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IMPACT OF BOTANICAL INSECTICIDES ON THE STINGLESS BEES, *TETRAGONULA IRIDIPENNIS* S. AND THE HONEY BEES, *APIS MELLIFERA* L. ADULTS BEES (HYMENOPTERA: APIDAE)

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ABSTRACT
Among the six botanical insecticides (Garlic Oil, Zatropha Oil, Emamectin, NSKE, Azwain Oil and Neem Oil) tested for*T. iridipennis*, the peak mortality was obtained due to exposure of Garlic oil (90%) and Neem oil (90%) while NSKE (70%) showed least toxicity to bees after 3 days of exposure. In case of *A. mellifera* also, the Garlic oil (100%) and Neem oil (93.34%) were found to cause peak mortality but Zatropha oil (76.67%) proven least toxic to bees

INTRODUCTION

One third of human food comes from plants pollinated by bees, making the study on bees important to ensure food safety and security (Ashman *et al*., 1999 and Biesmeijer *et al*., 2006). Bees are reported to pollinate over 70 percent of the world crops **(**Johnson and Hubbell, 1974**)** showing the importance of bee pollination in our ecosystem and agro-ecosystem. In *Brassica juncea,*bee pollinators were found to increase number of pod and percent pod set(Goswami and Khan, 2014).Over the synthetic insecticides, botanical insecticides present some advantages for safety of bees and other pollinatorsdue totheir fast degradation, mainly under high luminosity, temperature and humidity (Tsuzuki *et al*., 2000 and Matos Neto *et al.,* 2004). Meena *et al*. (2013)reported that tobacco, onion, neem seed kernel extract @ 5%, cow urine @50 lit/ha are safe for pollinators and insect's natural enemies.Never theless, even though these botanicals are of natural origin but prior to their application in field, the safety margin for the non-target organisms, such as bees, should be known. Therefore, the present paper deals to evaluate the impacts of the some botanical insecticides i.e. Garlic oil, Neem oil, NSKE, Azwain oil, Emamectin and Zatropha oil on survival of adult bees of *T. iridipennis* and *A. mellifera* and assessing their toxicities.

MATERIALS AND METHODS

The bioassays were conducted in Department of Entomology, GBPUA&T, Pantnagar in 2014. Adult bees of the species *T. iridipennis* and *A. mellifera* were collected from hived colonies at Apiary. The treatments were the six botanical insecticides and the control. For experiment, only those concentrations of botanical insecticides were selected which are recommended and generally used in pest management (Ashman, 1999**)**. The respective concentrations of insecticides were: garlic oil – 10ml/500ml, Zatropha oil - 5ml/L, Azwain oil - 10ml/500ml, Neem oil - 5ml/L, Neem seed kernel extract(NSKE) – 5% and Emamectin 20gm/ L. All the oils concentrations were prepared in 25% tepol solution while the NSKE and Emamectin concentrations were prepared using distilled water.In the control, only 25 % tepol was applied.

The experimental design was completely randomized, with three replications.For *T. iridipennis*, each experimental plot was formed by one Petri dish (9 cm diameterx 2 cm height) and for *A. mellifera,* experiments were plotted in 500ml capacity glass beakers. All experiments were performed with 10 bees in replications (Fig.1). To perform the bioassays, leaves of *bottle gourd,Lagenaria siceraria* (Cucurbitaceae) were used due to the importance of bees in the pollination of Cucurbitaceae and the current use of botanical insecticides in these crops (Santos *et al*.,2008**)**. The leaves were immersed in an aqueous solution containing each botanical insecticide at the concentrations mentioned for one minute. The leaves were placed to dry in the shade at room temperature for 2 minutes and then were placed into Petri dishes. Two plastic containers were placed inside the Petri dishes: one containing honey and the other, water(Xavier *et al*.,2010**)**. In the control, the leaves were immersed in 25% tepol. One, two, three and four days after the assembly of the bioassays, the dead insects per experimental unit were counted. The insects that had lost

motor coordination were considered dead.The mortality which occurred in the treatments was corrected by the mortality found in the control, with the use of the Abbott (1925) formula.The data of the corrected mortality of the last date of evaluation (on the fourth day) for each bee species were submitted to the analysis of variance and the averages of the treatments were used to calculate percent mortality in each treatment.

RESULTS AND DISCUSSION

The different botanicals showed significant toxicity against bees in comparison of control.The data regarding the % mortality of *T. iridipennis* kept in group of 10/treat/replications is presented in Table 1. The highest toxicity was obtained in Garlic oil and Neem oil ranging from 46.67%, 76.67%, 90% and 40%, 63.34%, 90% for 1st, 2nd and 3rd days after treatment, respectively followed by Azwain oil, Zatropha oil and Emamectin which showed43.34%, 66.67%, 86.67%; 40%, 63.34%, 83.35% and 26.67%, 46.67%, 83.34% mortality for 1st, 2nd and 3rd days after treatment, respectively. The NSKE showed least toxicity to bees showing 43.34%, 60% and 70% mortality for 1st, 2nd and 3rd days after treatment, respectively. In all the treatments, 100% mortality of bees occurred on day 4 after treatment.

