona irridipennis (Experiment)	Control	6.7 ± 6.7	0.0069	0.0101 – 0.0025	0.0211	0.1304 – 0.0134	0.0016
	0.005	36.7 ± 3.3					
	0.012	66.7 ± 14.5					
	0.015	93.3 ± 6.7					
	0.033	100 ± 0.0					
	0.045	100 ± 0.0					

Table 2:Toxicity effect of Dimethoate (30% EC)on *Apis mellifera* and *Trigona irridipennis* after 48hrs treatment

Species	Dose	% of Mortality* (mg/L) ± SE	LC_{50}±SE (mg/L)	UCL-LCL (mg/L)	LC_{95}±SE (mg/L)	UCL-LCL (mg/L)	x^2 (df=3)
Apis mellifera (Control)	Control	0.0 ± 0.0	0.108	0.116 – 0.101	0.154	0.192 – 0.138	0.6952
	0.078	6.7 ± 3.3					
	0.108	46.7 ± 3.3					
	0.128	80.0 ± 5.8					
Trigona irridipennis (Experiment)	Control	10.0 ± 5.8	0.0056	0.0064 – 0.0046	0.0183	0.0230 – 0.0155	0.2481
	0.005	46.7 ± 12.0					
	0.012	80.0 ± 11.5					
	0.015	93.3 ± 6.7					
	0.033	100 ± 0.0					
	0.045	100 ± 0.0					

Abbreviation: **Dose – Based on actual consumption, *LC_{50}***:lethal concentration that kills 50% of the exposed larvae, ***LC_{95}***:lethal concentration that kills 90% of the exposed larvae. **UCL**:upper confidence limit, **LCL**:lower confidence limit, **x^2**: chi-square, ***df***: degree of freedom.

ACKNOWLEDGEMENT

Authors wish to thank the management and Scientific Academic Board (SAB), IIBAT for their constant encouragement and providing the test facility for conduction of the experiment.

REFERENCES

1. Aliouane Y, Hassani A, Gary V, Armengaud C, LambinM,Gauthier M. (2009) Subchronic exposure of honeybees to sublethal doses of pesticides: effects on behavior. EnvironmentalToxicology and Chemistry 28(1); 113-122.
2. Johnson R (2010) Honey bee colony collapse disorder. CRS, Washington.
3. Laurino D, Manino A, Patetta A, Ansaldi M, Porporato M. (2010). Acute oral toxicity of neonicotinoids on differentbee strains. Redia93; 99-102.
4. Laurino D, Manino A, Patetta A, Ansaldi M, Porporato M. (2011) Toxicity of neonicotinoid insecticides to honey bees: laboratory tests. Bulletin of Insectology64; 107- 113.
5. Laurino D., Manino A., Patetta A., Ansaldi M., Porporato M. (2013) Toxicity of neonicotinoid insecticides on different honey bee genotypes. Bulletin of Insectology66(1): 119-126.
6. Desneux N, Decourtye A, Delpuech JM (2007) The sublethal effectsof pesticides onbeneficial arthropods; Annu Rev Entomol52:81–106.
7. Nocelli RCF, Malaspina O, Carvalho SM, Lourenc¸o CT, Roat TC, Pereira AM, Silva-Zacarin ECM (2012) Bees and frogs. In: Imperatriz-Fonseca VL, Canhos DAL, Saraiva AM Pollinators in Brazil-contribution and perspectives for biodiversity, sustainable use, conservation and environmental services. EDUSP, Sao Paulo.
8. Colin ME, Bonmatin JM, Moineau I, Gaimon C, Brun S, VermandereJP (2004) A method to quantify and analyse the foraging activity of honey bees: relevance to the sublethal effects induced by systemic insecticides. Arch Environ ContamToxicol47: 387–395.
9. Brittain CA, Vighi M, Bommarco R, Settele J, Potts SG (2010)Impacts of a pesticide on pollinators species richness at different spatial scale. Basic ApplEcol11:106–115.
10. Pham-Dele`gue MH, Decourtye A, Kaiser L, Devillers J (2002) Behavioural methods to assess the effects of pesticides on honeybees. Apidologie33:425–432.
11. Brittain C, Potts SG (2011) The potential impacts of insecticides onthe life-history traits of bees and the consequences for pollination. Basic Appl. Ecol.12:321–331.