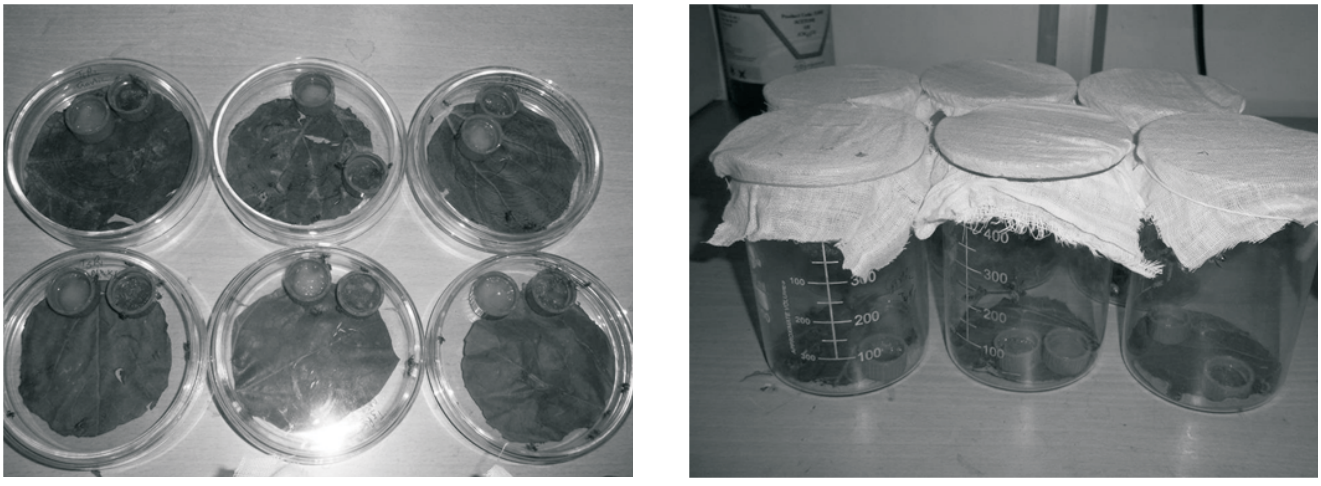
In case of *A. mellifera* also, the Garlic oil and Neem oil showed highest mortality 50%, 70%, 100% and 53.30%, 63.34%, 93.34%, respectively on 1st, 2nd and 3rd days after treatment, followed by NSKE (44%, 60%, 90%), Azwain oil (40%, 60%, 83.34%) and Emamectin (33.34%, 53.34%, 83.34%), respectively. The Zatropha oil showed least toxicity to honey bees showing 40%, 50% and 76.67% mortality for 1st, 2nd and 3rd days after treatment, respectively. All the tested botanicals caused complete mortality of bees within four days.

Koskor (2009) reported that even sublethal doses of Neem EC affect the pollen for agging capacity of *Bombu sterrestris*.Xavier *et al.* (2010) reported that garlic extract, neem oil and rotenone were not toxic to *Tetragonula angustula* and *Nannotrigona testaceicornis*. The most toxic insecticide to the *T. angustula* was citronella oil and the least toxic was andiroba oil. Eucalyptus oil and neem oil presented intermediate toxicity for *T. angustula*. Oliveira *et al.* (2012) found that for *Trigona spinipes*, the extracts of *Azadiracha indica* at concentrations of 3% and 7% produced 62.2 and 68.89% survival, respectively, *Anonna squamosa*at concentration of 10% produced 68.89% survival and green leaf of *Ricinus communis* at concentration of 7% produced 63% survival. This indicates that bees may transport residues of these toxic products on their bodies to the hives while visiting on insecticide treated flora and these might have a toxic action

Table 1: Response of stingless bee, *T. iridipennis* and honey bees,*A. mellifera* workers to their exposure to various botanicals

Treat.	Dose/conc.	Percent (%) mortality of workers bees after hrs exposure							
		Tetragonula iridipennis				*Apis mellifera*			
		24 hrs.	48 hrs.	72 hrs.	96 hrs.	24 hrs.	48 hrs.	72 hrs.	96 hrs.
Garlic Oil(T1)	10ml/500ml of 0.25% Tepol	46.67	76.67	90	100	50	70	100	100
Zatropha Oil(T2)	5ml/L of 0.25% Tepol	40	63.34	83.35	100	40	50	76.67	100
Emamectin(T3)	20gm/L of 0.25% Tepol	26.67	46.67	83.34	100	33.34	53.34	83.34	100
NSKE(T4)	5%	43.34	60	70	100	44	60	90	100
Azwain Oil(T5)	10ml/500ml of 0.25% Tepol	43.34	66.67	86.67	100	40	60	83.34	100
Neem Oil(T6)	50 ml/L of 0.25% Tepol	40	63.34	90	100	53.30	63.34	93.34	100
Control(T7)	-	-	-	6.67	10	-	-	2.31	7.34
SEM (±)		0.587	0.9981469	0.6965510	-	0.3600415	0.2018422	0.4906543	-
CD at 5%		1.849NS	3.144295NS	2.194228 NS	-	1.134178NS	0.6358296**	1.545626NS	-

SEM : Standard Error of Mean; NS : Non-significant; **: Significant



a) Stingless bees, *T. iridipennis* **b) Honey bees, *A. mellifera***

Figure 1: Experiment plotted for response of stingless bee, *T. iridipennis* and honey bees, *A. mellifera* workers to their exposure to various botanicals

on the young bees also. Thus, in opposition to general belief, botanical insecticides may also present a deleterious effect on bees, similar to organo synthetic insecticides although they took several hours to present toxic activity on adult bees. The problem can be solved by applying insecticides at evening hours or blocking the entrance gate of hive while applying insecticides.

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